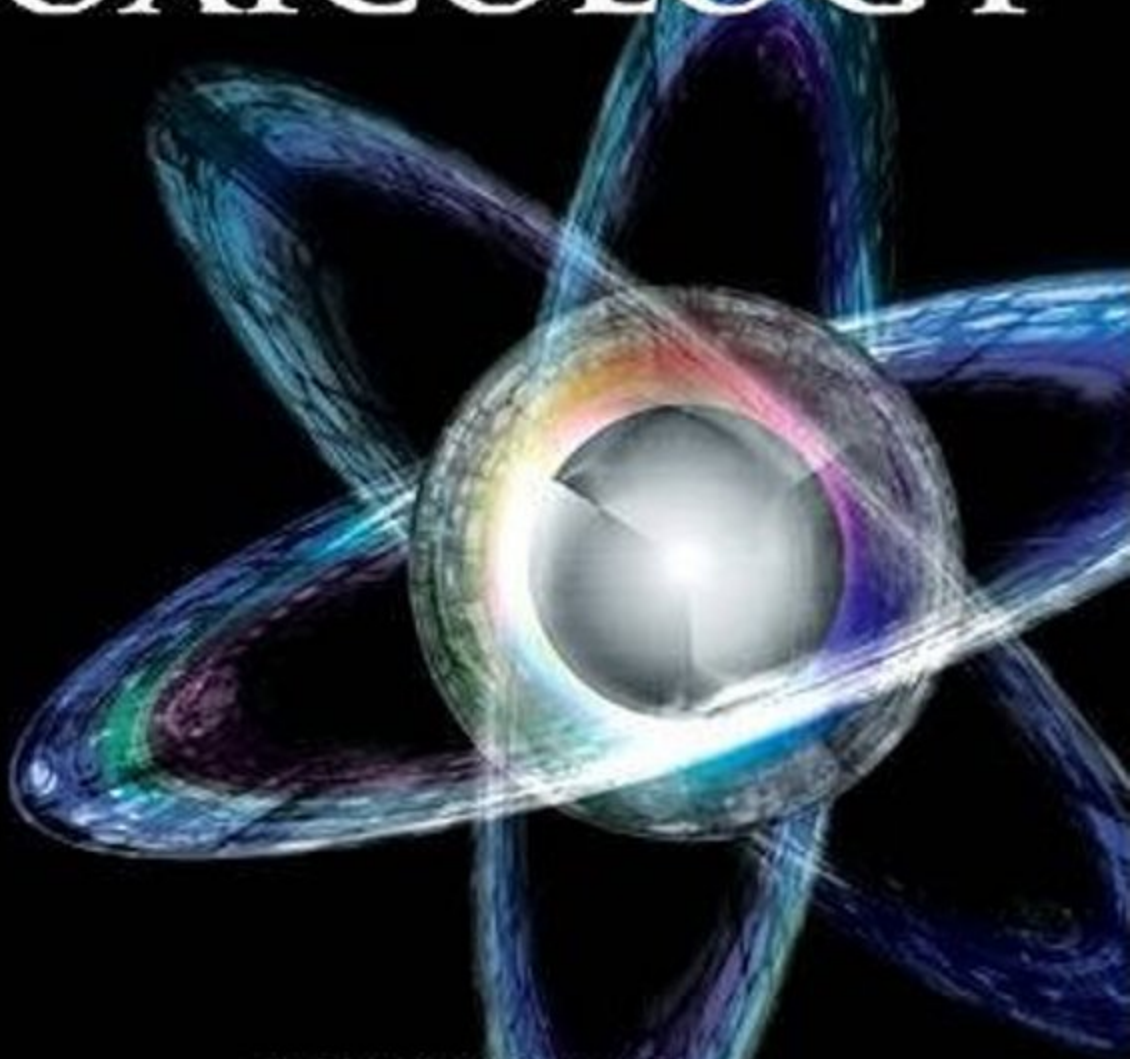
FOURTH EDITION

INFORMATION RESOURCES IN TOXICOLOGY



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For my parents, Yetty and Will,
my son, Jake,
and Nancy,
with love, appreciation, and respect

and in loving memory
of my pets,
Chi-Chi and Hercules

Concerning the oft forgotten wherefore of toxicology:

And even in our times it is said, venomous animals poison the water after the setting of the sun, so that the good animals cannot drink of it, but in the morning after the sunrise, comes the unicorn and dips his horn into the stream driving away the poison from it . . . this I have seen for myself.

—John of Hesse

Concerning the difficulty of coherently structuring information:

One day the devil and a friend were taking a stroll when they saw a man bend down and pick up something from the ground. He looked at it carefully and put it away in his pocket. The friend asked the devil, 'What did that man pick up?' 'He picked up a piece of the Truth,' answered the devil. 'That is unfortunate for you,' said his friend. 'On the contrary,' the devil replied, 'I am going to let him organize it.'

—Paraphrased from a talk given by Krishnamurti

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Foreword

Toxicology, like other sciences, has developed in phases. Toxicologists, however, claim that the initial phase of our discipline preceded that of most other biological sciences since it involved recognition by primitive man of the safe and dangerous agents in his environment. The next phase (antiquity and the Middle Ages) was characterized by the use of this information for good (therapeutics) and evil (poisoning). It was during the Renaissance that Paracelsus recognized the importance of the dose–response paradigm, and this marked the beginning of modern toxicology. Today toxicology is focused on molecular mechanisms, and using the Internet to store and exchange this and other information is becoming a key part in the evolution of toxicology. A major problem with using the Internet in toxicology is that the amount of information is overwhelming and that it varies greatly in quality. *Information Resources in Toxicology* addresses this problem by providing a roadmap for today's online enthusiast, and an annotated bibliography for other information sources in toxicology. This book is a gold mine for those of us who make lists of our favorite toxicology and regulatory websites, and will be invaluable to everyone who wants to know where to find general and specific information in all areas of toxicology and risk assessment in the US and around the world.

The fourth edition of *Information Resources in Toxicology* reflects the exponential growth of our discipline. Despite the book's increased size, it is easier to navigate because its many chapters have been logically clustered into relatively few sections. Each chapter in the global arena and subject categorization sections has been written by a well-recognized expert to insure that it is both authoritative and current. Similarly, the chapters on the Internet and Digital Tools and Special Topics (legal, education, funding, etc.) provide a pragmatic hands-on approach that will be of immense value to scientific researchers not well versed in such ancillary concerns. The section on Other Resources offers chapters on print media (journals, newsletters, bibliographies and similar collections, agency and organization documents and reports, etc.), as well as a delightful chapter on General Interest and Popular Works which nicely supplements the chapters on Scientific Principles and History in the introductory section.

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Preface

It has been 26 years since the first edition of this work was published. Toxicology, at the time, although not quite a fledgling science, still had not reached its maturity. The evolution of its experimental and theoretical underpinnings was gradual and continues to be refined, although its standing as a peer of other scientific disciplines is now assured.

The societal impact of toxicology lends it a layer of practical relevance that not every science can lay claim to. Given that we cannot avoid interacting with xenobiotics on a daily basis, toxicology plays a significant role in our lives. News of toxicological incidents continues to fascinate, be it melamine-tainted pet food, toothpaste containing traces of diethylene glycol, the recall of toys contaminated with lead-based paint, an assassination attempt on the President of Ukraine with dioxins, or the murder of a former Soviet agent with radioactive polonium 210.

While piecemeal efforts are being made globally to limit greenhouse gas emissions and otherwise rein in chemical releases, chemicals are still adamant in their refusal to respect geographic boundaries. Developing countries with bourgeoning economies are fueling much of this pollution, compromising the health of their citizens and people at a distance. And yet asking the developing world to eschew rapid economic progress in favor of a paced and sustainable approach for the benefit of the Earth and future generations, requires discussion, diplomacy, and compromise. Much work remains to be done.

The current edition's overall structure and goals adhere fairly well to those established in the last three editions. The intent remains to provide an extensive annotated bibliography and sourcebook to information in toxicology, a compilation of references to key documents, organizations, and other resources. What has changed is the extent to which digital versions of these resources, either complementing or replacing traditional paper formats, now predominate. It becomes an ever greater challenge to encompass the diversity, and multiple nodes of toxicology within the confines of, ironically, a single print publication, which is the format this book takes. However, the editors felt that despite the pervasiveness of information on the Internet, its search capabilities and free availability, there were still significant advantages to a highly structured hardcopy compendium, avoiding much of the extraneous web-based information and focusing on the relevant, either digital or other. Further, this edition's planned availability on Elsevier's Science Direct will give readers more comfortable with the digital environment, the option of also navigating and searching the book's content in an online environment.

The dual stream of advances in the science of toxicology itself and in the information technology to assist in its research and deliver its results has resulted in an array of new tools for generating, capturing, organizing, and disseminating data. These web tools and resources, exclusive of devices integrated with laboratory instrumentation, have been extensively covered in this new edition.

Toxicology's forward scientific march has resulted in the blossoming of a host of new areas ripe for further investigation. Emerging subjects, such as – 'omics, nanotechnology, high-throughput screening, etc., are joined with new perspectives on issues rooted in the past (e.g. chemical and biological warfare, animal welfare, effects of mixtures, risk assessment). The emphasis on the chemical-based orientation of toxicology persists and is reflected in the focus of this book, but biological and physical agents, particularly radiation, have not been neglected since their potentially hazardous effects are part and parcel of the science.

The online web environment, of course, is now an inevitable part of the professional and personal lives of most of us in the developed world, and remote and

economically deprived regions are catching up quickly. Google, Wikipedia, blogs, online social networking, virtual environments, and PDAs, have become part and parcel of our daily vocabulary and lives, and offer ever novel approaches to make sense of raw, sprawling information, and offer ways to make it easier to use whenever, wherever. Toxicology has benefited from these technologies.

This edition is much more of a collaborative endeavor than the previous three. Individual experts were solicited for virtually every chapter to assure the best selection of resources. We have also embraced the global nature of toxicology, both via contributors from different countries, and discussion of toxicology activities around the world. Transportation and communication technologies have hastened this globalism, and increasing cooperation on the economic and governmental fronts (the European Union being one example) are signs that no matter how well established toxicology may be in a single country, we cannot afford to be provincial and risk excluding the research and investigations of other countries. Thus, chapters here include compilations of toxicology resources in selected countries outside the United States, as well as a chapter devoted to international activities and the many multilateral conventions and initiatives relevant to the science.

Thanks are due, foremost, to my three Associate Editors, Steve Gilbert, Bert Hakkinen, and Asish Mohapatra. Their unparalleled knowledge of the science and significance of toxicology and its information infrastructure proved invaluable. Their overlapping networks of proficient colleagues from whose ranks they drew chapter contributors, and their ability to work smoothly together and with me, made the creation of this book an efficient and enjoyable process. Fred Stoss, our informal informatics advisor, brought to our project a broad grasp of the public health implications of toxicology and environmental health, and well-honed and respected skills in library and information science. And, of course, our many contributors, among whom the above editors are also included, form both the backbone of the book and the cement which holds it together.

Additional acknowledgment and praise is due to Keri Witman, Cindy Minor, Renske van Dijk, Rebecca Garay, Kirsten Chrisman, and Claire Hutchins, of Elsevier, our Acquisitions, Production, and Developmental Editors respectively, for recognizing the value of a fourth edition, nudging it through its insubstantial, preliminary, and partial stages, with sensible guidance, and ultimately molding a coherent and useful product in a handsome package.

Philip Wexler

Preface to the Third Edition

The goal of this revised third edition is to provide an up-to-date selective guide to sources of information in all aspects of toxicology and ancillary fields, such as environmental and occupational health and risk analysis. The core of this reference work is an extensive annotated bibliography of books categorized by subject. This is joined by listings of journals, organizations, audiovisuals, popular works, and many other areas. Perhaps the most obvious change in access to toxicology information in the 10 years since the second edition has been the growth of electronic sources of information and digital technologies to access it, sparked by the pervasiveness of personal computers in office and home and the still burgeoning Internet. It is, in fact, ironic that despite this phenomenal transition in scientific information-seeking behavior, we nonetheless have a need for and joy in old-fashioned information rich paper products, such as books. That said, I continue to harbor the hope that this book will one day be joined, but not replaced, by an electronic version.

The scope of toxicology has widened and its areas of focus have shifted significantly in the last decade. Whereas the subject breakdown of books is similar to that in the second edition, there are an increasing number devoted to biochemical, cellular, molecular, and genetic aspects and more of an emphasis on both mechanisms of action and risk assessment. There will always be a chemical or topic of the hour, be it Agent Orange or endocrine disruptors, to which it may seem a disproportionate amount of attention is paid. We have tried to include resources covering such subjects if their significance is likely to endure.

It has become considerably more difficult to know how to categorize items. There used to be a common understanding of what the words "book," "journal," or "newsletter" meant, but with these formats and others, as understood traditionally, being replaced or complemented by electronic versions, we in the information fields find ourselves groping for the right word to describe a resource. A database used to be a collection of information accessed directly over standard phone lines. It still may be, although we now have the much more multifaceted and versatile World Wide Web and Internet. Databases can be PC-resident, networked, on CD-ROMs, packaged with software that "does"something with or to the data and allows new data to be imported (e.g., modeling, structure–activity), etc. Words such as "book," "journal," or "newsletter," though not likely to vanish any time soon, will probably become much more nuanced and ambiguous, requiring clarification, perhaps, about whether one is talking about content in hard-copy print or digital form. We have thus, for want of good substitutes, used many of the same format types from earlier editions. There are many more cross-references, though, to Web sites.

Each chapter retained from the second edition, some renamed, has been considerably enlarged, and a number of new chapters have been added. The new chapters cover publishers, grants and other funding opportunities, assessment of physical hazards, patent literature, technical reports, an overview of international activities, and the IUPAC glossary. Also contributed were new chapters describing toxicological activities in Russia and Paraguay. The addition of three Associate Editors, each well versed in the intersection of toxicology and information, has energized and brought a fresh perspective to the text.

Many thanks to Tari Paschall, Destiny Irons, Kay Sasser, and Joanna Dinsmore of Academic Press. Their combined editorial and production skills have transformed a loose jumble of chapters into a coherent and logical whole.

Disclaimer

I wrote this book in my capacity as a private citizen, not as a government employee. The views expressed are strictly my own. No official support or endorsement by the U.S. National Library of Medicine or any other agency of the U.S. Federal Government was provided or should be inferred.

Philip Wexler

Preface to the Second Edition

Since the first edition of this book five years ago, the field of toxicology has continued to grow unabated. This younger sibling of the more established sciences is crossing more and more disciplinary boundaries while gradually refining its scientific basis. Much fundamental research is still necessary. The excitement of toxicology is based, in large measure, on the difficulty of making predictions about the response of biological systems to exogenous agents. Its challenge is to balance technological and product innovation with the guarantee for a reasonably safe and healthy environment.

This book considers toxicology primarily from the perspective of the harmful effects of chemicals on biological systems. "Harmful," of course, is a highly problematic word. "Harmful" may be on a clinical, pathological, or biochemical level. It may change over time in relation to advances in analytical instrumentation. The Congress, regulatory agencies at all levels of government, the courts, and the public all have their own ideas about what such words as "harmful," "hazardous," "poisonous," "toxic," and "adverse" mean. I will leave debate over these fine distinctions to others and consider all the terms as roughly synonymous for the purposes of this book.

Nonchemical concerns of toxicology relate to the effects of certain physical agents (e.g., radiation) and complex biotoxins (e.g., snake venoms, aflatoxins) on biological systems. Chemical, physical, and biological agents may act not only upon living organisms but upon atmospheric, terrestrial, and aquatic environments. Certain subjects are just beginning to gain a foothold in the realm of the toxicological sciences. Biotechnology, an explosively fertile field in its own right, meets toxicology when studies of the adverse effects of genetically engineered microorganisms are considered. The animal rights movement has made its presence strongly felt, and therefore alternatives to animal testing must be seriously examined by responsible toxicologists. The sophistication of new computer systems is allowing studies in such areas as structure-activity relationships. Indeed, computers in general are aiding experiments in direct measurement and analysis, as well as data capture, manipulation, and retrieval.

Areas of toxicology that this book has not stressed are management of hazardous wastes, aspects of pollution control, and engineering equipment considerations. Abuse of drugs, alcohol, and tobacco, while also within the broad scope of toxicology, have generally not been treated here.

This book of "information resources" is addressed to anyone who has a need to know where to look for toxicology information. A library cataloger may describe it as an annotated bibliography and directory. I prefer to think of it as a sourcebook, a kind of "Whole Toxicology Catalog." The current edition is an expanded and updated version of the first. The scope has been widened as indicated above, and there has been a finer subdivision of categories within toxicology. This remains a selective list with no attempt made to cover exhaustively all available materials. A selective list always assumes a certain presumptuousness on the author's part in judging some books more deserving than others. I have further risked charges of audacity by highlighting the books that I deem especially noteworthy with an asterisk (*). I have no concrete criteria for these judgments other than my personal opinion in examining the texts. Nonasterisked books may be just as, or more, valuable for certain applications and no slight is intended toward any of the authors. All quoted passages within annotations are taken from the item cited or from promotional literature. Book prefaces and the "Information for Authors" section of periodicals were typical sources

for such quotations. This edition includes many new books and new editions of older works. Thus, there has been a considerable increase in scope, size, and currency.

The other major change is the international coverage of the current edition. The inclusion of countries outside the English-speaking world was necessary to make this a thorough compendium. Unfortunately, I was unable to obtain contributions from all of the countries I would have liked to include, and I regret these omissions. Contributed chapters on the history of toxicology and on regulatory information were supplied. Also included are a variety of supplemental lists and directories, such as the directory of mutagenicity testing laboratories in the United States.

The organization of the book, an issue I struggled with in the first edition, continued to plague me here. The widely disparate nature of the form of material (book, series, monographic series, handbook, book in parts, etc.) and the interdisciplinary nature of the field itself have made it difficult to impose a wholly coherent and justifiable order on the work. It has not been easy to reconcile the following two seemingly contradictory facts: (a) organization of a combined directory/bibliography is critical in providing efficient access to the information contained therein; and (b) there is no perfect way to organize such a book. In the end, I hope the organization selected, along with the indexes and cross-references, will prove at least reasonable and convenient to use. The very best way to access information in a book of this nature is to create an online searchable computer version which should definitely be considered if future editions are contemplated. The other frustration an online version would eliminate is the difficulty of keeping up with new and changing information. As the manuscript for this book leaves my hands and makes it way to publication, over months, new toxicology resources will come to light.

I am indebted to many individuals for their assistance with this book. Certainly a sourcebook of this magnitude would not have been possible without all the fine contributions by my U.S. and international colleagues. Dr. Jose Alberto Castro, of Argentina, was particularly helpful in directing me to other international contributors and sharing with me his keen insight into toxicological information in developing countries. I would like to extend special thanks to Drs. Henry Kissman and George Cosmides for their many helpful suggestions and to Mr. Bruno Vasta for his encouragement of this project. I am equally grateful to Mrs. Aurora K. Reich for her continued interest and guidance. The valuable advice and good spirits of Elsevier' s Yale Altman cannot be underestimated as important factors in the successful completion of this book. Christine Hastings, the book's Desk Editor, miraculously transformed the dishabille of my manuscript into an elegantly tailored book. Finally, I am thankful to my friends, parents, Yetty and Will, and my wife, Susan, for more than I can express.

Disclaimer

I wrote this book in my capacity as a private citizen, not a government employee. The views expressed are strictly my own. No official support or endorsement by the U.S. National Library of Medicine or any other agency of the U.S. Federal Government was provided or should be inferred.

Philip Wexler

Preface to the First Edition

Although literature in toxicology is proliferating at a phenomenal rate, and access to this literature by use of computer data bases and other tools is fairly adequate, there has as yet been no succinct guide directing devotees of toxicology to the major sources of information in the field. This guide is an attempt to fill this void. It is a selective and annotated list of information resources. I have tried to select material that is or has the potential of being widely and frequently used and is exceptional in its content and presentation. In addition, I have included material that may not necessarily be of reference use but that is representative of a subject or format. Both relatively broad areas of toxicology and more specific fields of interest have been covered.

Toxicology deals with chemical, physical, and biological (i.e., plant and animal toxins) hazards to man. Chemicals have unavoidably been emphasized. The large number of potentially dangerous commercial chemicals and the large populations exposed to them has resulted in a focus of attention on chemical hazards in research, regulations, and press coverage. I have tried to balance this emphasis by including substantial resources on physical and biological hazards.

For the purposes of this guide, the following areas are within the scope of toxicology: industrial and household chemicals and substances, food, drugs, cosmetics, gases, radiation and radioactive substances, sound, heat light, laser, microwave, metals, minerals, trace elements, biotoxins (mushrooms, plants, insect stings, snake and marine life venoms), environmental pollutants, pesticides, industrial hygiene and occupational medicine, analytical techniques, chemical and forensic toxicology, epidemiology, contamination of water and air, carcinogenesis, mutagenesis, teratogenesis and reproductive toxicology, behavioral toxicology, toxicity testing, legislation, regulations, and societal issues, veterinary toxicology, and target systems toxicology. The concentration is that of health effects. Therefore, topics such as management and storage of wastes and waste disposal; engineering, equipment, and monitoring aspects; mechanical aspects of pollution, and ecology and environmental impact where man is not considered a key component of the biosphere are peripheral to the scope of this guide. In addition, the following topics have not been emphasized: alcohol and tobacco, drug abuse, allergy and hypersensitivity, and mechanical and traffic hazards.

The materials chosen are in English and the organizations are primarily within the United States. One chapter provides a glimpse into international activities.

The chapter divisions devised for this guide are somewhat arbitrary, although not indiscriminate. Some of the materials in both the periodicals and books sections, for instance, could have been merged into a chapter on handbooks (e.g., RTECS, TaSCA Inventory, etc.). Then, the associated problem of how to categorize items that were partially handbooks of data and partially expository prose, would have arisen. Directories, on the other hand, for which there is a separate chapter, could have been dispersed among the serials and books. After much thought, I have settled on the organization that follows.

The guide has been organized in a manner that should be most convenient for scanning as well as for accessing a particular item or class of items. The overall organization, along with the indexes, should provide sufficient access. I have avoided creating too many categories and chapters as this tends to confound matters and create an extremely disjointed product in a field where there is great overlap in subdisciplines.

There was a great temptation to make this guide much larger than it is, since there is no shortage of material. This, however, would have become unwieldy

and defeated the purpose of providing a core list of the most necessary and useful information.

All quoted passages within the annotations are taken from the item cited – for serials this information usually appears as scope notes or information for authors; for books, the quoted sections have usually been extracted from the preface.

This guide was compiled with the assistance of many individuals and organizations. Holdings lists of libraries, individual specialists' recommendations, reading lists for classes in toxicology, compilations of materials used in the creation of data bases, and library card catalogs were all consulted. The outstanding facilities of the National Library of Medicine, the Library of Congress, the National Institutes of Health Library, as well as those of other Washington area libraries, were utilized to examine virtually all of the items.

Special thanks are owed to the following individuals who provided valuable guidance and support throughout this project: Arthur Wykes, Mel Spann, Aurora K. Reich, Pat O'Brien, and Sally Moulton.

Since a guide such as this quickly becomes outdated it is essential that revised editions be published periodically. Comments and suggestions from readers regarding the content and organization of the guide as it exists, items omitted, those that seem unnecessary, or alternate ways of presenting the material would be greatly appreciated, as they will result in future editions of even greater value to the toxicologist.

The views expressed in this book are the personal opinions of the author and should not be taken to represent the views of any organization with which he is or has been associated.

Philip Wexler

ANNEX

1

Some Toxicological Abbreviations Used in This Book

ADI	Acceptable daily intake
ALARA(P)	As low as reasonably achievable (practicable) In the United Kingdom, regulations relating to worker exposure. In the United States, the goal of risk management (USNRC regulations).
ATP	Adenosine triphosphate
BAL	British anti-Lewisite
BATNEEC	Best available technology not entailing excessive cost
BPEO	Best practicable environmental option (United Kingdom)
bw	Body weight
ChemG	German Chemicals Act
DNn	See *NDn*
EC	Enzyme classification number or effective concentration
EC_n	Median effective concentration to *n*% of a population
EDI	Estimated daily intake
EDn	Median effective dose to *n*% of a population
EEC	Estimated exposure concentration
EED	Estimated exposure dose
EEL	Environmental exposure level
EMDI	Estimated maximum daily intake
EQO	Environmental quality objective
EQS	Environmental quality standard
ERL	Extraneous residue limit
ETS	Environmental tobacco smoke
GAP	Good agricultural practice
GLP	Good laboratory practice
GMP	Good manufacturing practice
HQ	Hazard quotient
HSG	Health and Safety Guide (IPCS)
IC	Inhibitory concentration
IDLHC	Immediately dangerous to life or health concentration
im	Intramuscular
inhl	By inhalation
ip	Intraperitoneal
IPD	Individual protective devices
I-TEF	International toxicity equivalency factor
iv	Intravenous
Koc	Organic carbon partition coefficient
Kow	Octanol-water partition coefficient
LC_n	Median concentration lethal to *n*% of a test population
LD*n*	Median dose lethal to *n*% of a test population
LEL	Lowest effect level, same as LOEL
LOEL	Lowest-observed-effect-level
LOAEL	Lowest-observed-adverse-effect-level
LTn	Median time for death of *n*% of a test population
LV	Limit value
MAC	Maximum allowable concentration
MCL	Maximum contaminant level (United States: Safe Drinking Water Act)
MCLG	Maximum contaminant level goal (United States: Safe Drinking Water Act)
MEL	Maximum exposure limit
MF	Modifying factor
MOE	Margin of exposure
MRL	Maximum residue limit
mRNA	Messenger ribonucleic acid
MSDS	Material safety data sheet

MTC	Maximum tolerable concentration
MTD	Maximum tolerable dose; maximum tolerated dose
MTEL	Maximum tolerable exposure level
NADP(H)	Nicotinamide adenine dinucleotide phosphate (reduced)
NDn	Median dose narcotic to *n*% of a population
NEL	No effect level, same as NOEL
NOAEL	No-observed-adverse-effect-level
NOEL	No-observed-effect-level
OEL	Occupational exposure limit
OES	Occupational exposure standard
pc	*Per cutim* (Latin) = through the skin
PEL	Permissible exposure limit
PMR	Proportionate mortality rate, ratio
po	*Per* os (Latin) = by mouth
Pow	Octanol-water partition coefficient
PPD	Personal protective device
PPE	Personal protective equipment
PSS	Poison Severity Score
PTWI	Provisional tolerable weekly intake
QSAR	Quantitative structure-activity relationship
RD	Rate difference
RfC	Reference concentration
RfD	Reference dose
RME	Reasonable maximum exposure (USEPA)
RNA	Ribonucleic acid
RR	Rate ratio
SAR	Structure-activity relationship
SC	Subcutaneous
SCE	Sister chromatid exchange
SMR	Standard mortality ratio
SNARL	Suggested-no-adverse-response-level
STEL	Short-term exposure limit
$\mathbf{t}_{1/2}$	Half-life
TCDD	2,3,7,8- Tetrachlorodibenzo-p-dioxin
TDI	Tolerable daily intake
TEF	Toxicity equivalency factor
TEQ	Toxicity equivalent
TLn	See LTn
TLV	Threshold limit value
TMDI	Theoretical maximum daily intake
TSEL	Tentative safe exposure level
TWA	Time-weighted average
TWAC	Time-weighted average concentration
TWAE	Time-weighted average exposure
UF	Uncertainty factor

ANNEX

2

Abbreviations of Some National and International Organizations and Miscellaneous Terms

ACGIH	American Conference of Governmental Industrial Hygienists
ACTS	HSE Advisory Committee on Toxic Substances (United Kingdom)
ASHRAE	American Society of Heating, Refrigerating, and Air-Conditioning Engineers (United States)
BCR	Bureau Communautaire de Reference (Bruxelles)
BIBRA	British Industrial Biological Research Association
CCFA	Codex Committee on Food Additives
CCOHS	Canadian Centre for Occupational Health and Safety
CCPR	Codex Committee on Pesticide Residues
CDC	Cancer Detection Centre
CEC	Commission of the European Communities
CERCLA	Comprehensive Environmental Response, Compensation, and Liability (United States)
CFR	Code of Federal Regulations
CHIP	Classification, Hazard Information and Packaging (United Kingdom)
COC	Committee on Carcinogenicity (United Kingdom)
COM	Committee on Mutagenicity (United Kingdom)
COPR	Control of Pesticides Regulations (United Kingdom)
COSHH	Control of Substances Hazardous to Health (United Kingdom)
COT	Committee on Toxicity (United Kingdom)
CPL	Classification, Packaging and Labeling
CRISP	Computer Retrieval of Information on Scientific Projects
CSM	Committee on Safety of Medicines (United Kingdom)
DART	Developmental and Reproductive Toxicology
DEA	Drug Enforcement Agency
DOD	Department of Defense
EC	European Community, European Commission
ECETOC	European Chemical Industry Ecology and Toxicology Centre
EEC	European Economic Community
EIA	Environmental Impact Assessment
EINECS	European Inventory of Existing Chemical Substances
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency (United States); same as USEPA
FAC	MAFF Foods Advisory Committee (United Kingdom)
FAO	Food and Agricultural Organization
FDA	Food and Drug Administration (United States)
FEMA	Federal Emergency Management Agency; also, Flavour and Extract Manufacturers Association
FONSI	Finding of No Significant Impact (United States)
FSC	Food Safety Council, Washington, DC
GEMS	Global Environmental Monitoring System
HSC	Health and Safety Commission (United Kingdom)

HSE Health and Safety Executive (United Kingdom)
IAEA International Atomic Energy Agency
IARC International Agency for Research on Cancer
ICRP International Commission on Radiological Protection
ICSU International Council of Scientific Unions
IFCC International Federation of Clinical Chemists
ILO International Labour Office
IPCS International Programme on Chemical Safety
IRIS Integrated Risk Information System
IRPTC International Register of Potentially Toxic Chemicals
ISO International Organization for Standardization
IUPAC International Union of Pure and Applied Chemistry
IUTOX International Union for Toxicology
JECFA Joint FAO/WHO Expert Committee on Food Additives
JMPR Joint FAO/WHO Meeting on Pesticide Residues
MAFF Ministry of Agriculture, Fisheries and Food (United Kingdom)
MARC Monitoring and Risk Assessment Centre (United Kingdom)
NBS National Bureau of Standards (United States); now NIST
NEHA National Environmental Health Association
NIH National Institutes of Health (United States)
NIOSH National Institute of Occupational Safety & Health (United States)
NIST National Institute of Standards and Technology (United States); formerly NBS
NRC National Research Council (United States)
NTIS National Technical Information Service
OECD Organization for Economic Cooperation and Development
OMS Organisation Mondiale de la Sante; same as WHO
OSHA Occupational Safety and Health Administration (United States and/or United Kingdom)
PSPS Pesticides Safety Precautions Scheme (United Kingdom)
RSC The Royal Society of Chemistry (United Kingdom)
RCRA Resource Concentration and Recovery Act (United States)
SCOPE Scientific Committee on Problems of the Environment (ICSU)
SIS Specialized Information Services
TEHIP Toxicology and Environmental Health Information Program
TIR Toxicology Information Roundtable
TIRC Toxicology Information Resource Center
TRI Toxic Chemical Release Inventory
UNEP United Nations Environment Programme
USEPA United States Environmental Protection Agency; same as EPA
USNRC U.S. National Research Council
WHO World Health Organization; same as OMS

PART

I

The Discipline of Toxicology

CHAPTER

1

Toxicology: A Primer

A. WALLACE HAYES

Toxicology is the science of poisons or the study of the untoward effects of chemicals or physical agents on biological systems. It has evolved over the centuries from the trial and error skills of the hunter-gatherer in finding 'safe' food to the applied art of poisoning enemies to a highly sophisticated science of mechanisms that is built upon numerous biomedical disciplines, including molecular genetics and molecular biology. The study of the deleterious interactions between an agent and a biological system also falls within the scope of toxicology. Yet toxicology remains a paradox – 'All substances are poisons; there is none which is not a poison. The right dose differentiates a poison and a remedy'. So stated, presciently, Philippus Theophrastus Aureolus Bombastus von Hohenheim (Paracelsus), a 16th century German-Swiss physician and alchemist.

From the beginning of civilization, man, in his quest for food, learned the ironic fact that certain potential foods produced varying degrees of illness or even death, and he soon was able to differentiate between the harmful and beneficial consequences associated with taking such materials into his body. Substances were, perhaps too readily, assigned a tag either of 'safe' or 'toxic', a dichotomy that in some ways has persisted to the present day. However, it is impossible to describe such a clear line of demarcation between strictly beneficial chemicals and harmful ones. The degree of harm or safety for any chemical is not always clear, though, because as Paracelsus noted, the dose makes the poison. All chemicals, including therapeutic drugs, can cause harmful effects in sufficiently large amounts. For example, both botulinum toxin (a natural neurotoxin protein produced by the bacterium *Clostridium botulinum* and one of the most poisonous natural toxicants known) and thalidomide (a synthetic chemical that caused severe birth defects in the offspring of mothers taking the sedative during pregnancy) are now FDA-approved for selected treatments in humans.

Many of the earliest practitioners of toxicology were women. For example, Lucrezia Borgia, the daughter of Rodrigo Lenzuoli Borgia or Pope Alexander VI, who specialized in faith-based poisoning, was an early Italian who helped develop poisoning into a simple but fine art. It is said that the Borgias selected and laid down rare poisons in their cellars with as much thought as they gave to their vintage wines. Catherine de Medici of Florence and Queen Consort of France tested and carefully studied the effects of various toxic concoctions on the poor and sick, noting the onset of action and symptoms that occurred. Marquise de Brinvillers poisoned her father, two brothers and her sister for their inheritance. Catherine Deshayes or 'La Voisin', who traded in selling poisons to wives who wished to rid themselves of their husbands, was later burned at the stake. One of the most prolific arsenic-poisoners in history was Goeie Mie ('Good Mary') of Leiden, The Netherlands, who lived in the 19th century. She poisoned at least 102 friends and relatives (27 died) between 1867 and 1884, distributing arsenic trioxide in hot milk to her victims after opening life insurance policies in their names.

History is filled with toxic events, such as Cleopatra's voluntary suicide by an asp (a venomous snake) or Socrates' mandated suicide by hemlock

(the poisonous plant, *Conium maculatum*, a common European herb that was probably the state poison of Ancient Greece). Adding arsenic or hellebore (a herb that is a cardiac poison) to wine was discreet, nearly undetectable and considerably less messy than a gun or a knife. Little has changed in the ensuing years. Poisons, as the solution to delicate political problems, became an art form not unlike painting or sculpture during the Renaissance period. Claims have been made that members of the Politburo allegedly gave Stalin warfarin (a synthetic derivative of coumarin, a chemical found naturally in many plants and used as an anticoagulant medication) and that the CIA, using botulinum-laced pills, made attempts on the life of Cuban Dictator Fidel Castro. Evidence seems to suggest that Ukrainian President Viktor Yushchenko was poisoned with dioxin (the common name for the group of compounds classified as polychlorinated dibenzodioxins) in an attempt to remove him from office as recently as 2006.

The first biological weapon described in Western literature may be the poison from a many-headed serpent, the Hydra, to poison Hercules' arrows. This led to the term toxic (from toxikon, Greek for poison arrow). The Romans used a variety of biological weapons as did Hannibal who had his sailors catapult pots full of venomous snakes onto the decks of opposing fleets. Other biological weapons have included: (1) the use of bellows in 4th century BC China to pump smoke from mustard and other noxious vegetable matter into tunnels dug by besieging armies; (2) smallpox-infected blankets that the British sent to the American Indians during the French and Indian Wars; (3) animal carcasses thrown by Confederate forces into wells during the Civil War; and (4) sharp bamboo stakes smeared with human feces by the Vietcong during the Vietnam War.

More modern toxic weaponry includes: chlorine gas, the first lethal chemical used in modern warfare, phosgene, hydrogen cyanide, mustards, tear gas and zyklon B (crystallized hydrogen cyanide). Chemical agents (mustard, sarin and tabun) were used in the Iran–Iraq War between 1983 and 1985 during which it was reported that as many as 7000 people were killed by these gases. Sarin gas contained in lunch boxes was released in the Tokyo subway system in 1995 killing 12 people. This attack was followed by the deaths of five people in the United States in 2001 by anthrax-laced letters. And one should not forget the cyanide-laced grape punch that Jim Jones forced his followers to consume killing the entire congregation of 912 people, including 276 children, or the more recent incident in New Sweden, Maine, where one person died from consuming coffee laced with arsenic. Because of its potency and its frequent use among the ruling class, arsenic is often referred to both as 'The King of Poisons' and 'The Poisons of Kings'.

Poisons may be found naturally in our foods. These natural toxicants include: fungal toxins such as aflatoxin, shellfish toxins, bacterial toxins and algal poisons. The world is full of toxins produced by a variety of plants and animals. Man has added to the list of poisons arising from his ability to chemically synthesize a large number of useful but potentially harmful materials. Environmental and workplace pollutants, arising from natural and man-made chemicals, are another cause of concern to the toxicologist.

Ultimately, the purposes of toxicology are: (1) to protect individual and public health, and the environment; (2) to provide information about the nature and severity of potentially harmful effects on human and animal health and the environment; (3) to ensure safe working conditions; (4) to ensure that products including our food, water and air are safe; and (5) to mitigate damage to natural habitats while at the same time allowing humankind to enjoy the benefits of a modern society. To achieve these goals, toxicology borrows freely from the basic sciences.

The multidisciplinary nature of toxicology is its greatest strength. By incorporating the capabilities and techniques of the biomedical sciences, including epidemiology and statistics, toxicologists utilize a wide range of expertise to investigate issues of critical concern to society.

Toxicology can be subdivided in a number of ways. One such division is based on the disciplines involved: (1) environmental; (2) economic; and (3) medical. Environmental toxicology includes the roles that engineers, environmental scientists, and chemical specialists play in the identification and quantification of both natural and synthetic pollutants, and the transfer of chemicals between and within air, soil and water. Economic toxicology involves biologists, chemists and basic medical scientists who identify and quantify the chemicals responsible for toxicological problems in industry, in foods, in consumer products, and in drugs. Medical toxicology utilizes the capabilities of physicians and veterinarians for the diagnosis and therapy of chemical intoxications, including the forensic aspects of clinical toxicology.

The consequences of the adverse effects of chemicals can be divided into one of two broad categories: (1) irreversible damage such as mutagenicity, carcinogenicity, teratogenicity or death and (2) reversible damage provided the initial insult does not totally overwhelm the exposed organism. Reversible effects may include, for example, organ damage (liver enlargement, gastrointestinal erosion) and functional damage (enzyme induction, respiratory depression).

There are at least four basic principles that are generally applicable to all chemical-induced biological effects of toxicological interest:

1. The chemical must reach a receptor site in a biological system before an effect can be produced. The pharmacokinetics (i.e., how the body acts on the chemical) and pharmacodynamics (how the chemical acts on the body) of the chemical in the biological system are essential in understanding how a chemical reaches the receptor.
2. Not all chemically induced effects are harmful (the basis for drug therapy).
3. The occurrence, intensity and frequency of chemically induced biological effects are dose-related (remember our old friend, Paracelsus).
4. Effects of chemicals on animals, if properly qualified, are generally applicable to humans. The physiology, biochemistry and anatomy must be evaluated and correlated between the test species and the human; generally, when the pharmacokinetics and pharmacodynamics of two species operate in a similar fashion, these two species will respond similarly to the same chemical.

How do we determine these untoward or adverse effects? There are sufficient data to indicate that every chemical is capable, under some conditions, of producing an effect on a biological system. These conditions vary greatly; from being practically unattainable under ordinary circumstances to being so readily attained that exposure of living tissue to minute doses of certain chemicals destroys cells. Effects vary from insignificance (i.e., the cell is able to carry on its normal function) to deleterious, and even lethal, effects resulting from extremely small amounts of some chemicals.

Most of the toxicological test methods that have been developed are the results of the practical need to obtain as much information as possible about the effects of chemicals on humans and the environment. Human experimentation is generally not part of a toxicology testing protocol because of moral, ethical and legal restrictions. Exceptions include testing of therapeutic agents and to a much more limited extent, some consumer products and pesticides where stringent human protocols may be employed. Testing methods in toxicology, therefore, most often involve the use of animals based on the hypothesis that results of toxicity studies in suitable animal models may be extrapolated to humans. That is, one may infer, to some extent, human response based upon the response of an appropriate animal model. Today, more and more toxicity testing procedures include the use of non-mammalian species, cell cultures and individual cells.

Over the years, certain types of toxicity testing procedures have been designed, modified and improved so that they are generally acceptable by most toxicologists. In fact a number of such protocols have been harmonized and accepted by governmental agencies around the world based upon acceptance of the protocol established by the Organization for Economic Co-operation and Development (OECD). OECD is an international organization helping governments tackle the economic, social and governance challenges of a globalized economy. Thirty countries now comprise the OECD and these countries have agreed to accept toxicology studies undertaken using OECD protocol guidelines.

Toxicological tests are designed to define the conditions that must be present when a biological cell is affected by a given chemical entity, and the nature of the effect produced. The result is manifested as an effect on the function and in many cases the structure, of the biological system. Toxicity tests are conducted not only for the purpose of demonstrating the existence of toxic effects but also to estimate the limits of safety associated with the use of a chemical. In any attempt to establish a concentration of a chemical in any toxicological test procedure, it is important to define what is meant by 'effect' and the confidence that can be placed on the results of the test. Essentially, certain measurable detrimental changes must take place within the animal, and within a reasonable amount of time after exposure.

In a properly conducted toxicity test, a control is run in parallel to the assay to ensure the viability and validity of the test system. Except for the omission of the test chemical, a negative control is run under exactly the same conditions as the test assay, including any vehicle (or solvent). The test outcome (cell growth, death, tumor incidence) must be statistically different from the negative control for the test to be considered positive. Ideally, there will also be a positive control (i.e. an agent that is known to give a positive result in the test assay). This is important because, in the event that the test results are negative, the positive control will demonstrate that it is at least possible to elicit the toxicity under investigation in the same species and using the same assay system. Otherwise, it is not known if the species or assay system is at all capable of showing the type of toxicity under investigation.

The extent to which a chemical compound is studied in the toxicology laboratory is largely dependent on the intended use of the compound. Those compounds that are intended for introduction into humans, such as drugs or food additives, require extensive toxicological testing. If the chemical (i.e., a drug) is to be used for only short periods, the extent of the toxicological testing is different than that for chemicals that are

to be used over long periods of time. Any chemical that is incorporated into hundreds of household or consumer products requires extensive toxicological testing even though the material may not be intended for direct consumption by humans.

Extensive toxicological testing means that the chemical or product is subjected to a series of individual tests that are designed to detect specific types of toxicity. If the chemical or product eventually will become an environmental pollutant, the extent of testing may well involve insects, fish, wildfowl and the species of interest. Thus in modern society, no chemical or product should be made available for human exposure (use or potential misuse) without appropriate toxicological evaluation by accepted methodology.

Toxicology testing protocols include the following types of tests: in situ (to examine the phenomenon exactly in place where it occurs; examining a cell within a whole organ intact and under perfusion); in silico (i.e. computer-simulated), in vitro and in vivo procedures. A list of the various types of animal toxicological tests is found in Table 1.1. Details of the tests summarized in Table 1.1 as well as the importance of care and maintenance of experimental animals can be found in Hayes (2007).

Notes on Table 1.1:

Acute testing takes place during relatively short periods of time in relation to an animal's lifespan. Chronic testing takes place during relatively long periods of time in relation to an animal's lifespan. Subchronic testing falls somewhere in between.

The LD_{50} (lethal dosage 50) is the amount of a chemical that is lethal to 50% of the experimental animals exposed to it, when ingested. LC_{50} (lethal concentration 50) is a similar type of lethality expressed as a function of concentration, usually when animals are exposed to the chemical via inhalation.

Toxicological tests are necessary to assess the harm or safety of medicines, consumer products, pesticides, household products, and industrial chemicals. Traditionally, these methods have used animals; however, in recent years, there has been increasing interest in developing alternative methods that reduce or replace animal use and that refine animal use to lessen or eliminate pain and distress.

Russell and Burch (1959) were the first to describe the concept of alternative methods. Commonly referred to as the '3R', this concept involves *reducing* the number of animals needed for a test, *replacing* animals with non-animal systems and approaches, and *refining* animal use to lessen or avoid pain and distress. Laws have been passed in the United States and around the globe requiring consideration of alternative methods prior to the use of animals in biomedical research. Following centuries of trial and error and detailed scientific investigation in more recent times, three axioms have emerged that are central to toxicology. These axioms, as posited by Mitchell et al are: (1) people differ; (2) dose matters; and (3) things change.

People differ: Individual differences are due to a number of factors including individual genetic makeup (polymorphisms), age (fetus, neonate, children, adults, elderly), gender (male, female, pregnant female), inherent drug metabolism, life style factors (smoking, alcohol use, previous exposures), health status including various diseases, and pre-existing or simultaneous exposure to environmental agents, household products, or therapeutic agents. Classic examples of the fact that people differ include allergies to food (e.g., peanuts and shellfish) and to drugs (e.g., penicillin).

Even more striking are the differences in the effects of the same chemical on a single individual that may be observed during various stages of life (in utero,

TABLE 1.1 Animal toxicological tests

- Single dose or acute tests
  - LD_{50} determination (24-hour test; survivors followed for 7–14 days)

  Not generally required by most regulatory agencies
  - LC_{50} determination (similar to LD_{50} but generally 4 or 8 hours exposure)
  - Topical effects; generally evaluated at 24 hours and at 7 days
- Repeat dose or prolonged tests (generally daily doses)
  - Subchronic testing

  Two species (usually rat and dog) for 90 days at 3–4 dose levels. Route of administration should be according to intended route of use or exposure

  Evaluation includes weekly body weight and physical examination, daily feed consumption and observation, ophthalmology examination (before and at termination) and blood chemistry, urinalysis, and hematology, at a minimum at termination

  All animals subjected to complete necropsy including histology of all organ systems at termination
  - Sensitization testing
  - Chronic testing (generally daily doses)

  Selected from results of subchronic tests, pharmacokinetic studies in several species of animals, in vitro metabolism in the liver of several species of animals including human

  Generally two species for 2–7 years depending on the species with a minimum of two dose levels

  Route of administration according to intended route of use or exposure

  Evaluation same as for subchronic testing (see above)
- Special tests
  - For potentiation with other chemicals or drugs
  - For effects on reproduction including teratogenicity
  - For mutagenicity
  - For carcinogenicity
  - For skin and eye effects
  - For behavioral effects
  - For immune effects

neonate, young adult, elderly). Table 1.2 illustrates how much more sensitive newborn rats are than older rats to DDT.

Dose matters: A good starting point for understanding toxicology is the postulate that all substances have the potential to be toxic. Sodium chloride (table salt) used in moderation is fine in the human diet, but consuming half a cup of salt a day causes electrolyte and kidney problems and eventually death. A small amount of another salt, potassium cyanide, can kill a human. Knowledge of the relative toxicity (potency) of a chemical and its potential benefits helps determine whether the material is acceptable for a particular use and, if so, in what dose. Table 1.3 shows examples of typically safe daily doses of some common chemicals and their respective lethal doses.

We are exposed to a myriad of chemicals, both natural and man-made, at work, home, and play every day – chemicals that we voluntarily consume in the foods we eat, in the drugs we ingest, in the water we drink, and in the air we breathe. We are also exposed to chemicals in the various personal care products that we apply to our skin. Fortunately, when a potentially hazardous material is distributed widely enough over an area, it is usually innocuous. For toxicity problems to arise, relatively high concentrations of the chemical are usually required (*Botulinum* toxin is one counter example where even a tiny amount results in adverse effects). We also need to remember that natural is not the same as safe. Depending upon a host of conditions, both synthetic and natural products may be safe or hazardous.

As Paracelsus articulated, the relationship between the dose of a chemical and its toxicity is fundamental to toxicology. Although we cannot always measure it, there is a dose at which there is no untoward or adverse effect (threshold) or, indeed, a beneficial effect, as with drugs. Similarly, there is an upper dose yielding a maximal response. Elucidation of this threshold phenomenon depends upon which parameters of toxicity or response are measured because there are different dose concentrations for different types of toxicity, ranging from measures of morbidity (elevated enzymes) to mortality. Consider Figure 1.1, showing a safe and therapeutic dose of aspirin at about 100 mg/kg and the variety of effects that occur as the dose increases.

A threshold, or concentration, below which no adverse effect is observed, depending upon a variety of factors and circumstances, is deemed to be safe following certain adjustments. Hence, such designations as: (1) threshold limit values (TLVs) for workplace exposure; (2) No Observable Effect Level (NOEL) for industrial chemicals; and (3) No Observable Adverse Effect Level (NOAEL) for pesticides, have been developed and accepted by regulatory agencies around the world.

The concept of a threshold for non-carcinogenic chemicals is for the most part universally accepted; however, controversy exists as to whether a threshold exists for carcinogenic chemicals. Establishing a threshold for such chemicals poses serious challenges. However, intuitively, human exposure to low doses of known or suspected cancer-causing agents, without ill effect, suggests that carcinogenic thresholds, at least for some such chemicals, must exist. Consider – sunlight (ultraviolet, or UV, radiation), certain consumer products containing formaldehyde or formaldehyde-releasing chemicals as a preservative, and grilled and fried goods (containing benzo-a-pyrene and/or acrylamide) as examples of cancer-causing chemicals that have thresholds.

The overall toxicity profile of a chemical depends on a number of factors including but not limited to the following: dose, intake route (ingestion, inhalation, dermal), exposure period (single or multiple dose), and whether or not the effect is reversible or nonreversible. For example, although vitamins are essential for continued health, it is possible to overdose on vitamins such as vitamin A and D since, among other reasons, they are retained within the body for long periods of time. The graph of Figure 1.2 illustrates effects of increasing dose of essential nutrients and non-nutritive toxicants.

TABLE 1.2 DDT LD_{50} in male rats of various ages

Age	LD_{50} (mg/kg)
Newborn	>4000
10 days	728
2 weeks	437
1 month	355
2 months	250
4 months	194
Adult	225

TABLE 1.3 Doses of common chemicals

Chemical	Daily use	Lethal dose	Safety ratio
Water	1.5 quarts	15 quarts	10×
Salt	1/3 ounce	7 ounces	21×
Caffeine	2 cups coffee	75 cups	38×
Ethanol	2 ounces	64 ounces	32×
Sugar	2 ounces	80 ounces	40×
Aspirin	2 tablets	90 tablets	45×

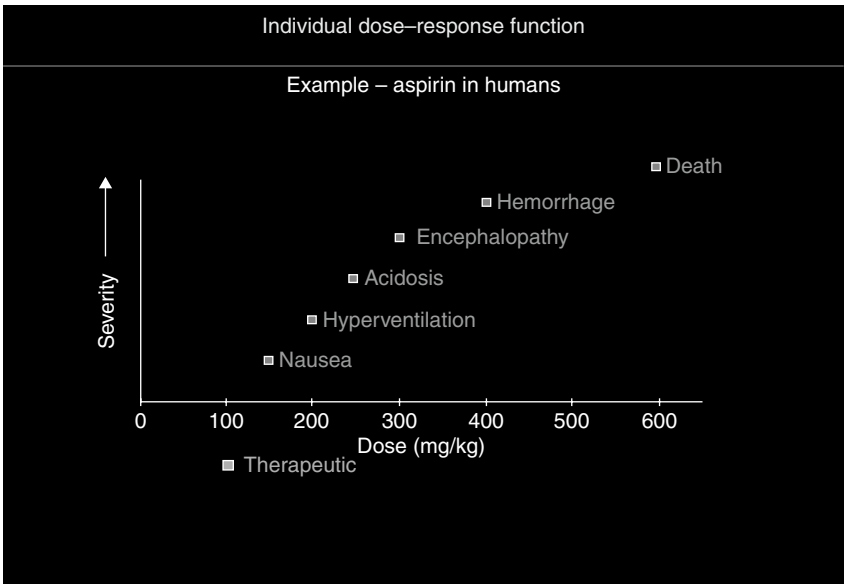

FIGURE 1.1 Individual dose–response relationship

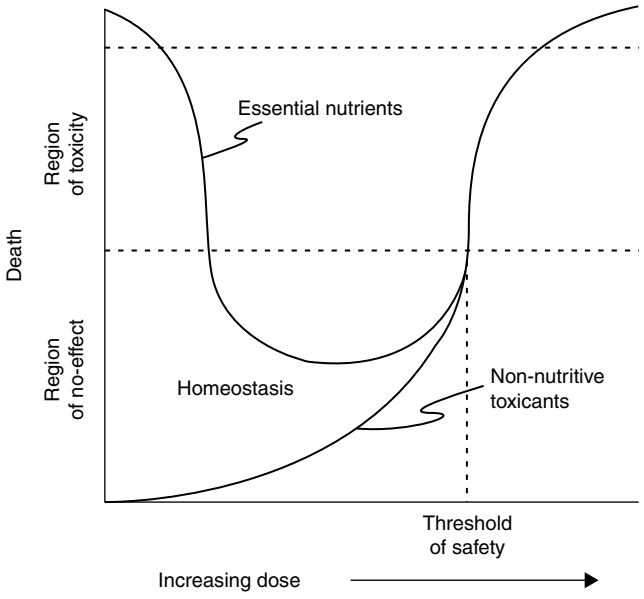

FIGURE 1.2 Examples of dose–response curves for essential nutrients and non-nutritive toxicants showing both a threshold and homeostasis

Thus, it can be seen that insufficient nutrients and excess nutrients can result in toxicity. At the extremes, an absence of nutrients or an extreme excess will result in death. For non-nutritive toxicants (i.e., toxic chemicals without any nutritional value), increasing the dose will result in increasing toxicity and ultimately death. Homeostasis is that region of the graph where the dose is low enough so that the body is able to compensate for the toxic insult and keep itself in balance.

Things change: Sometimes the host (i.e., the organism that is exposed to the chemical) plays a critical role in the outcome of toxicity. The process by which this occurs is called biotransformation and involves a chemical reaction within the organism in which one chemical is changed to another. Chemicals can enter the body and be absorbed by the body by a variety of means such as ingestion, inhalation, and dermal. They are distributed through many bodily compartments and finally excreted. What happens in between entry and exit, though, plays a key role in toxicity. Figure 1.3 is a generalized schematic of the fate of chemicals in the body.

As a chemical passes through the body, it will encounter a number of proteins known as enzymes that are present in all living systems. These enzymes accelerate chemical reactions (intermediary metabolism) that are necessary for growth, maintenance of integrity, and continuance of life. Distinctive microenvironments exist at the active sites of each enzyme to assist chemical inter-conversions. It is, therefore, not unexpected that a chemical undergoes chemical alteration(s) as it traverses a living system. What is eliminated from the biological system is not always the same as what entered the system originally.

Biotransformation usually decreases the ability, and in turn, the likelihood, of a molecule interacting with a biological system. The probability of potential damage is offset or lowered. Usually, but not always, the process makes the molecule more polar (frequently acidic) and thus more water-soluble. As such, the

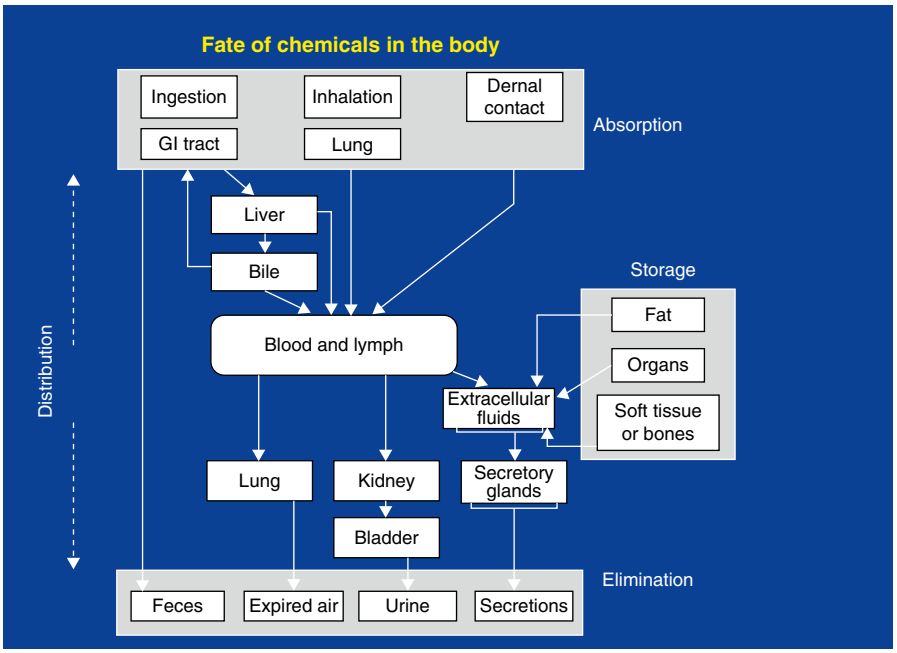

FIGURE 1.3 Fate of chemicals in the body

system can more easily remove the molecule via the kidneys (urine) or liver (bile). Figure 1.4 shows the enzyme epoxide hydrolase converting ethylene oxide, a chemical with genotoxic and other chronic toxic properties, into the somewhat less toxic ethylene glycol. On occasions, the chemical may be activated and converted into a more dangerous species whereby the body inadvertently poisons itself (see Figure 1.5). Phosgene is a poisonous gas used as a chemical weapon in World War I.

These three axioms (people differ, dose matters, and things change (chemicals transform)) help explain why humans respond in varied and often unpredictable ways to a common chemical insult.

Although the ultimate extreme in toxicity resulting from a chemical insult is manifested as a lethal effect, it is apparent that sublethal and even reversible effects of chemicals may be harmful or undesirable, and therefore should be considered in any evaluation of chemicals with regard to their degree of harm or safety. Safety implies the reciprocal of harm. The real question then for the toxicologist is 'Is It Safe?' (www.toxedfoundation.org) and under what exposure conditions. In order for the toxicologist to answer these questions, sufficient and appropriate information (data) is needed in two broad areas: (1) the toxicity or hazard profile of the chemical itself and (2) the exposure details regarding the individual or population under consideration.

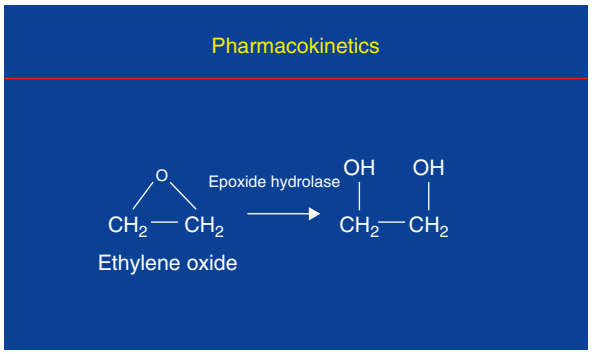

FIGURE 1.4 An example of a biotransformation (detoxication) reaction

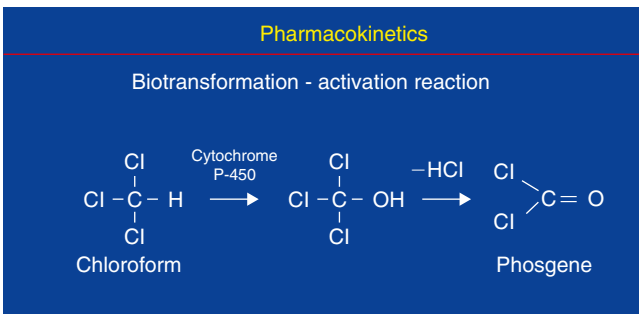

FIGURE 1.5 Example of an activation reaction

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http://www.toxedfoundation.org/.

CHAPTER

2

History of Toxicology

KATHERINE D. WATSON AND PHILIP WEXLER

All substances are poisons; there is none which is not a poison. The right dose differentiates a poison and a remedy.

(Paracelsus)

HIGHLIGHTS IN THE HISTORY OF TOXICOLOGY

The science dealing with the harmful effects of chemical agents on biological systems is called toxicology, from the Greek word *toxikon*, a bow (to shoot poisoned arrows) or a poison in which to dip arrowheads (Oxford English Dictionary 1989). A poison, for which it has long been surprisingly difficult to give an exact definition (Stevenson 1885, Stevenson 1959), may generally be taken to be a substance that is capable of destroying life or causing illness when introduced into, or absorbed by, a living system in small quantities. Toxicology is often considered to be a modern science as, since 1900, it has undergone continuous expansion and development by assimilating knowledge and techniques from most branches of the physical and biological sciences (Gallo 2001). Its origins, however, lie in the earliest history of poisons and poisoning. Historically, attempts to both kill and cure with chemically active preparations (poisons and drugs) have led to the evolution of toxicology, so that today it is a discipline of diverse application and widespread importance.

It is likely that the history of toxicology is as old as the history of the human race: early man must have learned 'to discriminate between things which were good to eat and those that were not' (Smith 1952). In exploring his environment and searching for food, he would have observed the healing or harmful effects of plants and minerals, and that the bites of certain insects and reptiles caused illness or death. It would have been a natural progression to use injurious substances for hunting, against enemies in warfare, and for homicide (Decker 1987). Arrow poisons were developed by ancient peoples in all parts of the world (with the possible exception of Australia and New Zealand), and many are still in use (Bisset 1989). Among the best known are the 'calabash curares' (derived mainly from varieties of *Strychnos* in South America), reptile poisons (venoms) from toads and salamanders in Central and South America, and ouabain, from African varieties of *Acocanthera* and *Strophanthus* (Paterson 1996). The science of pharmacology (which deals with the preparation, uses, and effects of drugs) has benefited from knowledge of these poisons, and some of the active agents derived from them are now used therapeutically in Western medicine.

The earliest use of arrow poisons probably occurred during the Mesolithic age, when arrows first began to appear. The archeological evidence does not permit firm conclusions to be drawn, but it is possible that Masai hunters who lived in Kenya 18 000 years ago may have used poison. Other sites in Africa indicate later use (3000–1700 BC), and in ancient Egypt and Nubia poisoned arrows appear to have been used during the period 3100–300 BC (Bisset 1989).

In China, arrow poisons have been known to the Han and other peoples for at least 2500 years. They were used for both hunting and warfare, and

documentary evidence indicates that the principal source of poison was *Aconitum*, the tubers of which yield aconitine (Bisset 1979). The same poison was also used in ancient India, where it was called visha and derived from a plant known as Bish. In Sanskrit literature, we find the term *visha-kanya*, or poison girl (maidens who had slowly developed a tolerance for aconitine, so that certain death would result from their embrace). The legend of using young girls as instruments of death originated in India and later spread into medieval European literature via Greek and Arabic writings (Copley & Boswell 1944). The hymns of the *Rig Veda* and *Atharva Veda* (1200–900 BC) show that poisoned arrows were used in war, and that the tubers of *Aconitum* were the major poison source. Later Buddhist and Sanskrit writings indicate the continued use of poisoned arrows (for hunting, warfare, and clandestine purposes) and reveal that a second source of poison was obtained from decomposing snakes; the latter is confirmed by Diodorus Siculus in his account of Alexander the Great's campaign (325 BC) in western India (Bisset & Mazars 1984).

Among the peoples of the ancient Middle and Near East, the Egyptians, Assyrians, Sumerians, and Hebrews all had some knowledge of poisons, from which they developed a primitive pharmacology. Much of their experience was bound up with mysticism and the supernatural, and many details remain unclear. However, where it has been possible to identify individual items of the ancient pharmacopeia, modern practice indicates that some remedies could have been extremely effective (Mann 1984). The Bible, where most references are to venoms (as in the Midrash and Talmud), does not contain a list of poisons or allude to their deliberate use (Borzelleca 2001). In all likelihood, the Hebrew people acquired much of their information about poisons in Egypt, where they not only endured a captivity near the end of the second millenium, but are also known to have established a vibrant community after the destruction of Jerusalem in the sixth century BC.

Egyptian knowledge of poisons appears to have been highly advanced (Nunn 1996). Originally divided into two kingdoms, Upper and Lower Egypt, the land was united under the first pharaoh (or king), Menes, in about 3000 BC. He is said to have cultivated and studied poisonous and medicinal plants, but there is no detailed description of his activities (Smith 1952, Borzelleca 2001). Following his reign, much information about animal, vegetable, and mineral poisons was accumulated in Egypt, and the discovery in 1872 of a complete medical text showed the extent of Egyptian learning. Named in honor of its discoverer, the German Egyptologist Georg Ebers (1837–1898), the Papyrus Ebers, written about 1550 BC, is a compilation of medical prescriptions derived from a number of much earlier sources. There are in total 829 prescriptions, of which 72% are quantified and a few are duplicated; spells and incantations are included throughout. The text lists many possibly active drugs, including (Mann 1984):

> Sulfate, oxide, and other salts of lead used as astringents and demulcents; pomegranate and acanthus pith as vermifuges; sulfate and acetate of copper; magnesia, lime, soda, iron, and nitre; oxide of antimony, sulfide of mercury; peppermint, fennel, absinth, thyme, cassia, coriander, carraway, juniper, cedar wood oil, turpentine, and many other essential oils; gentian and other bitters; mandrake, hyoscyamus, opium with other hypnotics and anodynes; linseed, castor oil, squills, colchicum, mustard, onion, nasturtium, tamarisk, frankincense, myrrh, and yeast.

Of the vegetable and mineral substances cited, some were, clearly, poisonous. Another papyrus provides an early record of the preparation of a poison, as it records the following warning:

> Pronounce not the name of I.A.O. under the penalty of the peach.

C.J.S. Thompson suggests that the Egyptians may have been able to distill a weak solution of hydrocyanic acid from peach kernels; I.A.O. is, possibly, a representation of the ancient Hebrew name for God (Thompson 1931).

The literature of ancient Greece contains many references to poisons and their use (Touwaide 1992), none more famous than Plato's account of the death of Socrates. Condemned to death for impiety and corruption of youth, the Athenian philosopher swallowed a fatal dose of hemlock in 399 BC. This was the state method of execution, the poison being derived from the tubers of *Conium maculatum* (the 'spotted hemlock' or 'poison hemlock'); for quicker effect, it may have been mixed with opium (Daugherty 1995). Other poisonous plants known to the Greeks were mentioned in the ninth (probably spurious) book of the *De Historia Plantarum* of Theophrastus (371–287 BC), and included aconite, hellebore, mandrake, and henbane (Wax 1994). The writings attributed to Hippocrates (460–c.377 BC), the 'father of medicine,' mentioned (among other things) about 400 drugs of mainly plant origin and suggested methods for the management of poisoned patients that relied primarily on limiting the absorption of toxic agents (Borzelleca 2001). During the reign of Attalus III, the last king of Pergamon in Asia Minor (reigned 138–133 BC), poisonous plants were cultivated and experiments made on condemned prisoners by Attalus and, probably, others in his court. Rulers lived in fear of poison, and Mithridates VI Eupator, king of Pontus

(reigned 120–63 BC), spent years searching for a universal antidote to all poisons; he has been called the first experimental toxicologist (Griffin 1995, Borzelleca 2001). After investigating individual venoms, poisons, and antidotes, he combined all of the effective substances into one antidote, which he took daily to obtain, reportedly successfully, immunity to poison. His formula, called Mithridatium, underwent considerable revision but survived in various forms until the nineteenth century. A variant derived from poisonous reptiles became known as theriac, and was equally long-lived in European pharmacopeias (Watson 1966, Wax 2006).

Theriac – a term derived from the word *theria* (dangerous or poisonous beasts) – became famous as a result of its association with the earliest extant work on poisonous animals, the *Theriaca* of Nicander of Colophon (fl. c. 197–130 BC). Also author of a shorter poem, the *Alexipharmaca*, Nicander is the best cohesive source for classical toxicology (Scarborough 1977). His poems describe venomous animals (snakes, scorpions, spiders, insects, and myriapods) and their bites and prescribe specific remedies; poisonous plants are also treated (Scarborough 1979). Working in the intellectual atmosphere created by Attalus III, Nicander was a poet of nature who was, quite possibly, ignorant of his subject: he has been traditionally considered to have taken his information directly from a lost work of Apollodorus of Alexandria, the *Peri therion* (*On Poisonous Animals*), of the third century BC (Scarborough 1979). Despite varying opinion on the originality of Nicander's work, it seems that he was widely influential (Touwaide 1997). Successive Greek and Roman authors (including Scribonius Largus, Celsus, Pliny, Galen, Philumenus, and Oribasius) took much of their information on toxicology from him; he was read and cited for many centuries (Knoefel & Covi 1991).

Following the work of Nicander, in which lay the beginnings of a scheme for identifying toxic agents by means of the symptoms they produce in human victims, a system of toxicology based on this principle developed between the second century BC and the first century AD (Touwaide 1991). The Roman naturalist and historian Pliny the Elder (23/24–79 AD), a great compiler of information, described the biological effects of poisonous plants and animals in his *Historia Naturalis*. In the works attributed to his contemporary, Pedanius Dioscorides (40–90 AD), there is a classification of poisons based on their origin (animal, vegetable, mineral) that remains convenient to this day (Touwaide 1984, Gallo 2001). Known as the father of materia medica, Dioscorides is generally thought to have been a physician in the service of the Roman legions. He studied the medicinal properties of plants and minerals, and provided descriptions of about 600 plants and 1000 simple drugs, with the diseases they might cure, in his *Materia Medica*, the leading text in pharmacology for 16 centuries. Later Greek and Byzantine physicians transmitted the established information, the last being Paul of Aegina (625–690 AD): Book 5 of his *Epitome* deals with toxicology, specifically bites and wounds of venomous animals (Borzelleca 2001).

Mineral poisons were also well known in the ancient world. In particular, the ores and compounds of arsenic, antimony, copper, mercury, and lead were familiar to many cultures. Pseudo-Dioscorides detailed the poisonous effects of arsenic (meaning sometimes the sulfide, sometimes the white oxide), litharge (red lead or lead oxide), cinnabar (mercuric sulfide), and white lead (lead acetate) (Decker 1987). Hippocrates, Nicander, Dioscorides, Galen, and Paul of Aegina wrote clinical accounts of lead poisoning, of which there were occasional epidemics (Nriagu 1983, Scarborough 1984), and miners were known to be at risk from the fumes created by smelting processes (Waldron 1973). After the third century AD and the synthesis by Galen (Touwaide 1994), few if any additions were made to the information presented by Pseudo-Dioscorides (Touwaide 1984), and a passage from Galen suggests that it would have been imprudent to do so because of the risk of encouraging crime (Decker 1987).

The chronicles of ancient Greece contain few references to cases of criminal poisoning, but the fact that Hippocrates required his students to swear that they would 'give no deadly medicine to any one if asked, nor suggest any such counsel' (Ackerknecht 1982) implies that it was a problem. Suicide by poison was fairly common; the state would give permission and provide a lethal dose of hemlock (Decker 1987, van Hooff 1990). In the Roman Republic, however, criminal poisoning reached epidemic proportions. In his *History of Rome*, Livy (59 BC–17 AD) recorded the details of an event that was supposed to have occurred in 331 BC: a series of deaths initially attributed to pestilence were found to be the result of poisoning. A slave informed the authorities that leading citizens who had all died of the same mysterious malady had in fact been poisoned by a group of matrons. A search of the women's houses yielded concoctions which they declared to be medicines; when required to drink the potions to prove their claim, they all perished. Further investigation disclosed 170 accomplices, who were tried and found guilty. According to Livy, there had never before been a trial for poisoning in Rome (Livy 1948).

At the time of the civil wars in Rome, poisoning had become so common that the dictator Sulla issued the *Lex Cornelia* in 82 BC. This was the first legislative attempt to prevent poisoning, and it carried harsh penalties: banishment and confiscation of property if an offender was of noble birth, exposure to wild animals if of low status. Later interpretations made the law applicable to careless preparers of drugs (Decker 1987). Despite this edict, however, homicidal poisoning continued to plague Rome, where according to Tacitus, Juvenal, and Suetonius, a class of professional poisoners arose and practiced their skills with impunity (Blyth & Blyth 1920). During the first century AD, the worst offenders were members of the ruling family, particularly Nero and his mother Agrippina, who used poison as a political tool. Both employed a Gallic woman named Locusta, who had been convicted of poisoning but pardoned and taken into imperial service. She used a variety of poisons, probably aconite, henbane, belladonna, arsenic, and poisonous fungi, and is reputed to have performed experiments on slaves supplied for the purpose (Smith 1952, Decker 1987, Wax 2006).

The death of Galen circa 216 AD marked the beginning of a long period of transition in Western (i.e., Greek) medicine, during which what is usually called monastic medicine gradually emerged. From about 500 to 1130, medical practice and writing resided in the hands of monks, where it was merely complementary to their divine mission (Ackerknecht 1982). The study of toxicology as a system of knowledge came to a halt in the Christian world and was not taken up again until after the rise of the school of Salerno in 12th century Italy (Niyogi 1981). It was no coincidence that Salerno was close to Arab Sicily because, following the rise of Islam in the seventh century, scholarship shifted to Muslim centers, where Arab and Persian physicians dominated medical learning. They discovered Greek medicine through translations made from Byzantine manuscripts and contributed their own original observations to the subject. Similarly, medical texts written in India were made available in translation.

Several Indian medical texts containing information about poisons, together with the works of Greek authors, became key sources of information for Arab toxicologists. The most important Indian works were those of Charaka (second century AD), Susruta (about 500 AD), and Shanaq (slightly later). The most complete Arabic works on toxicology still extant are the *Book on Poisons* of ibn Jabir (ninth century), the *Paradise of Wisdom* of al-Tabari (born c. 810), and the *Book on Poisons* of ibn Wahshiya (fl. late ninth century). Portions of the *Liber continens* of al-Razi (860–932) and the *Canon Medicinae* of ibn Sina (or Avicenna, 980–1037) consider poisons. There were in addition numerous other medical texts on poisons and poisoning, but many are now lost (Levey 1966). The *Canon* of ibn Sina and the *Treatise on Poisons and Their Antidotes* of Moses Maimonides (1135–1204) were particularly well known in medieval European universities and medical schools, where works written in Greek and Arabic were made available in Latin translation after the eleventh century.

The few new contributions made to knowledge of poisons during the Middle Ages came primarily from the physicians and alchemists of the Islamic world. They were the first to note the toxic properties of corrosive sublimate (mercuric chloride), and ibn Sina described the foul odor exhaled by victims of mercury poisoning. The replacement of arsenic trisulfide by white arsenic (arsenic trioxide) in poisonous preparations had a profound influence on the history of toxicology, as it became one of the most versatile and widely used poisons ever known (Niyogi 1981, Decker 1987, Borzelleca 2001). The medical works of Maimonides, a Jewish philosopher and physician in the service of the Sultan of Egypt, are still seen as modern in their approach to illness; his book on poisons contained original experiments, treatments, and views. The first part of the book discussed the bites of snakes and other animals, while the second considered poisoning with vegetable and mineral substances. For the former, he advised drawing the poison from the wound (sucking, cupping glasses, plasters) and antidotes (including theriac and Mithridatium); for the latter, vomiting and purging by means of various agents. Some of his suggestions – suitable diet, keeping the patient awake, sedatives applied to the affected spot or taken internally – hold true today; so, too, the composition of some of his medicinal recipes and their use according to the age of the patient (Maimonides 1966).

One century later, the professor of medicine at the University of Padua, Petrus of Abano (c. 1250–1316), wrote a book on poisons that was based upon his reading of Greek and Arabic works. His *De Venenis* classified poisons as vegetable, mineral, and animal, and listed all known poisonous agents with their symptoms and treatment. It also suggested methods for avoiding the ingestion of poison and for neutralizing it if taken (Brown 1924). This may explain the wide popularity of the book, which went through 14 editions after its first printing in 1472: the later Middle Ages and Renaissance were, in Italy, periods in which poison was frequently used to accomplish murder and political assassination. Schools of poisoning arose in Rome, Naples, and Florence and flourished until

the beginning of the eighteenth century. In Venice, poison was recognized officially as a means of furthering policy: the records of the infamous Council of Ten (a branch of the city's government) list, among other information, intended victims and the fees paid to poisoners for their services. By the seventeenth century, the activities of Italian poisoners had been redirected towards social, marital, and financial objectives. In Naples, Giulia Toffana (c. 1635–1719) sold arsenical solutions under the name of *Acquetta di Napoli* and is supposed to have poisoned over 600 people; in Rome, Hieronyma Spara conducted a similarly lucrative business (c. 1659), her clients being primarily young married women (Blyth & Blyth 1920, Smith 1952, Decker 1987). Both were executed for their crimes.

Italian refinements to the 'art' of poisoning are said to have been introduced to France by Catherine de Medici in the sixteenth century. Favored poisons included arsenic mixed with the decomposition products of an animal to which it had been administered (corrosive sublimate was sometimes substituted), cantharides, and mixtures of arsenic, aconite, belladonna, and opium. Poisoning became a public menace, and in 1662 Louis XIV issued a decree forbidding apothecaries to sell poisons to anyone unknown to them and requiring purchasers to sign a register. Professional poisoners thus had more incentive to ply their trade, but a series of scandals soon brought about their downfall. In 1676, the Marquise de Brinvilliers was executed for the murders of her father, brothers, and husband; she had been aided by a poisoner named Sainte-Croix, who was rumoured (incorrectly) to have died as a result of one of his own experiments. In 1679, the Chambre Ardente was appointed to investigate suspected poisoning cases, and within three years it had brought charges against 442 people. Many of the worst offenders were influential enough to escape trial; others were less fortunate. Of those executed, the most notorious was Catherine Deshayes, known as La Voisin: she was convicted of many murders, including those of 2000 infants. When it was revealed that she had sold poisons to the king's mistress, Madame Montespan, the court was summarily dismissed (Anon 1900, Decker 1987, Somerset 2003).

The 'Affaire des Poisons' represented the culmination of the period of professional poisoners in France, but the fact that the crimes were brought to light owed more to the use of torture to extract confessions than to the ability of doctors or chemists to detect and identify poisons. It was not until the nineteenth century that experimental toxicology became sufficiently developed to make such practices far more risky for the poisoner, but the foundations of this progress were laid much earlier, during the sixteenth century. The key figure at the time when traditional lore began to give way to objective investigation in science and medicine was Paracelsus (1493–1541), a controversial but influential physician, alchemist, and scientist. Despite the fact that his science was mixed with mysticism and astrology, his contributions to medicine were revolutionary. Paracelsus rejected the medical theories perpetuated by the Greco-Arabic classics, insisted on the value of experimentation (including the use of animal tests), and developed the idea that minerals and chemicals could have medicinal applications (iatrochemistry). His use of mercury preparations in the treatment of syphilis led to accusations of poisoning, to which Paracelsus replied by writing the *Third Defense*. It contains the following important statement:

> What is there that is not poison? All things are poison and nothing (is) without poison. Solely the dose determines that a thing is not a poison.

Consequently, toxicologists give credit to Paracelsus for stating one of the basic concepts in toxicology, that of dose dependency (Deichmann et al 1986). Paracelsus was the first to express the view that drugs and chemicals have effects on specific organs of the body (target organ toxicity), a concept which was further developed in the work of Felice Fontana (1730–1805) (Borzelleca 2001). In his experimental studies of the venom of the European viper and its effects on animals, Fontana discovered that the symptoms of poisoning caused by a bite were attributable to the direct action of venom on the blood (Hawgood 1995). His findings contributed to the ongoing debate about whether drugs and poisons acted through the nerves or by a process of absorption and transport in the blood. This question arose during the seventeenth century, when iatrochemists attempted to explain physiological and pathological phenomena in chemical terms. The debate stimulated chemical and physiological research throughout the seventeenth and eighteenth centuries, while the advances made in chemistry near the end of the eighteenth century inspired increasingly sophisticated analyses of animal and plant substances. These factors, together with a mounting acceptance of animal experimentation, led to the development of experimental toxicology as a distinct scientific discipline during the nineteenth century (Earles 1962).

The contribution made by physiology to toxicology is exemplified by the work of François Magendie (1783–1855), the first great experimental physiologist of the nineteenth century. He laid the foundation for the systematic study of the mechanisms by which poisons act in the body with his investigation of the

Javanese arrow poison *Upas tieuté*, which was later shown to contain strychnine (Earles 1961). His pupil and successor at the Collège de France, Claude Bernard (1813–1878), studied the nature of the action of curare on neuromuscular transmissions, effectively using a poison as an instrument for resolving important physiological problems (Thomas 1964). In addition, Bernard suggested that carbon monoxide poisoning occurs as a result of tissue asphyxiation caused by an irreversible combination with hemoglobin, which prevents the effective transport of oxygen to body tissues (Decker 1987). Another of Magendie's students, James Blake (1815–1893), found that there is often a relationship between the chemical structure of a drug and its biological activity, thus implying the concept of target organ toxicity (Leake 1975). There was subsequently a great deal of British research in the area of structure–activity relationships, perhaps the most sophisticated being that of Alexander Crum Brown (1838–1922) and Thomas Fraser (1841–1920) on organic alkaloids (Bynum 1970, Parascandola 1971). The successes of the experimental method in physiology, combined with notable advances in analytical chemistry, stimulated the development of pharmacology (Ackerknecht 1982). The complementary nature of toxicological and pharmacological research during the nineteenth century was embodied in the work of the Germans Rudolf Kobert (1854–1918), who studied the digitalis glycosides and the ergot alkaloids, and Louis Lewin (1850–1929), who became an expert on narcotics, alcohols, poisonous gases, and arrow poisons (Macht 1931).

The chemical approach to the study of poisons was pioneered by the work of a man who has long been considered the founder of modern toxicology, Mathieu Joseph Bonaventura Orfila (1787–1853) (Beeson 1930, Bertomeu-Sánchez & Nieto-Galan 2006). A Spaniard who made his career in Paris, Orfila established toxicology on a firm quantitative basis by introducing new, primarily chemical, experimental methods for proving lethal intoxications; diagnoses of that kind had previously been made solely on the basis of observed features. A trained chemist and physician, he performed experiments on thousands of dogs to gather the necessary data, and in 1814–15 he published a monumental work in two volumes: *Traité des poisons tirés des règnes minéral, végétal et animal, ou toxicologie générale, considérée sous les rapports de la physiologie, de la pathologie et de la médecine légale* (Paris: Crochard). The book examined the physiological and pathological effects of poisons, the symptoms of poisoning, antidotes, the chemical properties of poisons, and analytical methods for detecting them (Dall'Olio & Galzigna 1993). This was the first systematic attempt to correlate chemical and biological information concerning known poisons and was unique in combining the use of postmortem examination with analytical chemistry (Doull & Bruce 1986, Borzelleca 2001).

As the leading medicolegal expert of his time, Orfila made considerable contributions to legal (forensic) medicine. He made the important discovery that poisons are absorbed from the gastrointestinal tract and then accumulate in tissues specific to each poison, a finding that did much to further the progress of forensic toxicology. Previously, a chemist or a physician who found nothing in the stomach would not have troubled to examine the other organs of the body (Blyth & Blyth 1920). In Britain, the development of forensic toxicology was stimulated by the work of (Sir) Robert Christison (1797–1882), a native of Edinburgh who became professor of medical jurisprudence and of materia medica at the university there. His *A Treatise on Poisons in relation to medical jurisprudence, physiology and the practice of physic* (Edinburgh: A. Black, 1829) was the first textbook of its kind to be written in English. He regarded toxicology as the principal branch of medical jurisprudence, its object being to unite evidence from four sources (pathology, chemistry, physiology, and visible symptoms) in order to detect crime (Adam 1990, Crowther 2006).

The works of Orfila and Christison, which were widely read and translated, laid the foundation for the development of forensic toxicology during the nineteenth century. At a time when arsenic was easily available and widely used in criminal poisonings, Orfila was the first (1839) to extract it from human organs other than gastrointestinal tissue; in 1840, his analysis of organ samples resulted in the conviction of Marie Lafarge for the murder of her husband. The method used was a variation of that devised by James Marsh (1794–1846) in 1836, which was based upon Scheele's discovery (1775) that when zinc and acid act on arsenic salts, a gaseous compound (arsine) is evolved, that, when burned, deposits metallic arsenic. This test, which gave only qualitative results, marked the beginning of important stages in the development of chemical toxicology (Gettler 1956). A modification introduced by Berzelius in 1837 allowed quantitative evaluation by ensuring that the mirrors of arsenic formed by reduction were deposited in a glass tube. The device that he used became known as the Marsh-Berzelius apparatus. A further refinement was made in 1841 by Hugo Reinsch (1809–1884), who deposited arsenic on copper foil from solutions of hydrochloric acid; the test was useful for its easy manipulation and quick results (Campbell 1965). Three years later, Fresenius and von Babo devised a method for the

systematic search for all mineral poisons, using wet ashing with chlorine (a technique described by Duflos in 1838) (Niyogi 1981, Decker 1987). The first quantitative determination of metals in organs began about 1850, when they were weighed as a sulfate or oxide; electrolytic deposition was introduced in 1862.

New and precise methods of chemical analysis permitted the isolation of the major alkaloids from crude drug preparations (Lesch 1981). By 1833, aconitine, atropine, codeine, hyoscyamine, morphine, nicotine, and strychnine had been isolated from plants by methods which were later (1850) modified by the Belgian chemist J.S. Stas (1813–1891) to achieve their isolation from human tissue samples. His process was adapted in 1856 by F.J. Otto, who was able to obtain a purer alkaloidal residue and to remove more organic impurities. The modification became known as the Stas Otto method. In 1874, Selmi discovered the first cadaveric alkaloid, a morphine-like ptomaine. Color tests for alkaloids were developed between 1861 and 1882; by 1890 quantitative methods for analyzing them had come into use. Physiological tests for alkaloids, particularly strychnine, were first used in 1856 and continued to be recommended well into the 20th century (Willcox 1938). Tests for alcohol were devised by Lieben (iodoform crystal test, 1870) and others (chromic acid reduction method, 1852–1883), and later perfected to allow the quantitative analysis of alcohol in body fluids and tissues. Qualitative tests for carbon monoxide in the blood originated in the work of Hoppe Seyler (spectroscopic), Salkowski (alkali), and Stopczanski (dilution and tannic acid precipitation) between 1865 and 1889. In 1880, Fodor's palladium chloride reduction method allowed the quantitation of carbon monoxide in blood (Gettler 1956, Niyogi 1981, Decker 1987).

Textbooks of forensic medicine and toxicology proliferated throughout the nineteenth century. In Britain, the work of Christison was complemented by that of Alfred Swaine Taylor (1806–1880), an eminent medicolegal expert who wrote extensively on medical jurisprudence and toxicology. His books, which were based on his own experiences and incorporated legal precedents and judicial rulings, became standard texts which passed through numerous editions; the most recent (the thirteenth edition of *A Manual of Medical Jurisprudence*) appeared in 1984 (Coley 1991). A.W. Blyth's *Poisons: Their Effects and Detection* (1884) represented a valuable addition to the literature on analytical toxicology. In the United States, the first book pertaining to the symptoms and treatment of poisoning appeared in 1848: *A Practical Treatise on Poisons*, by O.H. Costill. In 1867, Theodore Wormley (1826–1897) published the first American text devoted exclusively to the experimental detection of poisons in organic mixtures, *The Micro-chemistry of Poisons*, which included the results of his original research. Within a few years, the professor of medical jurisprudence at the University of Pennsylvania, John Reese, produced a similar book (*Manual of Toxicology*, 1874), which he followed up a decade later with *A Text Book of Medical Jurisprudence and Toxicology* (1884) (Niyogi 1981, Wax 1994, Borzelleca 2001). During the later decades of the nineteenth century and those of the early twentieth century, a great amount of toxicological data was presented in the thorough textbooks of German scientists, particularly Kobert (*Compendium der praktischen Toxikologie*, 1887) and Lewin (*Gifte und Vergiftungen*, 1929) (Holmstedt & Liljestrand 1963). The latter is today especially remembered as the author of a toxicologist's view of world history: *Die Gifte in der Weltgeschichte* (1920).

The early part of the twentieth century is generally considered to mark the beginning of the development of the modern science of toxicology. However, the most rapid growth of the discipline occurred after World War II, as the production of organic molecules for use as drugs, pesticides, and industrial chemicals began to increase at an exponential rate (Gallo 1988). Today, toxicology is concerned with the many chemicals (there are now about 100 000 substances to which people could be exposed) that may be responsible for household, environmental, or industrial poisoning. While forensic and analytical toxicology continue to occupy an important position within the wider discipline, more and more attention has in recent years been paid to the biochemistry of toxin action, in an attempt to develop specific chemical antidotes. Modern toxicology utilizes skills and knowledge derived from pathology, pharmacology, physiology, biochemistry, chemistry, and statistics in order to study the quantitative effects of chemicals on living tissue (Oehme 1970, Loomis & Hayes 1996).

Research on anesthetic gases during the nineteenth century facilitated the development and use of poisonous war gases in the 20th (Leake 1975). Consequently, attempts to counteract the effects of chemical warfare agents and other toxic compounds – particularly arsenicals, introduced by Paul Ehrlich (1854–1915) for the treatment of syphilis – stimulated toxicological research after World War I. This resulted in the synthesis of the first specific chemical antidote, British anti-Lewisite (BAL), which was developed in 1945 by R. A. Peters, L. A. Stocken, and R. H. S. Thompson in Oxford. In a related development, the mechanistic studies which led to a better understanding of how chemicals exert toxic effects proved to be the basis for the synthesis of effective insecticides. During the 1940s,

the Swiss chemist Paul Müller discovered a compound, now known as DDT, which poisons insects when they come into direct contact with it. Some of the organophosphorus compounds developed for use as insecticides by Willy Lange and Gerhard Schrader during the 1930s and 1940s were so toxic that they are now classed as chemical warfare agents (Holmstedt & Liljestrand 1963, Marrs et al 1996).

With the use of increasingly powerful drugs and chemicals in the workplace and in therapeutics, it became clear that toxicology had an important role to play in public health: workers and consumers required protection from the adverse effects of chemical exposure, from food additives, and from other potentially toxic products. In Britain, the systematic application of scientific techniques to the detection and control of food and drug adulteration arose largely as a result of the work of the Society of Public Analysts, founded in 1874 (Stieb 1966). In the United States, concerns about adulteration were subject to congressional consideration for some three decades before the first American Food and Drug Act was passed in 1906 (Young 1989). This law was created under the impetus of Harvey W. Wiley (1844–1930), the head of the Bureau of Chemistry of the U.S. Department of Agriculture, and later influenced food safety legislation worldwide (Borzelleca 2001). There have since been a series of laws established, in the United States and elsewhere, that are designed to minimize public and, more recently, environmental encounters with harmful chemicals. Toxicologists are therefore required to provide accurate safety assessments when new chemicals of any kind are developed; the dose–response relationship for any adverse effect is particularly important (Doull & Bruce 1986).

The principal method used for assessing the safety of drugs, pesticides, food additives, and other chemicals prior to use is animal testing (bioassay), which can usually reveal the worst possible effects of a new substance. The 'toxicology database' is compiled by means of a set of 'testing protocol guidelines', which have been developed over the years (Doull & Bruce 1986). However, the thalidomide catastrophe of 1961 showed what the possible shortcomings of the system may be: studies do not always establish the full toxicity of the test agent, and most risk-extrapolation models that use the results of animal tests cannot allow for the fact that the test and target species are biologically different. This is one of the reasons why there is now an increasing social disquiet in regard to animal testing requirements and animal welfare. These concerns have led to the development of alternative methods in toxicology, particularly in vitro assays (Parascandola 1991), which are useful for prioritizing chemicals and for studying mechanisms of action. More recently, computer methods of predicting toxicity ('in silico' approaches) and the 'threshold of toxicological concern' concept have been incorporated into toxicity testing. Such methods do not presently satisfy the standards set by regulatory authorities, but they do allow reductions in animal numbers (Anderson & Russell 1995, Guengerich 2004, Kroes et al 2005). (Note: In vitro protocols are beginning to make inroads into regulatory agency acceptance. A good place to find out more about alternatives to animal testing is Johns Hopkins University's ALTWEB site, http://altweb.jhsph.edu/.)

Modern toxicology may be divided into six principal areas of application: regulatory, occupational, environmental, clinical, forensic, and analytical. In the United States, the eminent regulatory toxicologist Arnold J. Lehman (1900–1979) was instrumental in strengthening the commitment of the Food and Drug Administration (FDA) to toxicology. In 1955, he and his staff at the FDA published *Appraisal of the Safety of Chemicals in Foods, Drugs and Cosmetics*, the first attempt by the agency to provide guidelines for toxicological studies. Lehman's statement that 'anyone can become a toxicologist in two easy lessons, each of which takes ten years', has achieved the status of an adage among practicing scientists. Since then, significant contributions to the understanding of the mechanisms of action of various substances and to the establishing of safe exposure conditions (for humans and, where necessary, domestic and wild animals and plants) have been made by his successors at the FDA and other government agencies and by colleagues around the world (Borzelleca 2001). Regulatory toxicology will continue to have a vital role to play in setting standards, and is now beginning to adopt the interdisciplinary approach that will allow it to further evolve. For example, biological, computational, and statistical models must all be taken into consideration in assessing the risks associated with mixtures of different chemicals and with non-constant exposure patterns (Ryan 2000, Monosson 2005).

Occupational and environmental toxicologists study and monitor the causes, conditions, effects, and safety limits of exposure to workplace and environmental contaminants (Loomis & Hayes 1996). In many instances, there are clear links between industrial and environmental toxins: lead, for example, has long been a focus of debate, together with other heavy metals (Rosner & Markowitz 1987). During the nineteenth century, the use of arsenical insecticides led directly to the deaths of millions of bees and caused ill-health in humans and animals. This marked the beginning of public awareness of the fact that some substances can

be beneficial in one way but harmful in another (Whorton 1974). Similar problems occurred as a result of the introduction of DDT during and after World War II (Dunlap 1981). In 1962, the author of *Silent Spring*, Rachel Carson, touched off a heated debate about the links between industrialization and pollution when she claimed that 'we have put poisonous and biologically potent chemicals indiscriminately into the hands of persons largely or wholly ignorant of their potentials for harm' (Carson 1962). Although highly controversial, the book stimulated an organized approach to the study of chemical effects on ecosystems (Marco et al 1987, Davis 2001).

When cases of intoxication occur, the need for clinical toxicology becomes apparent: physicians are expected to make a correct diagnosis and implement appropriate treatment, which may involve delaying the absorption of the poison and/or enhancing its elimination (Flanagan & Jones 2001). Today, accidental and intentional self-poisoning contributes significantly to morbidity and mortality in many countries, most caused by household chemicals, drugs, pesticides, solvents, and carbon monoxide (Writer 1993). The establishing of poison control centers, the first of which opened in Chicago in 1953, has facilitated the compilation of information on the ingredients of pharmaceuticals and other industrial products and their toxicity, and has led to the creation of sophisticated information distribution systems. The ultimate aim is to quickly and accurately supply information to aid the diagnosis, treatment, and prevention of poisoning. Following an initial period of expansion, the introduction of national standards of service in the United States has led to a consolidation of the number of regional poison centers (62 in 2005), further encouraged (since 2000) by federal funding. Similar centers have been set up in many other countries; in Europe, the system has always been centralized (Tichy 1977, Wax 2006).

Since poisons continue to be significant causes of death and disease, forensic and analytical toxicology remain important sciences. Both employ the same methods and techniques but apply them to different ends. Forensic toxicology is concerned with intentional and accidental poisonings in relation to the law, while analytical toxicology deals with the detection, identification, and measurement of poisons and their metabolites in biological specimens (often for the purposes of screening patients, employees, athletes, etc., for drugs of abuse). Before the advent of spectroscopic and chromatographic methods in the early 1950s, chemical techniques for separating and identifying the increasing number of organic drugs were time-consuming and lacking in sensitivity. A steady process of technological development has made it possible to conduct rapid tests for a variety of compounds: gas and high-performance liquid chromatography, together with immunoassay techniques, now allow quantitation of most organic drugs, and electronic innovations continue to improve the sensitivity and specificity of analytical techniques (Fenton 2002). The detection of toxic metals in cases of chronic poisoning is achieved by mass spectrometric, electrochemical, radiochemical, and spectrophotometric methods; in acute cases, some chemical tests (e.g., Reinsch) remain relevant (Niyogi 1980, 1981, Decker 1987, Flanagan et al 1988). Although homicidal poisoning is now relatively infrequent (and often associated with healthcare professionals), recent serial (Harold Shipman, Michael Swango) and political cases (Viktor Yushchenko (2004), Alexander Litvinenko (2006)) serve as reminders that it has not gone away (Kinnell 2000, Wax 2006, Woods et al 2006).

During the past three decades, toxicological research has been increasingly devoted to a quantitative assessment of the probable health risks posed by chemicals to which humans might be exposed. Society is no longer willing to defer appropriate control until serious injuries have appeared (Lu 1996), and toxicological information is thus heavily relied upon by regulatory agencies responsible for prioritizing environmental health problems and policy (Fan & Chang 1996). Risk assessment and environmental regulations have, in effect, become the driving force behind how much of toxicology is now practiced in the United States. In the European Union, directives detail the requirements for toxicity and ecotoxicity testing necessary to comply with laws relating to the classification, packaging, and labeling of dangerous substances. Toxicity testing requirements are in fact remarkably similar across international boundaries (e.g. U.S., E.U., Japan, and Canada) (Woodward 1996).

Risk assessment is built upon a growing foundation of scientific knowledge that is mainly related to the recent advances made in our understanding of toxicology at the molecular level. This has followed directly upon the explosive growth of the science of molecular biology since methods for the sequencing of nucleic acids were developed in the mid-1970s. Together with biochemical (enzyme-oriented) approaches to the study of the metabolism of drugs and environmental toxicants, molecular toxicology has contributed to a better understanding of the nature, site, and mechanism of action of toxicants. Once the mechanism of toxicity of a compound is understood, it may be possible to design a replacement chemical that retains desirable properties but is less or non-toxic. The role played by genes in

metabolic activation and detoxification constitutes another leading area of research in modern toxicology (Josephy 1997), and the intelligent prediction of the genotoxicity of chemicals in simple systems today constitutes one of the major achievements in mechanistic toxicology (Guengerich 2005).

The molecularization of the life sciences has led directly to two new areas of toxicology: toxicogenetics (or genetic toxicology) and toxicogenomics. Genetic toxicology is an environmental health science concerned with the causes, effects, and long-term consequences of the genetic and chromosomal changes induced by exogenous agents (mutagens). These may be physical (e.g. radiation), biological (e.g. viruses), or chemical (on which the bulk of research to date has focused). It is both a laboratory and a regulatory science utilizing basic and applied approaches to achieve two aims: the determination of the impact of genotoxic agents found in the environment on the integrity of the human gene pool; and the application of genetic test methods to the detection and mechanistic understanding of carcinogenic processes (Frickel 2000, Brusick 2001). Toxicogenomics (the first paper using the term was published in 1999) developed as a deliberate combination of the fields of toxicology and genomics, and focuses on changes in gene expression resulting from exposure to xenobiotics; it thus is also of growing importance in health risk assessment. Gene expression profiles are seen as a means of enhancing knowledge of mechanisms of toxicity, classifying toxicants, and predicting toxicity and genetic susceptibility (Shostak 2005). It is the predictive capacity of toxicology in general that tends today to be seen as its most important future contribution to science, in drug development (Guengerich 2004, 2005), the effective extrapolation from animal to human models (Ryan 2000), in determining the genetic effects of chemicals (Monosson 2005), distinguishing between safe and toxic doses (Calabrese 2005), and more widely in risk assessment and risk management (Henry 2003).

It is clear that the development of toxicology as a recognized scientific discipline has proceeded at a rapid pace since the end of World War II, and its growth is likely to continue along interdisciplinary lines in the future. One of the most important consequences has been the establishing of training programs and the founding of scientific journals and societies (Borzelleca 2001, Gallo 2001). Graduate education in North America and Western Europe reflects the multidisciplinary nature of toxicology, as it is administered by a variety of university departments, including medicine (human and veterinary), pharmacy, pharmacology, chemistry, and public health. The modern toxicologist is thus a specialist in one or more branches of the field, as it becomes increasingly difficult for one individual to be qualified in all aspects of the science (Oehme 1970, Loomis & Hayes 1996). This specialization is mirrored in the hundreds of national and international organizations and journals that are dedicated to toxicology and related subjects. Toxicologists remain united, however, in their ultimate objective, which is the reduction of morbidity and mortality that occurs in humans and other living systems as a result of exposure to toxic substances. As the numbers and variety of potentially toxic chemicals continue to expand, so too does the science of toxicology.

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Key Figures and Documents

Georgius Agricola (original in Latin, 1556)
De Re Metallica
HC Hoover, LH Hoover, Trans. (1912)
London: Mining Magazine. A new edition was published in 1950 (Dover, New York).

At the time of its publication, this was the most exhaustive textbook ever written on mining and metallurgy, as well as on the workers in these fields. Entirely based on personal experience and observation, the book devotes a short section to the maladies of miners (Book 6, pp. 214–217): 'some affect the joints, others attack the lungs, some the eyes, and finally some are fatal to men'. The author recognized that arsenical poisoning can occur in shafts where the rock had been broken by fire and described the 'pernicious pests' (insects and 'demons') that inhabited mines.

Adrien Albert (1960)
Selective Toxicity, 2nd edition
New York: John Wiley & Sons.

This now familiar term was introduced to toxicology and pharmacology during a series of lectures delivered in London during 1948–49 and published in 1951. The second edition broadened coverage from chemotherapy to a wide variety of biochemical systems, and thus to a range of scientific disciplines in which chemical substances might effectively be used to injure some kinds of cells but not others with which they might be in close proximity.

Bernardino Ramazzini (original (2nd edition.) in Latin, 1713)
De Morbis Artificum Diatriba
WC Wright, Trans. (1940)
Chicago, IL: University of Chicago Press.

Ramazzini is regarded as the father of occupational medicine. His treatise describes the diseases of, among others, miners, gilders, chemists, tinsmiths, painters, sulfur-workers, mirror-makers, apothecaries, and tobacco-workers, and suggests methods of prevention and some remedies. He classified diseases as being caused firstly by the injurious character of the materials handled by workers, which emit noxious vapors; secondly, by unnatural postures of the body. Ramazzini was the first to recommend that physicians should enquire first of all as to a new patient's occupation.

Claude Bernard (and J. Pelouze) (1850). Recherches sur le curare

Comptes Rendus Hebdomadaires de l'Académie des Sciences 31: 533–537

Bernard and Pelouze studied the chemical and physical properties of curare and found that it kills without producing convulsions. They were able to explain the fact that the poison is relatively harmless when swallowed but fatal when injected by showing that the gastrointestinal mucous membrane does not permit its absorption into the bloodstream. They noted that the mode of action of curare is analogous to that of viper venom (cf. Fontana).

Claude Bernard (1857)

Leçons sur les Effets des Substances Toxiques et Médicamenteuses

Paris, France: Ballière.

Bernard used poisons as physiological instruments for the experimental study of the anatomical properties and functions of living organisms. This book considers the effects of, among others, nicotine, curare, potassium thiocyanate, carbon dioxide, carbon monoxide, and strychnine.

Robert Christison (1829)

A Treatise on Poisons, in Relation to Medical Jurisprudence, Physiology, and the Practice of Physic

Edinburgh, UK: Adam Black.

This is the first original and systematic English-language textbook of toxicology of the 19th century. Drawing together information gathered from French, German, and British periodicals, Christison intended his book to be an aid to the medical jurist who was faced with a case of suspected poisoning. He focused primarily on poisons commonly encountered in Britain and detailed the facts relating to their symptoms, pathology, physiology, and chemistry. His work contained many novel elements, including the idea that in many cases the aim must be to establish clearly the impossibility of poisoning.

EGC Clarke (ed.) (1969 and 1975)

***Isolation and Identification of Drugs in Pharmaceuticals, Body Fluids and Post-mortem Material*, 2 vols**

London: Pharmaceutical Press.

This book provides a reliable source of analytical data for drugs and other potentially poisonous substances, and it has therefore become a standard reference text for those concerned with the identification of poisons. Methods and techniques relevant to a wide variety of situations are included, so that the book is equally useful to forensic toxicologists, hospital biochemists, research workers, chemists, etc. Instructions for the use of the book are given in four languages and indicate the screening procedure to be followed when: the case is an emergency; there is evidence of the identity of the drug under investigation; there is no clue to the identity of the drug.

Papyrus Ebers (about 1550 BC)

B Ebbell, Trans. (1937)

Copenhagen, Denmark: Levin & Munksgaard.

Of the ancient Egyptian medical papyri, this is the longest and most complete. It consists, for the greater part, of recipes (many of which contain effective chemical substances) designed to treat various diseases and symptoms. The contents are much older than the date of writing and in later times were incorporated into the Greek materia medica, suggesting that this may be the first known pharmacopeia.

Felice Fontana (original in French, 1781)

Treatise on the Venom of the Viper; on the American Poisons; and on the Cherry Laurel and some other Vegetable Poisons

J Skinner, Trans. (1787)

London: J. Murray.

This is considered the first modern text of toxicology. Fontana identified fundamental questions and followed a rigorous experimental method in his research on the venom of the European viper, and he also studied curare and cherry laurel (hydrocyanic acid). He made important contributions to the fields of physiology, pharmacology, botany, chemistry, and anatomy.

François Magendie (and A. Raffeneau-Delile) (1809). Examen de l'action de quelques végétaux sur la moelle épinière

Nouveau Bulletin Scientifique de la Société Philomatique 1: 368–405

In a series of experiments on various animals, Magendie studied the toxic action of upas tieuté, nux vomica, St. Ignatius's bean, and other drugs of vegetable origin, thus marking the beginning of modern experimental pharmacology. He was able to show that upas and nux vomica (later shown to contain strychnine, a fact he had suspected) act on the spinal marrow, and was therefore able to conclude that drugs and poisons act solely by direct contact with target organs. Physiologists were thereby stimulated to further study the absorption and transport of drugs and poisons in living organisms.

Louis Lewin (1929)

Gifte und Vergiftungen

Berlin, Germany: Stilke.

In a single volume of nearly 1100 pages, Lewin summarized his own wide-ranging research and that of

others in the field of toxicology. His diverse interests allowed him to address the study of poisons and poisoning from an interdisciplinary point of view: he considered the historical, statistical, pharmacological, clinical, pathological, and sociological aspects of his subject. Toxicology is today a multidisciplinary field that attempts to extend this approach to scientific research.

Moses Maimonides (original in Arabic, 1198)
Treatise on Poisons and Their Antidotes
F Rosner (ed.) and Trans. (1984)
Haifa, Israel: Maimonides Research Institute.

The text is divided into an introduction (which praises the author's patron, the Vizier Al Fadhil) and two main sections. The first section deals with the bites of snakes and mad dogs and the stings of scorpions, bees, wasps, and spiders, with suggested treatment and remedies. The second section describes vegetable and mineral poisons and their antidotes. This treatise was translated into a number of languages soon after its appearance and served as a textbook of toxicology during the Middle Ages.

Nicander of Colophon (second century BC)
The Poems and Poetical Fragments
ASF Gow, AF Scholfield (eds.) and Trans (1953)
Cambridge, UK: Cambridge University Press.

Nicander was the author of two poems, *Theriaca* and *Alexipharmaca*, which provide the best cohesive sources for classical Greek toxicology. Both were based on the lost works of Apollodorus (third century BC), who wrote the first treatises devoted to the study of poisons. The *Theriaca* discusses the venoms and stings of snakes, spiders, scorpions, insects, lizards, and fish, and suggests remedies (mainly herbal, with some derived from animals). The *Alexipharmaca* describes vegetable poisons such as aconite, hemlock, henbane, and arrow poison, plus some others (blister beetles, fungi, salamanders, white lead); effects and antidotes are suggested throughout.

Paracelsus (original in German, 1567)
On the miners' sickness and other miners' diseases (G Rosen, Trans.)
In ***Four Treatises of Theophrastus von Hohenheim Called Paracelsus*** (1941)
HE Sigerist (ed.) Baltimore, MD: John Hopkins Press, pp. 43–126. A new edition was published in 1979 (New York: Arno Press).

Written in the 1530s but not published until long after the author's death, this monograph is entirely devoted to the occupational diseases of miners, particularly pulmonary ailments and mercury poisoning. The poisonous effects of various metals and the difference between acute and chronic toxicity are recognized. Influenced by his experience of mining and miners, Paracelsus developed generalized ideas about pathology and etiology which he used to explain the facts that he observed and the therapeutic remedies that he advocated.

Percival Pott (1775)
Cancer Scroti in Chirurgical Observations Relative to the Cataract, the Polypus of the Nose, the Cancer of the Scrotum, the Different Kinds of Ruptures, and the Mortification of the Toes and Feet
London: Hawes, Clark, and Collins.

Pott linked the occupation of chimney sweeps with cancer of the scrotum. This observation that chimney sweeps in 18th-century England suffered from a higher than expected incidence of scrotal cancer is a landmark in occupational disease, carcinogenesis, and epidemiology. '. . . every body is acquainted with the disorders to which painters, plummers, glaziers, and the workers in white lead, are liable: but there is a disease as peculiar to a certain set of people which has not, at least to my knowledge, been publickly noticed; I mean the chimney-sweepers' cancer'.

Selected References in the History of Toxicology

Note: This section should be used in conjunction with the bibliography appended to the previous part of this chapter, and includes books and articles in a variety of languages.

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CHAPTER

3

Development of Toxicoinformatics

STEPHANIE HOLMGREN

INTRODUCTION

Toxicology information systems have evolved swiftly from early, library-based bibliographic tools to advanced packages utilizing sophisticated computer and telecommunication technologies. These systems have evolved concurrently with the rapid expansion of the science of toxicology itself. Bibliographic files such as TOXLINE represent first attempts to handle the toxicology literature through online retrieval. Subsequent approaches applied the use of computers to provide literature-derived data, as in the HSDB or RTECS databanks, or to capture data directly from the laboratory. More advanced systems are utilizing computational and analytical approaches to extract knowledge from the laboratory data to predict outcomes. Societal concerns about hazardous substances, manifested in legislation and regulations, have been responsible for the generation of much toxicity information and the impetus to systematically collect and disseminate these data. Scientific progress in molecular biology, chemistry, and bioinformatics combined with advances in information technologies are also impacting the supply of toxicology information. The amount of information has risen dramatically over the years and it is more accessible and current than ever before. However, in order to derive meaning from the mounds of data and information, the field must rise to the challenge of fostering data accessibility, promoting data standards, and ensuring data quality.

THE REALM OF TOXICOLOGY INFORMATION

The field of toxicology has witnessed an unprecedented growth within the past 30 years. This explosion in subject matter, stemming largely from social concerns and matched by equally rapid technological innovation as well as scientific progress, has resulted in a serendipitous marriage between toxicology information and advanced systems to organize, analyze, and disseminate this information. This section will briefly define toxicology and describe the three influences on the growth of toxicology information.

As an applied science, toxicology seeks to protect biological systems against the unwanted effects from exposure to potentially harmful agents. Prior to the 1960s, toxicology was considered a sub-discipline of pharmacology and focused its attention on the safety of existing and proposed pharmaceutical and consumer products. However, environmental disasters throughout the 1950s and 1960s, such as the mercury poisonings in Minamata and 'killer fog' in London (Kovarik, 2006) edged toxicology closer to the forefront of environmental issues. A 1960 conference entitled 'Problems in Toxicology' (Coon 1960) brought together distinguished scientists to address not only food, drug, and cosmetic control but environmental chemicals, pesticides, industrial chemicals, radioactive materials, and more. The conference theme was that 'toxicity is suddenly upon us as a social problem' (Coon & Maynard 1960).

It took two more years with the 1962 publication of *Silent Spring* (Carson 1962) for the public to be jolted into an awareness of the dangers associated with the uncontrolled production and use of thousands of chemicals. Toxicology became caught up in the tide of the environmental movement. It moved out from under pharmacology's shadow and began to develop into a full-scale discipline of its own.

One of the key characteristics of toxicology is its multidisciplinary nature – drawing upon advances in chemistry, biology, genetics, statistics, and other sciences. As well, toxicology has spawned numerous subspecialties of its own; e.g., ecotoxicology, forensic toxicology, veterinary toxicology, clinical toxicology, to name a few.

As the discipline has grown, so too has the demand for and supply of toxicology information. Numerous and diverse groups have need for toxicology information, from research scientists and pharmaceutical drug developers to occupational hygienists and members of the public. How toxicology information is used is as varied as the type of users:

- to enhance understanding of how environmental agents affect biological, chemical, and genetic mechanisms
- to assess the risk of a chemical exposure
- to support regulatory decision-making
- to ensure effective and safe drug development
- to minimize or eliminate public and occupational exposures to hazardous substances.

Each application drives the type of information needed. Therefore, toxicological information takes many forms:

- Raw laboratory data (quantitative, qualitative, and descriptive) related to chemical properties, physical properties, toxic endpoints, etc.
- Field data that capture incidence statistics, exposure data, hazard monitoring, accidental release levels, etc.
- Visual images in the form of pathology slides, gene expression data, histochemical profiles, etc.
- Textual content from statutes/regulatory information, articles, technical reports, etc.

The demand for and supply of toxicology information has been powered by the interplay among three influential forces – regulatory measures, scientific progress, and technological advances.

Regulatory measures

In the early history of toxicology, regulatory and legislative efforts served as the impetus for the development of toxicology information systems. Prior to the mid-1970s, few toxicology-specific information resources existed. The environmental movement of the 1970s and societal concern regarding chemical hazards were translated into legislation and regulation mandating information dissemination of public and environmental health threats. The subsequent development of toxicology information systems to track and manage the requisite data can be attributed to these legislative efforts.

One of the earliest regulatory measures was the 1938 Food, Drug and Cosmetic Act which required an assessment of drug safety before marketing. The thalidomide birth defect scare in Europe prompted the Act to be amended in 1962. These amendments strengthened reporting requirements, resulting in increased generation of data related to efficacy, safety, and clinical experience; the maintenance of records; and the creation of corporate systems to handle these data.

The Occupational Safety and Health Act of 1970 called for the publication of 'a list of all known toxic substances by generic family or other useful groupings and the contractions at which such toxicity is known to occur' (Section 20(a)(6)). In compliance with this directive, the Toxic Substances List was published in 1971. This was the forerunner of RTECS. Other databases, such as IRIS, Genetox, DART, and others, have all been made possible under the EPA mandates for public dissemination of toxicity information on chemicals in general use.

The landmark 1976 Toxic Substances Control Act (TSCA) attempts to control the introduction, production, distribution, or use in commerce of any chemical that presents an unreasonable risk of injury to health or the environment. In response to the information-gathering requirements, the TSCA Chemical Substances Inventory was created to track chemicals in commerce. Requirements for the extensive testing of chemical substances developed after 1976, as well as for the reporting and retention of information by manufacturers, have resulted in the creation of numerous corporate information systems (Kraska 1995) and both internal and public EPA files.

The Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA, also known as the Superfund Act), authorized liability, compensation, cleanup, and emergency response for hazardous substances released into the environment and the cleanup of inactive hazardous waste disposal sites. It mandates the establishment of the Agency for Toxic Substances and Disease Registry, whose administrator will 'establish and maintain an inventory of literature, research, and studies on the health effects of toxic substances' (Section

104(I)(2)). Title III of the Superfund Amendments and Reauthorization Act (SARA) was directly responsible for the creation of the Toxic Chemicals Release Inventory (TRI).

The Hazard Communication (or Right-to-Know) rules first issued by the U.S. Department of Labor in 1983, and similar laws enacted by many states and municipalities, require that workers be informed by their employers about chemicals to which they are being exposed in the workplace. Among other requirements, the rules mandate written hazard communication programs, labels as hazard warnings, and extensive development of material safety data sheets (MSDS). Compliance with this law has made available to workers, customers, and the general public a considerable amount of toxicological data only previously available through internal company files (Kraska 1995).

Similar hazard communication initiatives have been implemented at national, regional, and international levels, resulting in a cacophony of hazard classification definitions and labeling systems. Accordingly, the same chemical may have multiple labels as well as safety data sheets in order to be sold both within the U.S. and worldwide. In 1992, the United Nations Conference on the Environment and Development (UNCED) identified the need for a globally harmonized system of classification and labeling of chemicals (GHS). The intent of the GHS is to create a united approach to defining and classifying chemical hazards and to communicating such hazards through labeling and safety data sheets (Silk 2003). Officially adopted by the United Nations in 2002, the goal is to have countries implement the GHS by 2008. In the short-term, companies and governments will need to modify their existing regulatory and information systems to capture the changes in hazard classification, chemical property information, pictograms, as well as new safety data sheet elements. In addition, database systems that aggregate hazard communication information will also need to be altered. The benefits in the long-run are that companies will not have to maintain multiple labeling and data sheets for every chemical they produce and workers, consumers, emergency responders, and transport workers will no longer be confused by a myriad of different schema.

The laws listed above and others – such as the Clean Air Act (1963) and Amendments (1997), the Consumer Product Safety Act (1972), the Federal Insecticide, Fungicide and Rodenticide Act (1972), the Resource Conservation and Recovery Act (1976), and the Safe Drinking Water Act (1977) – have been responsible for many of the currently available governmental and private information systems (Merrill 1996).

Information disclosure as part of regulatory directives is not just an American phenomenon. The accidental exposure of a population in Seveso, Italy to high levels of dioxin highlighted the need for legislation to improve the safety of industrial sites and recognized the importance of the European public's 'need to know' about the risk of exposure and safety procedures. The resulting Seveso Directive (Directive 82/501/EEC) and its Annex VII requires public dissemination of information regarding major industrial hazards and associated safety protocols. Both the Major Accident Reporting System (MARS) databank and the Community Documentation Centre on Industrial Risk (CDCIR) were created to meet these information mandates (De Marchi et al 1996).

One of the more recent government initiatives to impact toxicology information is the Data Quality Act (also known as the Information Quality Act) enacted in December 2000. The Data Quality Act (DQA) is composed of just two paragraphs incorporated into the Treasury and General Government Appropriations Act (Pub L. 106-554, 114 Stat. 2763A-153). The Act directs the Office of Management and Budget to establish government-wide guidelines that 'provide policy and procedural guidance to Federal agencies for ensuring and maximizing the quality, objectivity, utility, and integrity of information (including statistical information) disseminated by Federal agencies' (Sect. 515 Appendix C). In addition, federal agencies must provide a means for interested parties to contest the accuracy of the information.

The main consequence of the Act has been the filing of numerous petitions by industry to cast a shadow on the quality of information about to be used in upcoming regulatory decisions. By way of example, three 'requests for corrections' were made during the first year of the law's implementation (SKAPP). All three requests disputed study results associated with protecting the public or workers from effects due to atrazine, salt intake, and asbestos. Numerous other challenges have been made in recent years (OMB Watch 2005).

While proponents argue that DQA 'establishes a mechanism to hold government accountable for the quality of the information disseminated' (SKAPP), others see it as a tool to 'delay, manipulate, and unfairly affect the outcome of federal agencies' activities' (OMB Watch 2007). It remains to be seen what lasting effect the Data Quality Act will have on the dissemination and utilization by the government of toxicology-related information.

Without a doubt, increased social awareness and regulatory measures to protect workers and the public provided the initial thrust behind the surge in

toxicology information. Indeed, it has been suggested that pressure from the regulatory arena drives the development and evolution of toxicology (Doull 1984). Yet, in recent years, advances in both scientific progress and technological innovation have been largely responsible for propelling forward the supply of toxicology information, both in terms of volume and quality.

Scientific progress

As noted earlier, toxicology incorporates knowledge from a variety of other disciplines. As these fields develop, so too does toxicology. Scientific progress, especially in the spheres of molecular biology, bioinformatics, and chemistry has played a profound role in expanding the toxicology knowledge base and fostering new toxicology information systems.

Molecular biology

Molecular biology has been revolutionized by advances in hardware (automation, DNA sequencing, mass spectroscopy, microarrays, etc.) and new experimental techniques (polymerase chain reaction, siRNA, RNAi, etc.). The resulting sequencing of various genomes, analyses of gene expression, and insights into protein structure have opened new vistas in understanding the molecular basis of biological activity. Subdisciplines have emerged, each with their own tools and techniques, to study specific gene-activated molecules: genomics (DNA/RNA), proteomics (proteins), and metabolomics (metabolites). Toxicology is incorporating this new 'omics' knowledge into its own subdiscipline, toxicogenomics. The knowledge gained in understanding cellular networks and pathways will be critical in elucidating the mechanisms of toxic events.

The massive data generated from these studies are being captured in a multitude of mostly public databases – nucleotide sequences (e.g., GenBank, EMBL), protein sequences (e.g., SwissProt, RefSeq, UniProt), gene (e.g., OMIM, dbSNP), genome (e.g., Mouse Genome Database, VirGen), gene expression (e.g., ArrayExpress, OncoMine), metabolic pathways (e.g., PathDB, LIGAND) (Oxford University Press, 2006). Starting in 1996, *Nucleic Acids Research* began devoting its January issue to highlighting new molecular biology databases of interest to experimental and computational biologists. The resulting Molecular Biology Database Collection now amounts to 968 databases, up 110 from last year (Galperin, 2007). The growth in these databases signifies the richness of knowledge being uncovered. As well, the dissemination efforts in this area exemplify the global trend towards open public access to research.

Ultimately, the goal is to integrate the biochemical 'omics' knowledge with the physiological parameters to build a cohesive model of the biological system (Anand & Mehendale 2005). This new field, systems biology, relies on computational methods to construct a comprehensive model of the interplay among the key biological components (Ideker et al 2001, Hurban 2004). In addition, success will depend upon unique collaborations and partnerships among researchers from varying disciplines (Hurban 2004). Towards that end, the Institute for Systems Biology was designed to 'transcend traditional organizational and disciplinary barriers' (Institute for Systems Biology 2006). Likewise, the National Center for Toxicogenomics at NIEHS was created to facilitate a cohesive strategy for advancing toxicology using a systems approach. The focus of its effort is the Chemical Effects in Biological Systems (CEBS) database (discussed below).

Bioinformatics and computational biology

The insights from 'omics' research would not be feasible without the corresponding development of bioinformatics (Witkamp 2005). The magnitude of data and information garnered through the 'omics' technlogies, such as DNA sequences, transcriptional changes, protein networks, and metabolic pathways, must be properly organized and structured before it can be analyzed. Bioinformatics has emerged to meet the challenge. The union of biology, computer science, linguistics, statistics, among other fields has become indispensable as more high-throughput approaches are used for molecular analyses. Utilizing algorithms, text and data mining, and visualization techniques, bioinformatics generates computational, or in silico, approaches to answer complex biological questions (Reynolds 2005).

Although bioinformatics is also referred to as computational biology, attempts have been made to distinguish the two terms. Typically, bioinformatics refers to the collection, management, and dissemination of data, whereas, computational biology is the application of the data to understanding biological activity (Schmidt 2003a). At a basic level, bioinformatics is represented by the various databases, such as GenBank, that are strictly repositories of data structured for easy retrieval. At an intermediary level are tools, such as BLAST or SAGEmap, that perform insightful sequence alignment and function and structure analysis. Finally, more complex computational biology is exemplified by sophisticated information

systems, e.g., expert systems, which integrate data from multiple sources to solve multifaceted problems.

The need to incorporate data types from other disciplines combined with the sheer magnitude and complexity of data, make bioinformatics essential to toxicology research. The significance of the role can be seen in the number of courses, books, journal articles, forums, and organizational departments now devoted to computational toxicology.

Bioinformatics and computational toxicology have infiltrated every aspect of toxicology research – from risk assessment and hazard identification to drug development and predictive toxicity. The expectation is that computational toxicology will resolve many of the complex challenges still facing the discipline – calculating low dose–response curves, extrapolating animal toxicity results to human outcomes, discerning the toxicity of chemical mixtures, and uncovering the key to individual susceptibility (Anand & Mehendale 2005).

Chemistry

Because toxicology is concerned with the effects of chemicals on biological systems, chemical information is inherently part of the toxicology domain. The history of chemical information is quite long, so this section will merely highlight chemoinformatics developments that support progress in toxicology. Chemoinformatics is often defined as 'any activity related to the application of information technology to the study of properties, effects and uses of chemical agents' (Rosania et al 2007).

The need for chemoinformatics has been driven by the general increase in the number of compounds discovered (estimated at 1 million/year), the corresponding amount of information becoming available on these compounds, and the resulting complexity of the chemical questions that need to be resolved (Engel 2006). The array of chemical information is diverse, incorporating bibliographic text, physiochemical properties, spectra, structure, reactions, etc. *Chemical Abstracts*, one of the first bibliographic print indices, was also one of the first to convert to digital form in the 1950s. Databank repositories extract chemical property and spectra data from print sources such as *Beilstein Handbook of Organic Chemistry* and *Gmelin Handbook of Inorganic Chemistry* into their online equivalents. A third form of database captures the crucial chemical structure and reaction information (Engel 2006). CAS Registry is the largest and most comprehensive structure database for organic and inorganic compounds, peptide sequences, proteins, and nucleic acids (CAS 2007). ChemReact, CASREACT, ChemInform, among others provide chemical reaction information.

Searching for chemical substances by name, structure, or property is critical to utilizing chemical and toxicology information systems. Varying naming conventions and synonyms make it a challenge to search for a substance in a uniform manner. Accepted descriptive chemical nomenclature has been developed by both the International Union of Pure and Applied Chemistry (IUPAC) as well as the Chemical Abstracts Service. Numerical systems, such as Beilstein's Lawson number and CAS Registry Numbers, assign a unique identifier to each substance that denotes some chemical family and structure information (Wright 2001).

Early structure searching relied on chemical nomenclature and linear notation because initial computing systems could not interpret two-dimensional structure diagrams (Chen 2006). Chemical representation has since evolved from line notation (e.g., Wiswesser, SMILES) and matrices, to connection tables and 3D computer-based representations (e.g., CORINA, CONCORD) (Engel 2006). Two relatively recent initiatives to encode chemical information to enhance machine-readability include IUPAC's InChI (http://inchi.info/) and the Chemical Markup Language (CML), based on the XML schema (http://www.xml-cml.org/).

Structure locator services, such as ChemFinder (http://chemfinder.cambridgesoft.com/) and ChemIDplus (http://chem.sis.nlm.nih.gov/chemidplus/), maintain a central listing of chemical structures and provide full structure-searching capability, usually through structure software like ChemDraw (Richard et al 2006). These tools link textual information with the chemical structure and property data.

Chemical modeling and computational chemistry require extensive and well-annotated data sets to develop machine learning methods and conduct in silico processing (Gasteiger 2006). Inhibiting the research effort has been the proprietary ownership of the popular small molecule databases, such as MDL's Available Chemicals Directory and the American Chemical Society's CAS Registry (Chen et al 2005). However, in recent years, several public initiatives are fostering the ability to interconnect data sets and export data in formats capable of rigorous analysis. Among these are ChemDB, Harvard's ChemBank, UCSF's ZINC, and the European Bioinformatics Institute's ChEBi. Each database has its own unique combination of objectives, data set size, and informatics capabilities (Chen et al 2005). PubChem (http://pubchem.ncbi.nlm.nih.gov/), available through the NCBI's Entrez system, integrates chemical, structural, and biological properties of over 12.8 million small molecule compounds. The backbone of PubChem is

comprised of three databases: PC Substance, PC Compound, and PC BioAssay, focusing on substance information, compound structures, and bioactivity data, respectively. The database has been enriched through connections to other Entrez databases.

Beyond databases, more advanced expert systems are being developed for computer-assisted structure elucidation (CASE) and synthesis design (CASD) as well as quantitative structure–activity relationships (QSAR) (Chen 2006). It is through QSAR that toxicologists are starting to predict in silico the toxicity of a chemical.

The next trend is the fusion of bioinformatics (the large-molecule space) with chemoinformatics (the small-molecule world). That union is necessary to correlate the chemical's structure and its reactions with the chemical's associated biological effects (Gasteiger 2006).

Chemoinformatics faces several challenges in the coming years. First, researchers need more comprehensive and validated data sets. These data sets need to not only be publicly available, but well-annotated, standardized, and interconnected. Finally, more efficient analytical tools are needed to extract knowledge from these large-scale repositories (Mallard 1999, Chen et al 2005).

Technological innovation

The unprecedented leaps in computing speed, hard disk size, and memory space have facilitated the storage, retrieval, analysis, and dissemination of ever-increasing volumes of data and information. As a result, the paper-based tools of card catalogs and indexes have been transformed into fully searchable databases.

Telecommunications and digital networks form the backbone of the Internet and World Wide Web, making it possible to freely share a wealth of information not only locally, but globally as well. Web browsers, search engines, subject directories and hypertext support information retrieval on the World Wide Web. Electronic mail, listservs, instant messaging, and discussion groups facilitate social networking and person-to-person communication. Wireless communication networks are enabling portable, handheld devices to be used in a variety of applications. The National Library of Medicine has reviewed a handful of these toxicology-related PDA software programs (National Library of Medicine 2006).

In addition, analytical tools and instruments have increasingly become integrated with computing systems to create a seamless flow of capturing and storing to analyzing and interpreting data. One of the earlier systems, developed by the National Center for Toxicological Research in the late 1970s, permitted collection, processing, and analysis of large-scale, rodent-based tests (Lawrence et al 1977). On a much larger scale, Xybion's PATH/TOX (http://www.xybion.com/index.php?pg=51) system integrates toxicology, pharmaceutical, histology, pathology, necropsy, and other laboratory activities into a unified comprehensive data acquisition and management system. Usually, such data-collecting and -processing systems are intended for support of research and testing within an organization and the resulting data banks are not usually accessible to outsiders. However, the advent of the Internet and increasing researcher expectation are gradually encouraging open data accessibility.

Some examples of databases that are making research results publicly available include the various NCBI *Entrez* molecular biology databases such as GenBank and the Swiss Institute of Bioinformatics ExPASy server for proteomics. These centralized databases provide a web interface for any researcher to upload data and perform queries. Another form of open access data sharing is through federated data sites where each facility maintains its own site, but a central interface allows researchers to search across the multiple resources. The Biomedical Informatics Research Network (BIRN) was developed in this mode. Funded by the National Institutes of Health, BIRN is a 'geographically distributed virtual community of shared resources offering tremendous potential to advance the diagnosis and treatment of disease' (Biomedical Informatics Research Network 2007).

These technological advances have created a paradigm shift in scientific discovery. The most visible impact can be seen in the generation, utilization, and dissemination of exponential volumes of information. The ironic consequence is that technological progress has generated an ever-expanding volume of data, requiring yet faster and more powerful information systems to manage it all. But more significantly, technology has embedded itself into the core of the scientific research process – impacting what approaches are used, the rate of progress achieved, and the direction of research effort. The discipline of toxicology is not immune to technology's influence. The conduct of toxicology has been recast with an increased reliance on technology-driven approaches.

BACKGROUND IN TOXICOLOGY INFORMATION SYSTEMS

The above three factors have generated a plethora of reports, articles, toxicity tests, etc., subsequently prompting a need for information systems to collect,

organize, manage, and analyze the influx of data and information stemming from these sources. This section will briefly define information systems and highlight the seminal role of the National Library of Medicine in advancing toxicology information systems.

What is an information system?

While today we tend to presume an information system requires computing technology, in fact, it may be 'automated or manual and comprises people, machines, and/or methods' (ATIS 2007) to 'capture, transmit, store, retrieve, manipulate, or display information to serve a specific purpose' (Alter 1996).

The intended purpose of the information system defines the type of data, structure, and interface to be used in the system. When dealing with the hybrid nature of toxicology, an added challenge exists of managing information from diverse disciplines, each with its own terminology, datasets, methodologies, and technologies.

Early toxicology information systems

Toxicology literature began as early as 1500 BC with the Ebers Papyrus describing the effects of poisons (Doull 2001). The discipline did not find its own publication voice until 1930 with the *Sammlung von Vergiftungsfällen* [*Archives of Toxicology*] (Copestake 1999). A 1959 editorial in the first issue of the English journal *Toxicology and Applied Pharmacology* stated that the journal was needed because 'toxicology is emerging as a scientific discipline and that there is a need for centralization of toxicology data' (Doull 2001). Until the 1970s, printed matter and professional meetings were the primary mechanism for information dissemination in the field.

The subsequent growth in publishing brought on by increased demand for toxicology information due to regulations and researcher interest, spurred the need for a way to manage and track the literature. Indexing and abstracting tools were consequently developed to capture the wealth of information encapsulated in the journal articles. Such reliable standards as *Biological Abstracts, Chemical Abstracts, Excerpta Medica*, and *Index Medicus* offered means of tracking toxicology literature (Smyth 1960), albeit in a limited way by today's standards. Still, no information systems were dedicated to serving the toxicologist, to pull together and make readily accessible the far-flung data being generated by increased testing and appearing in an increasing array of publications.

One of the key documents providing an insight into the dissemination of toxicology information was the 1966 Report of the United States President's Science Advisory Committee entitled 'Handling of Toxicological Information' (President's Science Advisory Committee 1966), known here as the PSAC Report. The PSAC Panel expressed its concern about the dispersion of toxicological information over a large area of the published journal literature, published and unpublished reports, and unpublished information files of industrial companies and government agencies. The panel's major finding was that 'there exists an urgent need for a much more coordinated and more complete computer based file of toxicological information than any currently available, and further, that access to this file be more generally available to all those legitimately needing such information' (PSAC, p. 212). The recommendations of the PSAC Panel led, in 1967, to the establishment of the Toxicology Information Program (TIP) at the National Library of Medicine (NLM) (Miles 1982).

Leading the computing wave: NLM's Toxicology Information Program

The TIP came into existence around the same time that computing technology, networks, and telecommunication links were becoming mainstream applications. NLM took advantage of this technology to develop MEDLARS (Medical Literature Analysis and Retrieval System) in 1964, followed in 1971 by MEDLINE, the online version of *Index Medicus*. As part of NLM, the Toxicology Information Program was able to leverage this expertise and, as a result, has played a key role in effectively employing technology to make toxicology information widely and publicly available.

The Toxicology Information Program's first initiative was to launch TOXLINE, the only available comprehensive bibliographic electronic database of toxicology literature. The program developed further fact-type databases for chemical (Chemline and ChemID) and toxicological (Hazardous Substance Data Bank) applications. Either because of legislative mandate or out of a desire to make their information more broadly accessible, other federal agencies contributed their databases to the TIP network; e.g., the Environmental Protection Agency's GENE-TOX and IRIS (Integrated Risk Information System) and the National Cancer Institute's CCRIS (Chemical Carcinogenesis Research Information Systems). As the breadth and number of databases continued to expand in the network, a need emerged to aggregate the sources within a single 'portal'. In 1985, TOXNET was developed to meet that need. It currently provides access to TOXLINE, HSDB (Hazardous Substance

Data Bank), ChemID*plus*, IRIS (Integrated Risk Information System), ITER (Integrated Toxicity Estimates for Risk), GENE-TOX, ALTBIB (Bibliography on Alternatives to Animal Testing), among others. An added feature of TOXNET is the ability to search across multiple databases at one time.

The program's name was changed to Toxicology and Environmental Health Information Program (TEHIP) in 1994 to reflect its expanded role in creating, organizing, and disseminating environmental health information. In 1995, the Institute of Medicine (IOM) formed the Committee on Toxicology and Environmental Health Information Resources for Health Professionals. The task of this committee was to investigate the information needs of health professionals and to recommend to the NLM the role it should play in organizing and directing access to environmental health and toxicology information. The committee's findings (Liverman et al 1997), like the 1966 PSAC Report, supported the importance of ready access to environmental and toxicological information and the continuing need for coordination to assist in this endeavor. The committee also declared that since the environment is increasingly recognized as having an impact on human and ecological health, there is a far larger and diverse potential audience for this type of information. And finally, the committee recognized the importance of the NLM in playing a key role in organizing and providing pointers to all available toxicology and environmental health information.

Today, TEHIP, through its Environmental Health and Toxicology website (http://sis.nlm.nih.gov/enviro.html), offers access to a comprehensive array of resources spanning toxicology, hazardous chemicals, environmental health, and related areas of importance to health professionals, the general public, scientists, and policymakers. Besides the TOXNET databases, other available resources include ToxTutor, a tutorial on the basics of toxicology, and DIRLINE, a directory of useful resources in health, biomedicine, and toxicology. ToxSeek is a recently incorporated customizable metasearch and clustering engine for toxicology and environmental health topics. Among future projects is a Dietary Supplements Labels Database, and the World Library of Toxicology, Chemical Safety, and Environmental Health, a curated gateway to quality web resources around the world (Wexler 2004).

THE TECHNOLOGY WAVE IN TOXICOLOGY INFORMATION SYSTEMS

Virtually all toxicology information systems now rely on a database infrastructure to systematically store a collection of data or information in order to facilitate retrieval. As a result, toxicology information systems have evolved as new programming software and tools have enhanced database management systems. Early database systems of the 1980s used relational databases and structured query language (SQL) to facilitate easier searching and quicker retrieval of information from the database. However, as the volume and complexity of data expanded, the need to support browsing and intricate queries became important. Object-oriented programming was developed in the 1990s as a solution. At the same time, Java, ColdFusion, and other tools were being used to integrate databases with the new online world of the World Wide Web. The latest trend is to convert database content into an XML (Extensible Markup Language) format in order to exchange data between disparate systems. As larger (terabyte and even petascale) systems continue to develop, more will be required of the technology to handle and analyze the data.

Database content has typically taken two forms: literature-based and fact-based. However, the recent computing advances have added a third form, knowledge-based.

Literature-based (referential)

Bibliographic retrieval systems, whether online or in printed form, are referential in that they direct the user to published literature that contains the sought-after facts.

As mentioned previously, the earliest toxicology information system with a database backbone was TOXLINE, a one-stop source for bibliographic information in toxicology. The original intent to follow the MEDLINE lead and 'mechanize' an existing abstracting and index (A&I) source for online bibliographic retrieval had to be adjusted because no one secondary source adequately covered the field of toxicology. It was decided, therefore, to combine 'toxicology subsets' from various A&I services into one file that would look reasonably homogeneous to the online user. Thus, TOXLINE initially incorporated relevant segments from *Index Medicus, Biological Abstracts, Chemical Abstracts*, and *International Pharmaceutical Abstracts* (Bauden 1979, Schultheisz 1981).

Because of the continual growth of toxicology information in the published arena, TOXLINE did not reach its goal of becoming the single 'one-stop shopping center' for toxicology information, but one of a number of online databases to be consulted for comprehensive retrieval of information (Schultheisz et al 1978, Bac 1980). As a result, several changes were made in 2000 to TOXLINE. Since a significant portion of TOXLINE

citations come from MEDLINE, NLM created an independently searchable toxicology subset in PubMed to offer medical subject headings (MeSH), related articles, document delivery, and link-out features. The remaining TOXLINE subsets fall into areas such as technical reports and research projects, meeting abstracts, other special literature (such as the RISKLINE database from the Swedish Chemicals Agency and the CIS database from the International Labour Office), plus a variety of archival collections (e.g. Pesticides Abstracts, Poisonous Plants Bibliography, etc.) still retained and relevant, but no longer being updated (Goshorn 2001).

Other non-NLM toxicology-related bibliographic databases include BIOSIS, Enviroline (from the Congressional Information Service), TSCATS (EPA) and Pollution Abstracts which covers environmental fate and release literature. Cancer-related literature is accessible through two National Cancer Institute funded resources, CANCERLIT, now a subset in PubMed, and the *Chemical Carcinogenesis Research Information System* (CCRIS) file, available through TOXNET. Pesticide information is available in the Crop Protection File (Derwent) and AGRICOLA (National Agricultural Library) files. NIOSHTIC-2 (U.S. National Institute for Occupational Safety and Health) and the CIS file from the International Labour Office cover the bibliographic records for occupational exposure to chemicals and other toxic hazards.

Fact- or data-based (descriptive)

Facts and data are often extracted from primary sources, such as handbooks, and provide data elements or descriptive facts related to the subject. While *data* and *fact* tend to be used synonymously, *data* often connote numeric values, while *facts* represent observations that are described in words (Wright 2001). The descriptive elements may cover the substance's identity, chemical/physical properties, structure, production or use, environmental fate and level of release, occupational health and safety limits and guidelines, and toxicity data (dose/response, pathology, effects, etc.).

Initial toxicology databanks were literature-derived factual data stores such as the U.S. government-sponsored systems HSDB (Hazardous Substances Data Bank), RTECS (Registry of Toxic Effects of Chemical Substances), and IRIS (Integrated Risk Information System).

The HSDB (http://www.nlm.nih.gov/pubs/factsheets/hsdbfs.html), built and operated by the NLM, was started as the Toxicology Data Bank (TDB) in 1978 to provide users online, interactive access to evaluated toxicological data. All data are referenced and derived from a core set of books, government documents, technical reports and selected primary journal literature. HSDB is peer-reviewed by the Scientific Review Panel (SRP), a committee of experts in the major subject areas within the databank's scope. The HSDB, with over 150 data elements and over 5000 chemical records, is organized as a handbook of compounds with their chemical, physical, toxicological, and environmental attributes. It focuses on the toxicology of potentially hazardous chemicals and is enhanced with information on human exposure, industrial hygiene, emergency handling procedures, environmental fate, regulatory requirements, and related areas.

The Registry of Toxic Effects of Chemical Substances (RTECS) is a compilation that provides brief descriptions of substances for which acute or other toxic effects have been reported in the literature. As with other toxicology information systems intended to support U.S. health and safety initiatives, the RTECS system has been mandated by the U.S. Congress and is created under the sponsorship of NIOSH. The original edition, known as the Toxic Substances List, was published on June 28, 1971 and included toxicological data for approximately 5000 chemicals. RTECS now contains over 160 000 chemicals, providing nomenclature, CAS registry numbers, and mutagenic, teratogenic, and carcinogenic effects data, as well as references to government regulations and standards. RTECS is available through several commercial vendor systems (e.g., Dialog, MDL, Micromedex/Tomes, STN International) and not as part of the TOXNET Web database offerings.

Two toxicology literature-based systems are the Carcinogenic Potency Database (CPDB, http://potency.berkeley.edu/cpdb.html) by University of California at Berkeley and the Lawrence Berkeley National Laboratory and the Genetic Toxicology Database (GTD) developed by the U.S. National Toxicology Program. Both databases captured the results of chronic, long-term animal tests that had been published in the literature through 1998. A variety of qualitative and quantitative data was analyzed and included species, strain, route of administration, dose duration, tumor type, and carcinogenic potency (TD_{50}), among others. CPDB captured the results of 6153 cancer tests related to 1485 chemicals, while GTD reports on 2300 chemicals. Although no longer being updated, both of these databases provide useful historical data on the toxic effects of a variety of chemicals.

More recently, the 'data' or 'fact' databases are becoming repositories of data generated from experimental or field studies. The National Toxicology Program uses its own local website (http://ntp.niehs.nih.gov/) to disseminate a range of data available

from both acute in vitro and in vivo studies as well as from its traditional 2-year toxicological and carcinogenesis studies. Further contributions include results from immunology, developmental, reproductive, and genetic toxicity studies.

Similarly, the National Gene Vector Laboratory (NGVL) Toxicology database (http://www.ngvl.org/pharmtox/) was recently developed to publicize information on animal studies that investigate the biodistribution of gene therapy vectors to different target organs and to evaluate potential toxic effects associated with the use of various vector systems. These studies are critical in assessing the safety of a vector and are used by the FDA to support their use in gene therapy clinical trials.

The U.S. EPA's EnviroFacts Data Warehouse (http://www.epa.gov/enviro/) provides a single portal to access U.S. EPA data about environmental activities that may affect air, water, and land in the United States. Several databases, including the Toxic Release Inventory, are searchable through EnviroFacts.

Knowledge-based (discovery, analysis, prediction)

Many of the recently developed approaches are sophisticated computerized systems designed to collect, process, and especially analyze biological data generated from research and testing. These complex systems have been made possible by the progress mentioned earlier in bio- and chemoinformatics, computational biology, biostatistics, and computer science. The sophisticated algorithms and modeling used in these systems have been targeted to elucidate a toxin's mechanism of action, identify biomarkers of individual susceptibility, and predict a chemical's toxicity.

The two most active applications for knowledge-based toxicology information systems are in the fields of toxicogenomics and predictive toxicology.

Toxicogenomics

During the 1990s, microarray technology replaced the traditional gel electrophoresis and autoradiography for gene detection. The new high-throughput technology, being almost 6000× faster than the older method of DNA sequencing, has culminated in a wealth of data (Schmidt 2003b). Microarrays can be used to profile gene expression, identify potential drug targets, or detect genetic alterations (e.g., mutations, sequence changes). Applied to toxicology, microarrays make it possible to identify a toxicant's gene expression 'fingerprint' to gain insights into its molecular mechanisms of toxicity (Shankar & Mehendale 2005). The ability to profile genes expressed in a cell or tissue also provides toxicologists with a means to detect early toxicant exposure, compare modes of action across species, and differentiate classes of toxicants (Ballatori 2003).

The challenge of toxicogenomics involves the annotation, data integration, data analysis, data mining, and database/tool development necessary to extract knowledge from the resulting microarray data (Mattes et al 2004). The Gene Ontology (GO) was developed to fulfill the need to annotate gene function and bridge the gap between the gene's sequence and its biology (Gene Ontology Consortium 2001). In addition, text mining algorithms are being utilized to extract relationships from the literature on gene functions, pathways, and protein networks (Rajpal 2005).

General microarray repositories are numerous; e.g., ArrayExpress and NCBI's Gene Expression Omnibus for multiple arrays, HuGE Index for expression of human genes in normal tissue, Oncomine for cancer arrays, among many others. It is recommended that researchers do not rely on only one resource, since the number of published sequences as well as the quality of annotations varies by site (Schmidt 2003a).

Full-scale toxicogenomic databases have only recently been developed within the past several years. The U.S. Drug Administration's National Center for Toxicogenomics Research (NCTR) created ArrayTrack (http://www.fda.gov/nctr/science/centers/toxicoinformatics/ArrayTrack/), a database that combines varied public sets of chemical data, toxic endpoints, gene sequence and function, and pathway information into a prototype toxicoinformatics system. As a test-bed design, the objective of ArrayTrack is to improve techniques for managing, visualizing, extracting, and disseminating the data from microarray studies (Tong et al 2003). In 2005, efforts were made to integrate ArrayTrack with the Chemical Effects in Biological Systems Knowledge Base.

The National Institute of Environmental Health Sciences' National Center for Toxicogenomics (NIEHS/NCT) began development in 2004 of the Chemical Effects in Biological Systems (CEBS) Knowledge Base (http://cebs.niehs.nih.gov/). It is one of the first of its kind to aggregate chemical, toxicity, molecular expression, pathway, and regulatory data from different sources into a searchable, unified interface. CEBS can be searched by compound, structure, gene, pathway, among other variables.

The Comparative Toxicogenomics Database (CTD) (http://ctd.mdibl.org/) is setting out to be the first to compile aquatic and mammalian data to facilitate cross-species comparisons of interactions between chemicals and a gene or protein. The ultimate goal is

to elucidate which genes are conserved across species, what toxic effects do chemicals have on these genes or their proteins, what is the molecular mechanism behind the toxicity, and what accounts for the genetic basis of individual susceptibility (Mattingly et al 2006).

The development of CTD started in 2003 with a three-phase approach. First, gene sequences, toxic chemicals, and bibliographic references were installed in the system. The sequence data came from GenBank for nucleotide and SWISS-PROT for proteins. Reference literature associated with these sequences was extracted from both the source databases as well as PubMed. The second step incorporated analytical tools, such as BLAST for similarity searches and ClustalW for multiple alignments. The final phase involved creating an online public interface for dissemination (Mattingly et al 2006). CTD and CEBS were designed to be complementary and compatible with one another (Waters 2003).

Predictive toxicology

Two forces are compelling the development of information systems that can predict the toxicity of a substance. First, societal concerns over animal testing and the resulting implementation of the 'Three R' principles to reduce, refine, or replace animals in testing are turning toxicologists towards in vitro and in silico techniques. As well, the escalation in the volume of both chemical and pharmaceutical compounds waiting for testing mandates quicker, more cost-effective methods of ranking and classifying compounds.

Predictive toxicology is the union of bioactivity profiling through bioassays with chemoinformatics, data mining, and quantitative structure–activity relationship (QSAR) modeling (Richard 2006). The bioassays highlight a cell's toxic response to a chemical. Comprehensive, extensive, and public bioassay data repositories, such as PubChem, are necessary to achieve valid predictions (Richard 2006). In addition, data standards and controlled vocabulary for data mining and chemical structure representation and indexing for chemoinformatics must also be in place. Finally, QSAR expert systems distill the data and attempt to quantitate a chemical's structure with its physical property or biological effects (e.g., toxic endpoint) (Pittinger et al 2005).

QSARs are generally applied in three areas: priority setting for chemical testing, classification of the chemical's hazard, and screening for health and ecological risk (Pittinger et al 2005). Preliminary testing of a drug or chemical for toxic effects can quickly eliminate that drug from further development or raise the priority to fully test the chemical. A variety of QSAR systems are already available for various applications: physical-chemical properties (EPISUITE), environmental fate and transport (EFAST, PBT Profiler, Catabol), aquatic toxicity (ECOSAR), and human health effects (TOPKAT, MCASE, DEREK).

Use of QSARs in the regulatory process has slowly become acceptable, but only subsequent to analysis of the empirical study data. The OECD has compiled an extensive database on Chemical Risk Assessment Models (http://webdomino1.oecd.org/comnet/env/models.nsf) that tracks QSAR models currently being used by OECD government members. The EPA employs several types of QSARs as part of its need to screen and prioritize chemicals. For example, EPA uses TOPKAT to predict the health effects associated with endocrine-disrupting chemicals that are byproducts of drinking water disinfection products (Pittinger et al 2005). Finally, the European Union's Registration, Evaluation, and Authorization of Chemicals (REACH) program has approved the use of QSAR to expedite the screening process of 29 342 chemicals planned for review (Hengstler et al 2006).

The Environmental Protection Agency unveiled its Distributed Structure-Searchable Toxicity (DSSTox) database (http://www.epa.gov/ncct/dsstox/index.html), which offers curated chemical structures in combination with historical toxicity data to foster structure–activity modeling. At its core is a set of standards for chemical structure data and documentation files that are promoted for use in other chemical relational databases and SAR models.

Toxicogenomics and predictive toxicology are not mutually exclusive methods. Efforts are underway to integrate EPA's DSSTox and NCT's CEBS to establish an infrastructure for linking chemical structure searching with traditional toxicity, molecular mechanisms, and chemical profile data (Environmental Protection Agency 2007).

APPLICATIONS OF TOXICOLOGY INFORMATION SYSTEMS

Besides drawing from other disciplines, toxicology information and its systems contribute to other fields. Described below are a handful of toxicology information systems applications used in environmental science, clinical medicine, drug development, occupational health, and public health.

Environmental toxicology

The field of environmental toxicology explores the passage of agents through the environment and how

those agents may have injurious effects on flora, fauna, and the broader ecosystem. Chemical, as well as species-specific, information is critical to ecotoxicology systems. Chemical property databases of relevance include CHEMFATE and BIODEG. Both extract empirical data on a chemical's environmental fate and biodegradation from the bibliographic literature (Russom 2002). Ecotoxicity databases are often used for risk assessment, chemical screening and ranking, and predictive modeling.

In 1995, the EPA's ECOTOXicology (ECOTOX) database was developed as a single portal for searching and retrieving toxicity data from the AQUIRE (aquatic life), PHYTOTOX (terrestrial plants) and TERRETOX (wildlife) databases (http://cfpub.epa.gov/ecotox/help.cfm?sub=about). It was originally accessible to government users through telnet, but became publicly available when a web-based interface was launched in 2000.

Currently, ECOTOX includes more than 320 000 individual effect records abstracted from 17 195 peer-reviewed publications representing over 7800 chemicals and 5300 aquatic and terrestrial species. ECOTOX facilitates data sharing through the option of ASCII (American National Standard Code for Information Interchange) delimited file formats.

The Environmental Residue-Effects Database (ERED) (http://el.erdc.usace.army.mil/ered/) is a joint EPA–US Army Corp of Engineers effort that extracts from the literature reported correlations between tissue contaminant concentrations and toxic responses (e.g., behavioral, biochemical, cellular, reproductive, etc.). The database covers literature published from 1964 to 2001 and contains over 3463 records abstracted from about 700 publications, covering more than 222 compounds and 188 aquatic species.

Two expert systems, IPEST and POCER (Pesticide Occupational and Environmental Health Risk Indicator) calculate the environmental impact of a pesticide for a specific field crop on groundwater, surface water, air, soil, and humans (van der Werf & Zimmer 1998, Claeys et al 2005).

Geographic information systems (GIS) have found novel uses in the areas of risk assessment and exposure. The U.S. Environmental Protection Agency has developed a GIS-based application that incorporates wind speed, pesticide application rates, and other parameters to calculate the likelihood of non-target areas being exposed to a chemical hazard, which plant species would be more sensitive, and charting possible locations for field surveys or monitoring (Pfleeger et al 2006).

Clinical toxicology

The application of toxicology information in clinical practice typically is directed towards treating patients who are experiencing adverse effects from a toxic agent or pharmaceutical interaction. While historically, poison management information has been text-based, poison control centers and emergency physicians today rely on online tools such as Micromedex' POISINDEX (http://www.micromedex.com/products/poisindex/). This system quickly and accurately identifies ingredients for thousands of commercial, biological, and pharmaceutical products and provides data on clinical effects, range of toxicity, and treatment protocols. Similarly TOXBASE, a product of the UK National Poisons Information Service, is a longstanding poison and drug interaction database that has been used since 1998 (http://www.spib.axl.co.uk/). Skyscape has developed another tool specifically for mobile use. Its 5 Minute Toxicology Consult (5MTox) is a handheld version of the desktop download edition. It is geared toward the clinician who needs to quickly assess and treat a poisoned patient (http://www.skyscape.com/estore/ProductDetail.aspx?ProductId=271). CliniTox is a computer-based decision support system to provide veterinarians with the most recent clinical toxicology information for poisoned farm animals. Users may search based on chemical, type of application, or clinical/pathological outcome (Kupper et al 2004).

Drug discovery and development

Combinatorial chemistry and high-throughput screening techniques have fostered phenomenal growth in the amount of potentially useful pharmacological compounds. Yet, that increased number has not translated into an increase in new drug applications to and successful acceptance by the FDA (Borman 2006). The culprit of the high attrition rate is the failure of compounds to pass toxicity testing (Johnson 2001). The intersection of predictive modeling, toxicogenomics, microscale computing, and chemoinformatics offers the possibility to mine the essential ADME Tox (absorption, distribution, metabolism, and excretion) and pharmacokinetic data to optimize a chemical's pharmacological properties and minimize its toxicity (Johnson 2001).

Pharmacological data repositories include Wombat (http://sunsetmolecular.com/products/?id=4), a database of over 136 000 chemical and 307 000 biochemical activity, and its derivative Wombat PK (http://sunsetmolecular.com/products/?id=5,

a clinical pharmacokinetic database of 643 drugs with human ADMETox outcomes.

The application of microscale computing for determining the metabolic fate of a compound is speeding up the drug discovery process by eliminating toxic compounds earlier in the preclinical phase of development. The Metabolizing Enzyme Toxicology Assay Chip (MetaChip) can rapidly and efficiently gauge a drug's metabolic reactions as if it were occurring in a human liver (Lee et al 2005).

Occupational health

Ensuring the safety of workers requires knowing the nature of chemical hazards and what to do in the event of an exposure. One of the earliest useful resources was a reference book entitled *Patty's Industrial Hygiene and Toxicology. Patty's* is now available online as an e-book, making it much more accessible and easier to use. Two multi-file systems that integrate medical, chemical hazard, environmental, toxicological, regulatory, and risk information includes TOMES (Micromedex) and ExPub (Expert Publishing). TOXNET's HAZMAP (http://hazmap.nlm.nih.gov/) links jobs and hazardous tasks with occupational diseases and their systems. Utilizing mobile technology, the Wireless Information System for Emergency Responders (WISER) provides emergency personnel with ready information (e.g., substance identification, human health effects, containment advice, etc.) to respond to hazardous material incidents (http://wiser.nlm.nih.gov/).

Numerous international efforts are involved in providing chemical safety information. The International Programme on Chemical Safety's INCHEM database (http://www.inchem.org/), provides current and peer-reviewed chemical safety publications and database records. The OECD's Environmental, Health and Safety Programme has an extensive compilation of databases related to high production volume chemicals, industrial chemical releases, among others (http://www.oecd.org/linklist/0,2678,en_2649_34365_2734144_1_1_1_1,00.html).

Public health

Numerous information systems have been developed specifically for public health professionals or for the public directly. In January 2001, the Pew Environmental Health Commission issued the report 'America's Environmental Health Gap: Why the Country Needs a Nationwide Health Tracking Network' (Pew Environmental Health Commission 2000). The report, which stated that the existing environmental health system is neither adequate nor well-organized, recommended the creation of a 'Nationwide Health Tracking Network for disease and exposures'. As a result, the CDC's National Environmental Public Health Tracking Program (McGeehin et al 2004) was created to track, monitor, and correlate the relationships among hazards, exposures, and health effects. Its website (http://www.cdc.gov/nceh/tracking/) serves as a compendium of its own as well as other government agencies resources, databases, and programs.

NLM's TEHIP has been a leader in developing more public-oriented toxicology resources. Four interesting databases useful for the public audience include the Household Products Database (HPD), ToxTown, ToxMap, and Lact-Med (Wexler 2004). Through the Household Products Database (http://hpd.nlm.nih.gov/) consumers can link consumer brand products with known health effects associated with their ingredients. The information is extracted from the product labels and Material Safety Data Sheets. ToxTown (http://toxtown.nlm.nih.gov/) is an interactive website that engages the public to learn about the interrelationship among chemicals, the environment, and public health. Locations are highlighted where people may be exposed to chemicals and further information regarding the nature and effects of the chemical is provided. ToxMap (http://toxmap.nlm.nih.gov/toxmap/main/index.jsp) uses geographic information system technology to generate local, state, or national maps where Toxic Release Inventory chemicals have been released on-site into the air, water, or ground. LactMed (http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?LACT) is useful for both clinicians and breastfeeding mothers regarding which drugs may be transmitted through breast milk. Extracted from peer-reviewed literature, the data include maternal and infant levels of drugs, possible effects on breastfed infants and on lactation, and alternate drugs to consider.

Public interest groups and grassroots organizations have also been contributing to the mass of toxicology information systems in recent years. Originally launched by Environmental Defense in 1998, the chemical Scorecard (http://www.scorecard.org/) provides local environmental information on the release of toxic chemicals from nearby industrial facilities. The site was transferred to Green Media Toolshed in 2005. The CHE Toxicant and Disease Database (http://database.healthandenvironment.org/) summarizes links between chemical contaminants and approximately 180 human diseases or conditions. The information

is primarily based on human epidemiological data. The Pesticide Action Network's (PANNA) online PAN Pesticides Database (http://www.pesticidesinfo.org) aggregates human toxicity, ecotoxicity, and regulatory information from various sources on over 6400 active ingredients in pesticides.

CHALLENGES AHEAD FOR TOXICOLOGY INFORMATION SYSTEMS

Given toxicology's current state of reliance on technology-driven methods, it is not surprising that its challenges are technology-based. Despite, or maybe because of the revolutionary advances, the toxicology information realm is still fragmented, utilizing varying non-exchangeable data formats. As well, 'lack of [quality] data' (Yang et al 2006) still impedes the efforts of toxicologists and others to garner a comprehensive understanding of a chemical's effect on biological systems. Thus, toxicology will continue to be challenged to improve data sharing and data integration.

Data sharing

Recently, the concept of data sharing has gained momentum, perhaps in part, due to the U.S. National Institutes of Health's (NIH) requirement that grant proposals submitted to NIH should include a data-sharing plan (National Institutes of Health 2003) and also in part due to publisher requirements for authors to submit study data to repositories (Board on Life Sciences 2003). Two elements need to be in place to facilitate data sharing – freely available data and a controlled vocabulary to facilitate effective retrieval.

The emergence of large, publicly accessible datasets in the past few years has created an environment for open scientific query. These repositories provide the opportunity for researchers to tap into larger than in-house datasets and employ new analyses and new methods. Furthermore, knowing what has already been researched can minimize duplication of effort. The challenge is maintaining funding levels to support these resource-intensive undertakings. Numerous databases, some quite large like BIND and SwissProt, have faced funding challenges and either shut down or were appropriated by commercial vendors (Beltrão 2005).

Naming conventions are notoriously ambiguous in the biosciences. Sharing data assumes that the data terminology itself is the same or can be readily synchronized. A controlled vocabulary creates a structured, unique terminology to eliminate redundant and synonymous terms (Burgoon 2007). Successful initiatives include the NLM's Medical Subject Headings (MeSH) and Unified Medical Language System (UMLS). The Human Genome Organization (HUGO) developed a controlled vocabulary to ensure that each gene is designated only one official name or abbreviation (Burgoon 2007). As well, the Developmental Toxicology database (DevTox) created a Nomenclature Information System designed to harmonize teratology terminology (http://www.devtox.org/nomintro.htm).

Controlled vocabularies are used to generate ontologies, which are an attempt to comprehensively catalogue and describe the relationship among concepts for a specific field. The Gene Ontology (GO) classifies genes by molecular function, biological process, and cellular component to enable databases to communicate with one another and be compatible for data mining (Yang et al 2006).

Data standards

The ability to report, share, and conduct computational analyses between disparate high-throughput datasets requires a robust, dynamic informatics infrastructure. The foundation of that infrastructure mandates a cooperatively developed and widely applied set of data standards. The data standards 'landscape' involves reporting standards, object models, and markup languages (Burgoon 2007).

Data exchange standards create a framework for organizing experimental data. A number of standards and data exchange checklists are in the process of development. Many of these initiatives are tailored to a specific technology or subject area (e.g., nucleic acid sequence data (FASTA, Ensembl), proteins (PDB, mmCIF), protein interation (Proteomics Standards Initiative), and microarrays (MIAME, MAGE-ML)) (Ball et al 2004).

With regard to toxicology, toxicogenomics researchers have extended the Minimum Information About a Microarray Experiment (MIAME) to encompass toxicogenomic-specific fields to create MIAME/Tox (http://www.mged.org/Workgroups/rsbi/MIAME-Tox-Checklist.pdf). Also, the Standard for Exchange of Nonclinical Data (SEND) was launched by the Clinical Data Interchange Standards Consortium (CDISC) to facilitate the transfer of non-clinical safety data from industry to the U.S. Food and Drug Administration (Yang et al 2006). A more recent proposal is underway by a cross-disciplinary group for a 'strawman' checklist defining the absolute minimum information required to report toxicology data (Fostel et al 2007). The intent of this proposal is to lay the groundwork for building more specific standards within toxicology. The standard model will require the same data elements to be

reported across all toxicology arenas (e.g., transcriptomic, clinical pathology, histopathology, etc.). As a result, the standard will facilitate seamless data sharing and database entry across divergent systems.

Finally, the online world has triggered the development of computer languages which use identifier tags to 'markup' or annotate the digital data element. These tags, by describing the document's structure and data elements, provide the computer with instructions on how to format, display, or use the content. Leadscope developed ToxML, an XML-based toxicology-specific markup language, to standardize descriptive tags for compounds, drug information, and types of toxicity tests (e.g., genetic, carcinogenesis, skin sensitivity, environmental fate, etc.) (http://www.leadscope.com/toxml.php). Molecular biology as well as chemistry has seen a plethora of XML-based schema develop. Faced with a myriad of choices, researchers often choose a schema based on regulatory or data repository mandate rather than what is research or cost effective (Burgoon et al 2006).

The benefit of standards is exemplified by the Stanford Microarray Database's initiative to create a seamless pipeline that feeds data from its microarray studies directly into the public repository ArrayExpress (Ball et al 2005).

FUTURE DIRECTIONS

Without a doubt, regulatory, technological, and scientific factors will continue to impact the evolution of toxicology information systems in the future. However, technological advances will be at the forefront of augmenting the toxicology knowledge base in the coming years. Microscale techniques, biosensors, remote instrumentation, and grid computing are a few innovative technologies that are being incorporated in the field.

Evolving microfluidics techniques coupled with scaled-down analytical tools are stimulating the development of cell-based microsystems, also known as 'lab-on-a-chip'. Through the integration of fluid dynamics and electrical, optical, and physical measurements, these chips consolidate several steps of an assay into a single system (Craighead 2006, El-Ali et al 2006). The chips make it possible to isolate and observe an individual molecule. As a result, the lab-on-a-chip will have several uses such as to monitor cells for changes due to pathogen or pollutant exposure, measure biochemical byproducts of cell lysis, or control the growth and differentiation of cells (El-Ali et al 2006).

Biosensors, such as the type used to monitor blood glucose levels, are finding numerous applications in toxicology, especially related to exposure science. These sensors combine a biological element (e.g., tissue, antibody, enzyme, etc.) with physiochemical detectors to calculate a chemical's biological 'fingerprint'. Applications include remote sensing of airborne bacteria, assessing drug residues in food, or detecting levels of a toxic substance before or after bioremediation (Schwartz & Collins 2007).

Recent sensing modalities from nanotechnology and biodefense are being incorporated to create sensors capable of accurately capturing real time data for assessing personal exposure levels (Schwartz & Collins 2007). Successful devices will need to be portable, inexpensive, easy-to-use, and mildly inconvenient (e.g., used in a watch, phone, even clothing) (Schwartz & Collins 2007). The goal will be to correlate the exposure with biomarkers and ultimately with individual susceptibility (Schmidt 2006).

Analytical tools and instrumentation will continue to be computerized. One area seeing innovative developments is in pathology and histopathology. Digitization techniques are necessitating the formation of pathology informatics to manage the hundreds of image data points (McCullough et al 2004). Digital instrumentation also fosters collaboration and technology sharing for research or training. GLI2C CyberChemistry Collaboration is an example of how remote sharing can provide training opportunities for scientists in the developing world (Fitch et al 2006). Students, a group in the U.S. and another group in Africa, load water samples prepared for pesticide analysis onto instruments. Using the web, the instruments are operated remotely by each group and results are relayed between the students. The project was such a success that a new course is being considered to compare lead problems in paint in inner-city Chicago with leaded gasoline used in Africa.

The high-throughput, data-rich environments brought about by scientific and computing advances require ever faster and more robust computing power to not only extract knowledge, but to be able to visualize it. Even current high-performance computing systems are being stretched to their maximum capability. Grid computing, whereby individual computers are interconnected to create a shared network of resources, is offering a powerful solution. Grid computing is finding applications in the area of environmental modeling, large-scale simulations, and high-end visualization. Another future avenue will be the merger of high-throughput and high-performance computing to accommodate analysis of 'many smaller problems' with 'many CPUs' (Derra 2002).

TeraGrid (http://www.teragrid.org) is currently the world's largest 'cyberinfrastructure' coordinating access to high-performance computers, over 100

databases, and high-end experimental resources. The TeraGrid has been used in the Models for Infectious Disease Agent Study (MIDAS) to more effectively respond in the case of an infectious disease outbreak (Anonymous 2007). Another application is IBM's BlueGene/P, which is directing its 1 petaFLOP of computing power towards protein folding to gain insights into the relationship between a protein's structure and its function (Allen 2001).

Tapping into the power of this high-performance computing is the European Center for Virtual Reality. The Center is using virtual reality, or in virtuo, methods to imitate a cell and its environment. Sophisticated models allow the system to simulate complex interactions and replicate the full sequence of reaction at granular levels. The benefit of this approach is that each study element is independent, allowing parameters to be changed at will without needing to devise new experiment protocols (Desmeulles et al 2006).

SUMMARY

Toxicology has been described as 'both a science and an art' (Doull 2001, p. 15). The science entails experimental observation and data collection, while the art manifests itself as prediction or application. In other words, the systems we use to manage the toxicology-related information directly determines how well the practice of toxicology is managed (Kissman 1980).

Regulatory pressure, scientific progress, and technological advances have transformed the toxicology information infrastructure from its descriptive literature-based and databank beginnings to its current dynamic analytical and predictive systems. That infrastructure, composed of computing networks, telecommunications, and informatics tools, has laid the foundation for researchers to gain insights into chemical risk assessment, hazard identification, exposure monitoring, mechanisms of toxicity, among many others. Despite the expansion in the toxicology knowledge base, many complex questions remain. Answers will only be found once cohesive, freely available, and validated information systems are interconnected. Thus, as the scale of toxicological inquiry increases, so too does the 'researcher's interaction with the information infrastructure' (Kalawsky 2005, p. 1867).

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CHAPTER

4

Toxicoinformatics Today

MARK A. PERSHOUSE, MELISA BUNDERSON SCHELVAN, AMY ERBE, CORBIN SCHWANKE, AND ELIZABETH PUTNAM

'Toxicoinformatics is an emerging scientific discipline that integrates approaches from multidisciplinary fields of bioinformatics, chemo informatics, computational toxicology, informatics technologies and physiologically-based pharmacokinetic modeling with the objective of knowledge discovery and the elucidation of mechanisms of toxicity.'

National Center for Toxicological Research

Toxicoinformatics represents the synthesis of several different approaches to archiving, organizing, and navigating complex data dealing with toxicologic studies. One approach would be to consider toxicoinformatics simply a subset of the bioinformatics field, a collection of data generated in an attempt to understand toxicological mechanisms. This may be a helpful generality, but does not capture the ultimate scope of the field. For those reading the opening quote above, the reality has already grasped them that most in toxicology already pursue toxicoinformatics on a daily basis. Toxicoinformatics brings together many diverse scientists, from computational toxicologists, to pharmacokinetic modelers, to microarray specialists. Initially, the focus was on analysis of genomic data generated following exposure of various model organisms to toxicants. This has grown to include many associated technologies and disciplines. The compiled lists of resources below include 20 books, 15 journals, 18 manuscripts, two organizations, and eight databases or websites, which can be helpful in exploring toxicoinformatics.

Navigating toxicoinformatic resources requires a command of numerous websites, but paramount among these sites are those that compile many helpful sites and effectively serve as gateways. In this field, the ToxNet website serves this purpose and provides a number of useful sites and search engines to help investigators find toxicoinformatic resources.

TOXNET

The home page for this site begins with a searchable access to 14 different databases. These databases cover a number of relevant subjects, from hazardous substances (HSDB), integrated risk information for over 500 chemicals (IRIS), genetic toxicology test results on over 3200 chemicals (GENE-TOX), maps of toxic chemicals released into the environment (TOXMAP), a bibliographic database of toxicologic citations (TOXLINE), and an interactive guide to commonly encountered toxicants (Tox Town). Databases can be searched one at a time or in multiples. While this is not the only gateway available to those interested in toxicoinformatics databases, it is one of the easiest to use and most robust. It is thus a great place to begin.

RESOURCES

Books

Andreas D Baxevanis, BF Francis Ouellette
Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd edition
New York: John Wiley & Sons.

This is a textbook style resource containing 18 chapters. This book covers the use of databases for

bioinformatics as well as predictive and comparative algorithms. Biological examples are used to explain different strategies for performing computational analysis. It is considered one of the best training manuals for navigating the NCBI suite of databases.

Martin J Bishop
Guide to Human Genome Computing 2nd edition
San Diego, CA: Academic Press.

The *Guide to Human Genome Computing* contains 12 chapters useful in the field of human genome analysis as it might apply to toxicoinformatics. This book contains topics such as internet resources, genetic analysis, sib-pair studies, comparative mapping, radiation hybrids, sequence ready clone maps, human genome sequencing, ESTs, gene prediction, and gene expression.

JA Bond
Comprehensive Toxicology: General Principles
New York: Elsevier Science Inc.

Toxicokinetics, mechanisms of toxicity, and risk assessment are covered in this overview of the field of toxicology.

Jurgen Borlak
The Handbook of Toxicogenomics: Strategies and Applications
Weinheim, Germany: Wiley-VCH.

This book will be useful for those interested in developing research strategies in the area of toxicogenomics, incorporating the interdisciplinary aspect of the field to cover the wide range of topics involved.

Michael E Burczynski
An Introduction to Toxicogenomics
Boca Raton, FL: CRC.

The new discipline of toxicogenomics is outlined in this overview. Focusing on toxicology, the central concept underlying the use of microarray analysis for biomedical research is explained. Included in discussions is an overview of the actual mechanics of array-based genomic analysis and techniques used for quality control and material handling. A key aspect of the book is input into analysis of large-scale datasets using clustering methods such as genetic algorithms.

A Malcolm Cambell, Laurie J Heyer
Discovering Genomics, Proteomics, and Bioinformatics
Upper Saddle River, NJ: Benjamin Cummings.

This is a 'workbook'-style textbook targeted at upper-level undergraduates and first-year graduate students. It uses real case studies and web activities to give the student an interactive learning experience.

Hsinchun Chen, Sherilynne S Fuller, Carol Friedman, William Hersh
Medical Informatics: Knowledge Management and Data Mining in Biomedicine (Integrated Series in Information Systems)
New York: Springer Science.

This book contains three sections, each divided into multiple chapters. The first section provides a foundation for understanding the field of medical informatics. Sections two and three provide practical discussions for the use of medical informatics.

Anthony DeCaprio
Toxicologic Biomarkers
New York: Taylor & Francis.

This reference provides the reader with a thorough knowledge of biomarker theory by detailing the development and practical applications of biomarkers in a variety of scientific fields including toxicology, forensics, and pharmaceutics. This guide includes recent studies describing the generation and utilization of biomarkers for the detection of toxicant exposure, human health risk assessment uses, occupational safety testing, drug development applications, and biological and chemical warfare agent detection.

Sean Ekins
Computational Toxicology: Risk Assessment for Pharmaceutical and Environmental Chemicals
Weinheim, Germany: Wiley-VCH.

The predictive tools commonly used in the field of risk assessment for applications such as pharmaceutical development and environmental evaluation are discussed in this book.

Warren J Ewens, Gregory Grant
Statistical Methods in Bioinformatics: An Introduction
New York: Springer Science + Business Media

This book contains 15 chapters. It includes a section on biological topics, including: sequence analysis, BLAST, microarray analysis, gene finding, and the analysis of evolutionary processes. Important statistical techniques are also discussed, including: hypothesis testing and estimation, Poisson processes, Markov models and Hidden Markov models, and multiple testing methods.

Neil C Jones, Pavel A Pevzner
An Introduction to Bioinformatics Algorithms (Computational Molecular Biology)
Cambridge, MA: MIT Press.

An Introduction to Bioinformatics Algorithms is an undergraduate-level text. This book contains discussions of problems that are biologically relevant as well as approaches to possible solutions. Also included are

short biographies of some of the leading personalities in the field.

Dan E Krane, Michael L Raymer
Fundamental Concepts of Bioinformatics
Upper Saddle River, NJ: Benjamin Cummings.

This book is co-authored by a biologist and a computer scientist to give a unique perspective on the field of bioinformatics. It focuses on basic concepts such as available programs for doing computational analysis and the algorithms used to design them.

Thomas Lengauer, Raimund Mannhold, Hugo Kubinyi, Hendrik Timmerman
Bioinformatics: from Genomes to Drugs
Weinheim, Germany: Wiley-VCH.

This book contains eight chapters. The text focuses on the practical 'application' of bioinformatics and uses real-life scenarios to illustrate points.

David W Mount
Bioinformatics: Sequence and Genome Analysis
Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.

This textbook contains 13 chapters. It focuses on the methods used for analyzing DNA, RNA, and protein data. The second edition contains chapter guides and explanatory information panels for students.

CA Orengo
Bioinformatics: Genes, Proteins, and Computers (Advanced Text)
Oxford, UK: BIOS Scientific Publishers Ltd.

This 18-chapter textbook is an advanced-level bioinformatics resource. It covers topics ranging from molecular evolution to global approaches for studying protein–protein interactions. It concludes with a section on data management and internet technologies.

Jonathan Pevsner
Bioinformatics and Functional Genomics
New York: Wiley-Liss.

This book is designed to give the computer scientist a better understanding of the needs of the biological scientists using their programs. This book brings theoretical principles together with practical applications. It also includes background on the principles of bioinformatics.

Micaela Reddy, RS Yang, Melvin E Andersen, Harvey J Clewell III
Physiologically Based Pharmacokinetic Modeling: Science and Applications
Weinheim, Germany: Wiley-VCH.

This book offers an overview of the principles of physiologically based pharmacokinetic (PBPK) modeling. This modeling technique is becoming increasingly important in human health risk assessments and in supporting pharmacodynamic modeling for toxic responses. This is the first comprehensive reference of its kind.

Jim E Riviere
Biological Concepts and Techniques in Toxicology
New York: Taylor & Francis.

Proteomics, toxicogenomics, and metabonomics are highlighted in this guide as examples of disciplines that will impact the future of toxicology. This book offers information on some of the latest advances in molecular biology, mathematical modeling, quantitative risk assessment, and biopharmaceutical development.

Edward H Shortliffe, James J Cimino
Biomedical Informatics: Computer Applications in Health Care and Biomedicine (Health Informatics) 3rd edition
New York: Springer Science.

This book contains 10 chapters starting with the emergence of biomedical informatics as a discipline and continuing with a section on data storage and clinical reasoning. The book also contains chapters on computing, system designs, industry standards, language, imaging, and, finally, ethics.

K Clive Thompson, Kirit Wadhia, Andreas P Loibner (2005)
Environmental Toxicity Testing
Oxford, UK: Blackwell Publishing Ltd.

This reference examines issues in assessing environmental toxicity, discussing how ecotoxicity results are interpreted and applied.

Journals

Artificial Intelligence in Medicine (1989–)
Federal Republic of Germany: Amsterdam Elsevier Science Publishing.
Web: http://sciencedirect.com/science/journal/09333657

'Artificial Intelligence in Medicine publishes original articles from a wide variety of interdisciplinary perspectives concerning the theory and practice of artificial intelligence (AI) in medicine, human biology, and health care.' (description excerpted from the journal's website)

Bioinformatics (1998–)
Oxford, UK: Oxford University Press.
Web: http://bioinformatics.oupjournals.org/

'The leading journal in its field, *Bioinformatics* publishes the highest quality scientific papers and review

articles of interest to academic and industrial researchers. Its main focus is on new developments in genome bioinformatics and computational biology. Two distinct sections within the journal – *Discovery Notes and Application Notes* – focus on shorter papers; the former reporting biologically interesting discoveries using computational methods, the latter exploring the applications used for experiments.' (description excerpted from the journal's website)

BMC Bioinformatics (2000–)
London: Biomed Central.
Web: http://www.biomedcentral.com/1471-2105

'*BMC Bioinformatics* is an Open Access, peer-reviewed journal that considers articles on all aspects of computational methods used in the analysis and annotation of sequences and structures, as well as all other areas of computational biology.' (description excerpted from the journal's website)

BMC Medical Imaging (2001–)
London: BioMed Central.
Web: http://www.pubmedcentral.nih.gov/tocrender.fcgi?journal=41

'*BMC Medical Imaging* is an Open Access, peer-reviewed journal that considers articles on the use, development, and evaluation of imaging techniques to diagnose and manage disease.' (description excerpted from the journal's website)

Briefings in Bioinformatics (2000–)
Birmingham, AL: H. Stewart Publications.

'*Briefings in Bioinformatics* is an international forum for researchers and educators in the life sciences. The journal publishes reviews for the users of databases and analytical tools of contemporary genetics and molecular biology and is unique in providing practical help and guidance to the non-specialist. Papers range in scope and depth, from the introductory level to specific details of protocols and analyses encompassing bacterial, plant, animal and human data.

Detailed subject areas covered by the journal include: DNA sequencing, expression profiling, alignment methods, gene expression studies, protein profiles and HMMs, metabolic and signalling pathways, structure and function prediction, mapping and microarrays.' (description excerpted from the journal's website)

Cancer Informatics (2005–)
Auckland, NZ: Libertas Academica.
Web: http://www.la-press.com/caninfo.htm

'2005 has been a busy and highly productive year for Cancer Informatics. This is somewhat remarkable in view of the fact that last year was the journal's first year of publication. Cancer Informatics was established as the official journal of the International Society for Cancer Informatics (ISCI), established by Associate Professor James Lyons-Weiler in the same year. Working in collaboration with the Association is Libertas Academica, a publishing firm committed to high editorial standards, open access publishing methodologies and superior user-service standards. The journal is fortunate to have at its helm James Lyons-Weiler as Editor-in-Chief.' (description excerpted from the journal's website)

Computerized Medical Imaging and Graphics (1988–)
Tarrytown, NY: Elsevier Science.
Web: http://sciencedirect.com/science/journal/08956111

'*Computerized Medical Imaging and Graphics* is an important source for the latest information on the medical use of new computer applications in radiological imaging, 3-D imaging and microscopy, including research methods and results in CT, MR, PET, SPECT, digital radiology, DSA, ultrasound, confocal microscopy, 3-D reconstruction, image analysis and color analysis. The Journal provides for the rapid review of original research papers, review articles, and preliminary research publications in this important field.' (description excerpted from the journal's website)

International Journal of Medical Informatics (1997–)
Shannon, Co. Clare, Ireland: Elsevier Science Ireland Ltd.
Web: http://sciencedirect.com/science/journal/13865056

'The Journal provides an international medium for dissemination of original results and interpretative reviews concerning the field of medical informatics.' (description excerpted from the journal's website)

Journal of the American Medical Informatics Association (1994–)
Philadelphia, PA: Hanley and Belfus.
Web: http://www.jamia.org

'AMIA's bimonthly journal, JAMIA, presents peer-reviewed articles that assist physicians, informaticians, scientists, nurses, and other health care professionals develop and apply medical informatics to patient care, teaching, research, and health care administration. JAMIA has rapidly established a reputation for presenting high-quality, cutting-edge information. Each issue contains state-of-the-art reviews, discussion forums, and invited editorials presented as brief reviews or full-length papers. A variety of

formats accommodates work at all stages, from model formulation through definitive studies.' (description excerpted from the journal's website)

Journal of Biomedical Informatics (2001–)
San Diego, CA: Academic Press.
Web: http://www.sciencedirect.com/science/journal/15320464

'The *Journal of Biomedical Informatics* (formerly *Computers and Biomedical Research*) has been redesigned to reflect a commitment to high-quality original research papers and reviews in the area of biomedical informatics. Although published articles are motivated by applications in the biomedical sciences (for example, clinical medicine, health care, population health, imaging, and bioinformatics), the journal emphasizes reports of new methodologies and techniques that have general applicability and that form the basis for the evolving science of biomedical informatics.' (description excerpted from the journal's website)

Journal of Chemical Information and Modeling (2005–)
Washington, DC: American Chemical Society.
Web: http://pubs.acs.org/jcim

'Astute chemists, computer scientists, and information specialists look to this bimonthly's insightful research studies, programming innovations, and software and book reviews to keep current with advances in this integral, multidisciplinary field.' (description excerpted from the journal's website)

Journal of Computational Biology (1994–)
New York: Mary Ann Liebert Inc.
Web: http://www.liebertonline.com/cmb

'Journal of Computational Biology provides a forum for communication of scientific and technical issues associated with the analysis and management of biological information at the molecular level.' (description excerpted from the journal's website)

Journal of Molecular Modeling (1995–)
Berlin, Germany: Springer.
Web: http://www.springerlink.com/openurl.asp?genre=journal&eissn=0948-5023

'The Journal of Molecular Modeling focuses on "hardcore" modeling, publishes high quality science including Life Science Modeling (including QSAR, data mining/bioinformatics, structure and substructure search), Materials Modeling, New Methods, and Computational Chemistry in an interdisciplinary manner.' (description excerpted from the journal's website)

Neuroinformatics (2003–)
Totowa, NJ: Humana Press Inc.
Web: http://www.neuroinformaticsONLINE.com

'Neuroinformatics publishes original articles and reviews with an emphasis on data structure and software tools related to analysis, modeling, integration, and sharing in all areas of neuroscience research. The editors particularly invite contributions on: (1) Theory and methodology, including discussions on ontologies, modeling approaches, database design and meta-analyses; (2) Descriptions of developed databases and software tools, and of the methods for their distribution; (3) Relevant experimental results, such as reports accompanied by the release of massive data sets; (4) Computational simulations of models integrating and organizing complex data; and (5) Neuroengineering approaches, including hardware, robotics, and information theory studies. Neuroinformatics also publishes independent "tests and evaluations" of available neuroscience databases and software tools, and fosters a commitment to the principles of tool and data sharing.' (description excerpted from the journal's website)

Journal articles

Bao W, Schmid JE, Goetz AK, Ren H, Dix DJ (2005) A database for tracking toxicogenomic samples and procedures. Reprod. Toxicol. 19: 411–419.

Burgoon LD, Zacharewski TR (2007) dbZach toxicogenomic information management system. Pharmacogenomics 8: 287–291.

Dix DJ, Houck KA, Martin MT, et al (2007) The ToxCast program for prioritizing toxicity testing of environmental chemicals. Toxicol. Sci. 95: 5–12.

Mattes WB, Petit SD, Sansone SA, Bushel PR, Waters MD (2004) Database development in toxicogenomics: issues and efforts. Environ. Health Perspect. 112: 495–505.

Matthews EJ, Kruhlak NL, Cimino ML, Benz RD, Contrera JF (2006) An analysis of genetic toxicity, reproductive and developmental toxicity, and carcinogenicity data: I. Identification of carcinogens using surrogate endpoints. Regul. Toxicol. Pharmacol. 44: 83–96.

Matthews EJ, Kruhlak NL, Cimino ML, Benz RD, Contrera JF (2006) An analysis of genetic toxicity, reproductive and developmental toxicity, and carcinogenicity data: II. Identification of genotoxicants, reprotoxicants, and carcinogens using in silico methods. Regul. Toxicol. Pharmacol. 44: 97–110.

Pelletier DJ, Gehlhaar D, Tilloy-Ellul A, Johnson TO, Greene N (2007) Evaluation of a published in silico model and construction of a novel bayesian model for predicting phospholipidosis inducing potential. J. Chem. Inf. Model 47: 1196–1206. [Epub ahead of print April 12 2007].

Perkins R, Tong W, Hong H, et al (2002) Toxicoinformatics for prediction of endocrine disruptors. Int. J. Toxicol. 21: 539.

Ralaivola L, Swamidass SJ, Sigo H, Baldi P (2005) Graph kernels for chemical informatics. Neural Netw. 18: 1093–1110.

Richard AM (2006) Future of toxicology–predictive toxicology: An expanded view of "chemical toxicity". Chem. Res. Toxicol. 19: 1257–1262.

Shi L, Tong W, Goodsaid F, et al (2004) QA/QC: challenges and pitfalls facing the microarray community and regulatory agencies. Expert Rev. Mol. Diagn. 4: 761–777.

Tong W, Perkins R, Fang H, et al (2003) ArrayTrack–supporting toxicogenomic research at the U.S. Food and Drug Administration National Center for Toxicological Research. Environ. Health Perspect. 111: 1819–1826.

Tong W, Fang H, Xie Q, Perkins R (2003) Decision forest: combining the predictions of multiple independent decision tree models. J. Chem. Inf. Comput. Sci. 43: 525–531.

Tong W, Welsh WJ, Shi L, Fang H, Perkins R (2003) Structure-activity relationship approaches and applications. Environ. Toxicol. Chem. 22: 1680–1695.

Tong W, Xie Q, Hong H, et al (2004) Development of public toxicogenomics software for microarray data management and analysis. Mutat. Res. 549: 241–253.

Tong W, Xie Q, Hong H, et al (2004) Using decision forest to classify prostate cancer samples on the basis of SELDI-TOF MS data: assessing chance correlation and prediction confidence. Environ. Health Perspect. 112: 1622–1627.

Organizations

The Arabidopsis Information Resource (TAIR)
Sponsor: TAIR is produced by the Carnegie Institution of Washington Department of Plant Biology, and the National Center for Genome Resources (NCGR).
Web: http://www.arabidopsis.org

TAIR is a database for the genetics and molecular biology of the higher plant species, *Arabidopsis thaliana*.

CDER's Office of Pharmaceutical Science
Informatics and Computational Safety Analysis Staff (ICSAS)
E-Mail: Joseph.Contrera@fda.hhs.gov
Web: http://www.fda.gov/cder/Offices/OPS_IO/default.htm

The ICSAS is an applied regulatory research unit whose responsibilities include development of databases of toxicological and clinical endpoints, software development for pharmaceutical industry drug development, etc.

MAQC
The Microarray Quality Control Project
Leming Shi
National Center for Toxicological Research
Phone: 1-870-543-7387
E-Mail: leming.shi@fda.hhs.gov
Web: http://edkb.fda.gov/MAQC/

'Microarrays represent a core technology in pharmacogenomics that was identified by the U.S. Food and Drug Administration's (FDA) Critical Path Initiative as a key opportunity for advancing medical product development and personalized medicine. The FDA issued the "*Guidance for Industry: Pharmacogenomic Data Submissions*" to facilitate scientific progress and the use of pharmacogenomic data in drug development and medical diagnostics.' (description excerpted from the website)

NCTR's Center for Toxicoinformatics
National Center for Toxicological Research
3900 NCTR Road
Jefferson, AR 72079
Phone: 870-543-7142
E-Mail: weida.tong@fda.hhs.gov
Web: http://www.fda.gov/nctr/science/centers/toxicoinformatics/

'The NCTR's Center for Toxicoinformatics was established on June 2nd, 2002. The primary function of this program is to apply and develop toxicoinformatics approaches for omics research and traditional toxicological studies at NCTR and beyond to FDA.' (description excerpted from the website)

Databases

DSSTox
Sponsor: U.S. Environmental Protection Agency
Web: http://www.epa.gov/ncct/dsstox/

Distributed Structure-Searchable Toxicity (DSSTox) Database Network is a project of EPA's Computational

Toxicology Program, helping to build a public data foundation for improved structure–activity and predictive toxicology capabilities. The DSSTox website provides a public forum for publishing downloadable, standardized chemical structure files associated with toxicity data.

The Endocrine Disruptor Knowledge Base
Sponsor: U.S. Food and Drug Administration
Web: http://edkb.fda.gov/

'The Endocrine Disruptor Knowledge Base (EDKB) website consists of a biological activity database, relevant literature citations, computational models, and ultimately, models for risk assessment. It is designed to help research and regulatory scientists, and other interested parties set priorities for testing of endocrine disrupting compounds, make use of the existing body of knowledge, and reduce dependency upon slow and expensive animal experiments.'

EXTOXNET
Sponsor: Oregon State University
Web: http://extoxnet.orst.edu/

'The EXTension TOXicology NETwork (EXTOXNET) is an effort of University of California, Davis, Oregon State University, Michigan State University, Cornell University, and the University of Idaho. Some of the goals of EXTOXNET are to stimulate dialog on toxicology issues, develop and make available information relevant to extension toxicology, and facilitate the exchange of toxicology-related information in electronic form, accessible to all with access to the Internet. The EXTOXNET InfoBase is accessible via the World Wide Web (WWW).'

The Pharmacogenetics and Pharmacogenomics Knowledge Base (PharmGKB)
Sponsor: Stanford University
Web: http://www.pharmgkb.org

'The PharmGKB database is a central repository for genetic, genomic, molecular and cellular phenotype data and clinical information about people who have participated in pharmacogenomics research studies. The data includes, but is not limited to, clinical and basic pharmacokinetic and pharmacogenomic research in the cardiovascular, pulmonary, cancer, pathways, metabolic and transporter domains.'

Saccharomyces Genome Database (SGD)
Sponsor: SGD Curators (The SGD is in the Department of Genetics at the School of Medicine, Stanford University.)
Web: http://www.yeastgenome.org/

SGT is a database for the compilation of the genetics and molecular biology of *Saccharomyces cerevisiae*, or budding yeast.

SOURCE
Sponsor: Genetics Department at Stanford University
Web: http://source.stanford.edu/cgi-bin/source/sourceSearch

'SOURCE is a unification tool which dynamically collects and compiles data from many scientific databases, and thereby attempts to encapsulate the genetics and molecular biology of genes from the genomes of *Homo sapiens*, *Mus musculus*, *Rattus norvegicus* into easy to navigate GeneReports.'

TOXNET
Sponsor: The National Library of Medicine
Web: http://toxnet.nlm.nih.gov/

A collection of databases centered on toxicology, hazardous chemicals and environmental exposures. Includes links to databases such as ToxLine, IRIS and DART.

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PART

II

Subject Categorization: Books and More

CHAPTER

5

General Texts

CAREY POPE

The layman, student, academician, or practicing toxicologist has a number of excellent texts that can serve as information resources for any and all aspects of toxicology. Many general texts have been updated over the last few years to incorporate recent advances, for example in the molecular understanding of toxic reactions and mechanisms. The general texts in toxicology can be concise (e.g., Timbrell's *Introduction to Toxicology*) or voluminous (e.g., the 14-volume work *Comprehensive Toxicology*). *Casarett and Doull's Toxicology*, currently in its seventh edition, remains the most complete single-volume resource for toxicological information. Some texts are written with the experimental scientist in mind, while others are written for the public health specialist, instructor, regulator, or the layman.

There are also a number of excellent scientific journals covering all aspects of general toxicology. Several of these journals are the official journals for professional societies including the U.S. Society of Toxicology (*Toxicological Sciences*), the British Society of Toxicology (*Toxicology*), the European Society of Toxicology (*Archives of Toxicology*), and the American College of Toxicology (*International Journal of Toxicology*). Many focus on publications dealing with mechanisms of toxicity. The *Archives of Toxicology* has the longest record of publication (since 1930) and those with the highest impact factors reported for the year 2007 include the review journal *Critical Reviews in Toxicology* (5.15) and *Chemical Research in Toxicology* (3.51), *Toxicology and Applied Pharmacology* (3.8) and *Toxicological Sciences* (3.81). What all of these texts and journals generally have in common is contributions from leaders in the field, providing a substantial resource to persons interested in up-to-date knowledge of how chemicals adversely affect living systems.

Resources are increasingly available on CD-ROM or as web-based material. Additional general texts may be found in specific subject areas such as clinical toxicology or risk assessment.

RESOURCES

Books

Aldridge WN (1996)
Mechanisms and Concepts in Toxicology
London, UK: Taylor and Francis.

Published in the year of his death, this introduction to toxicology by Norman Aldridge is a classic. The book is clearly written and well organized to cover how chemicals elicit toxicity in an easily understandable manner. Kinetics of chemical transport and metabolism, interactions with target molecules, selective toxicity, thresholds, biomonitoring, epidemiology, and environmental and ecotoxicology are covered with specific examples provided throughout. This book is an excellent, succinct overview for students of toxicology.

Anderson D, Conning DM (eds.) (1993)
Experimental Toxicology: The Basic Issues, 2nd edition
Cambridge, UK: Royal Society of Chemistry.

This text contains 25 chapters covering the methods of toxicity evaluations from animal husbandry to experimental design/statistics to experimental ethics. Early chapters focus on basic factors involved in conducting

toxicity evaluation considerations, e.g., physical nature of the toxicant to be studied, dosing routes and internal and external modifying factors (e.g., species, age, nutrition) while later chapters cover issues related to specific areas of toxicologic investigation (e.g., immunotoxicology, reproductive/teratogenesis, carcinogenicity) and integrative material such as risk assessment methodology and regulations/consulting services. While the second edition of *Experimental Toxicology: The Basic Issues* was published over a decade ago (1993), it remains an excellent overview of major issues related to conducting toxicity evaluations and the use of the data generated.

Ballantyne B, Marrs T, Syversen T (eds.) (2000)
General and Applied Toxicology, 2nd edition
London: Macmillan Reference LTD.

This in-depth collection (three volumes with over 2100 pages) has contributions from over 140 experts in the field. Volume 1 covers the 'basic science' of toxicology including chapters on fundamentals (e.g., dose–response), toxicokinetics, mechanisms of cell death, biotransformation, statistics, the toxicology of mixtures as well as chapters on techniques including pathology, clinical chemistry, and considerations of hazards in the laboratory. Volume 1 is also a wealth of information on the theoretical and practical importance of route of administration on toxicity. Volume 2 systematically covers mammalian organ system, genetic, reproductive, and developmental as well as environmental and wildlife toxicology. Volume 3 contains a remarkable amount of information on different specializations (e.g., occupational, industrial toxicology/hygiene, regulatory toxicology) and chapters on topics such as chemical terrorism, disasters, biomarkers, toxicology and the law, and others. Finally, specific agents are discussed in Volume 3 including food additives, pesticides, solvents, metals, warfare agents, and even animal toxins. An extensive subject as well as chemical index is included.

Bingham E, Cohrssen B, Powell CH (eds.) (2001)
Patty's Toxicology, 5th edition
New York: Wiley.

With eight volumes and over 1000 pages, this resource provides in-depth information on toxic hazards of chemicals primarily of industrial concern. *Patty's Toxicology* is a break-out of the original *Patty's Industrial Hygiene and Toxicology* originally published in 1948, which went through four editions. *Patty's Toxicology*, 5th edition, provides basic information on toxicologic principles, and detailed information regarding toxic actions of metals, aromatic hydrocarbons, organic nitrogen compounds, organic halogenated hydrocarbons, aliphatic carboxylic acids, ketones, alcohols, esters, epoxy compounds, glycol ethers, and synthetic polymers. This book is an essential resource for industrial toxicologists.

Boelsterli UA (2003)
Mechanistic Toxicology
London: Taylor and Francis.

This is an introductory text for both undergraduate and graduate students addressing mechanisms of toxicity. The book is clearly written, full of descriptive figures, and contains summary 'learning points' and suggested further reading material at the end of each chapter.

Derelanko MJ, Hollinger MA (eds.) (2002)
CRC Handbook of Toxicology, 2nd edition
Boca Raton, FL: CRC Press.

The 2nd edition of this handbook contains a plethora of toxicology-related facts of use to a variety of disciplines. Basic information is presented throughout in tables (over 500) and figures, minimizing text. Mammalian organ system toxicity is covered chapter-by-chapter in detail. There are eight separate chapters devoted to regulatory toxicology. New chapters cover aquatic toxicology, endocrine toxicology, consumer products, medical devices, and other topics. The *CRC Handbook of Toxi-cology* is one volume packed with useful information for experimenters, regulatory and consulting toxicologists alike.

Gilbert SG (2004)
A Small Dose of Toxicology
Boca Raton, FL: CRC Press
Web: www.asmalldoseof.org

This layman's introductory text on toxicology uses real-life context and simplification of scientific data for the non-scientist reader. *A Small Dose of Toxicology* also serves as a resource, however, for the toxicology student and instructor as well. The author provides a general primer in toxicology illustrated with well-known examples of chemicals including alcohol, caffeine, nicotine, pesticides, heavy metals, solvents, and radiation.

Hayes AW (ed.) (2007)
Principles and Methods of Toxicology, 5th edition.
Boca Raton, FL: CRC Press.

This single volume with over 1800 pages covers basic principles and selected toxic agents, but focuses on the description of methods in experimental toxicology. The 37 chapters provide a history of the field and an overview of toxicology principles, describes current testing

protocols for evaluation of various types of toxic responses, and provides guidance on the interpretation and analysis of toxicologic data. An extensive glossary and index is included. *Principles and Methods of Toxicology* remains a resource for both students and professionals.

Hodgson E, Levi PE (2004)
A Textbook of Modern Toxicology, 3rd edition
Stamford, CT: Appleton & Lange.

This updated edition of a classic textbook for graduate students provides a solid exposure to basic principles of toxicology, toxicant classes, biotransformation, generation and role of reactive metabolites, mechanisms of toxicity, organ system toxicity, toxicity testing methods, forensic and clinical toxicology, risk assessment, environmental toxicology, analytical methods, and other topics. A glossary is included.

Hodgson E, Mailman RB, Chambers JE (1998)
Dictionary of Toxicology, 2nd edition
London: Macmillan Reference.

Over 70 contributors provide concise explanations for more than 2000 of the most critical terms and concepts in toxicology. Chemical structures and chemical abstract services (CAS) numbers are provided for many toxic agents. Some important entries outside of toxicology provide context and relationships to other fields. The *Dictionary of Toxicology* serves as a resource for toxicologists and non-toxicologists and facilitates the standardization of terminology.

Josephy PD, Mannervik B (2006)
Molecular Toxicology, 2nd edition
New York: Oxford University Press.

This book focuses on the molecular basis of biotransformation and toxicity of chemicals. The second edition of *Molecular Toxicology* is organized into three parts, Toxicity at the Cellular Level (Part 1), Enzymology of Biotransformation (Part 2) and Molecular Principles Applied to Specific Toxicants (Part 3). In Part 3, the molecular basis of toxicity is described using examples including alkylating agents, methemoglobinemic agents, aromatic amines, polycyclic aromatic hydrocarbons, and acetaminophen.

Kent C (1998)
Basics of Toxicology
New York: John Wiley.

Basics of Toxicology is designed as a text for undergraduate environmental technology students. It provides an overview of anatomy, physiology and chemistry information in the context of an introduction to toxicology. 'Sidebars' are included to emphasize critical concepts. A glossary and bibliography are included.

Klaasen CD (ed.) (2008)
Casarett & Doull's Toxicology: The Basic Science of Poisons, 7th edition
New York: McGraw-Hill.

The most-recognized and comprehensive resource for toxicologists, the 7th edition of *Casarett & Doull's Toxicology: The Basic Science of Poisons* has over 1300 pages and contributions from over 50 experts in the field. All major topics of toxicology are covered from history to principles to applications. The book is organized into 33 chapters covering general principles (1–4), disposition (5–7), non-organ directed toxicity (e.g., carcinogenesis, 8–10), target organ toxicity (11–21), specific classes of agents (22–27), environmental toxicology (28, 29), and applications (e.g., regulatory toxicology, 30–33). The 7th edition contains more up-to-date coverage of advances in the molecular basis of toxicology. This book remains an essential text for any individual interested in toxicology.

Lewis RA (1998)
Lewis' Dictionary of Toxicology
Boca Raton, FL: Lewis.

This dictionary contains over 1100 pages of brief definitions for common terms used in toxicology. There is extensive cross-referencing but no illustrations. This book is a resource for students and professionals.

Loomis TA, Hayes AW (1996)
Loomis's Essentials of Toxicology, 4th edition
San Diego, CA: Academic Press.

Loomis's Essentials of Toxicology is a brief, general overview of toxicology. It includes discussion of the major classes of toxicants, general properties of chemicals and how they interact with biological systems, methods used to demonstrate toxic responses and the basis for diagnosis and treatment of toxic responses in humans. Examples or case studies are used throughout for demonstration. *Loomis's Essentials of Toxicology* is clearly written and can serve as an excellent introduction to toxicology for both undergraduate and graduate students.

Lu FC, Kacew S (2002)
Lu's Basic Toxicology, 4th edition
New York: Taylor & Francis.

This is an excellent overview of toxicology for students taking toxicology courses or for scientists in related disciplines. The book is organized into four parts with 25 chapters: Part I (general principles of

toxicology), Part II (testing procedures for conventional and non-target organ toxicities), Part III (target organs and systems), and Part IV (toxic substances and risk assessment).

Marquardt H, Schafer S, McClellan RO, Welsch F (eds.) (1999)
Toxicology
San Diego, CA: Academic Press.

Toxicology is a comprehensive text covering principles/fundamentals of toxicology, organ toxicity as well as chemical classes, toxicokinetics, biotransformation, targets, applications, and environmental toxicology. Emphasis is placed on specific areas including risk assessment, mechanisms of cell death, and methodological approaches. *Toxicology* has excellent illustrations throughout. It is organized into six parts with 52 chapters and over 1200 pages. An appendix includes valuable information including reference doses, drinking water standards, and values.

Massaro EJ (ed.) (1997)
Handbook of Human Toxicology
Boca Raton, FL: CRC Press.

Handbook of Human Toxicology contains over 1100 pages organized into five sections: metals toxicology, nutritional toxicology, inhalation toxicology, immunotoxicology, and reproductive and developmental toxicology. The text effectively uses tables and figures to summarize important concepts. Each section contains complete reference lists.

Niesink RJM, de Vries J, Hollinger MA (1996)
Toxicology: Principles and Applications
Boca Raton, FL: CRC Press.

The text of *Toxicology: Principles and Applications* was developed from a course administered through the Open University of the Netherlands. This book containing over 1200 pages and 200 tables focuses on basic principles and concepts of toxicology. Extensive illustrations are included throughout. Each of the chapters (fundamental principles, molecular aspects of toxicity, organ toxicology, organs involved in absorption and elimination, organs involved in maintaining homeostasis, and applications) constitutes a study unit with an individual table of contents, introduction, learning 'core', self-assessment questions and answers, feedback, and summary. A final examination is included at the end of the book that covers the entire 'course'. A list of abbreviations, formula index, glossary, and overall index is included. While it has been over a decade since publication and some areas are necessarily not up-to-date, this book is still a useful learning resource for students and instructors of toxicology.

Ostler NK, Byrne TE, Malachowski MJ (1996)
Health Effects of Hazardous Materials
New York: Macmillan.

This book is intended as an introduction to toxicology for environmental technicians. Topics covered include origin and classification of toxic agents, ADME, target organ toxicity, environmental toxicology, radiation, and common industrial hazards.

Ottoboni MA (1997)
The Dose Makes the Poison: A Plain Language Guide to Toxicology, 2nd edition
Hoboken, NJ: Wiley.

This book is a layman's introduction to toxicology. The author discusses factors and concepts (e.g., dose–response) important in understanding how chemicals elicit toxicity. The second edition covers public distrust of science, epidemiology, reproductive toxicology, and risk assessment relative to current environmental problems. No-effect levels and thresholds, margins of safety, and bioaccumulation are discussed in a clear-cut, easily understandable manner.

Schiefer HB, Irvine DG, Buzik SC (1997)
Understanding Toxicology: Chemicals, Their Benefits and Risks
Boca Raton, FL: CRC Press.

Understanding Toxicology: Chemicals, Their Benefits and Risks is another layman's introduction to toxicology. It provides a concise (160 pages), general overview of the principles of toxicology. This book is for non-toxicologists interested in chemical safety, real and perceived toxic risks, hazardous wastes, and common hazards around the home, at work, and in the environment.

Sipes IG, Gandolfi AJ, McQueen CA (eds.) (1997, 2002)
Comprehensive Toxicology
New York: Pergamon.

This extensive collection of toxicologic information covers the breadth of all subdisciplines of the field. *Comprehensive Toxicology* was published as 13 volumes (with Volume 13 being an index) in 1997, while an update (Volume 14, Cellular and Molecular Toxicology) was published in 2002. While early volumes cover principles (Volume 1), testing (Volume 2), and biotransformation (Volume 3), the remaining volumes are primarily organized by organ system effects. With contributions from leaders in the field, this collection serves as an extensive resource for the spectrum of toxicology interests.

Stine KE, Brown TM (2006)
Principles of Toxicology, 2nd edition
Boca Raton, FL: CRC Press.

Principles of Toxicology is an introduction to toxicology organized by systems: molecular and cellular, physiological, and environmental and ecological. The format is somewhat different from other introductory texts in that toxicity testing and risk assessment are discussed early on (Chapter 1). Subsequent chapters cover toxicokinetics, biotransformation, cellular mechanisms, genomics, non-target system toxicity, organ system toxicity, and applications. Some case studies are included as well as a brief appendix with chemical structures of some of the toxicants discussed.

Timbrell J (1997)
Study Toxicology through Questions
London: Taylor & Francis.

This concise book (160 pages) provides a substantial set of short answer, problem-solving, data interpretation, and multiple choice questions (and their answers) covering all major areas of toxicology including mechanisms, types of toxic responses, modifying factors, biotransformation, disposition, and others. *Study Toxicology through Questions* can be a valuable resource for exam preparation and review, for both students and instructors.

Timbrell JA (2002)
Introduction to Toxicology, 3rd edition
London: Taylor & Francis.

Introduction to Toxicology is an excellent text for the introductory toxicology class. It is organized into 12 chapters. Chapters 1–4 provide an introduction with history of toxicology, and discuss disposition, biotransformation, and types of exposures and toxic responses. Chapters 5–11 cover different classes of toxicants including drugs, industrial chemicals, food additives, pesticides, environmental contaminants, and both natural and household products. The final chapter is devoted to toxicity testing and risk assessment. Each chapter has a summary, learning objectives and sample questions. The answers to all questions are provided at the end of the book along with an appendix. Thus, this text is an excellent learning resource for the beginning toxicology student.

Wexler P (2005)
Encyclopedia of Toxicology, 2nd edition
Oxford, UK: Elsevier.

The *Encyclopedia of Toxicology* is a four-volume compendium of over 3000 pages, with topics arranged alphabetically and covering all aspects of the field including principles and concepts, specific toxicants, types of responses and their mechanistic basis, federal and international regulations, toxicological societies and more. This work was designed primarily as a resource for the non-toxicologist, but is a valuable source of information for students and professionals in toxicology as well. The encyclopedia is extensively indexed and cross-referenced and contains an extensive glossary.

Woolley A (2003)
A Guide to Practical Toxicology: Evaluation, Prediction, and Risk
London: Taylor & Francis.

As the title implies this book is a practical guide to toxicity testing methods and interpretation of results. Initial chapters address the principles of toxicology and then proceed with examining testing methods from in vitro testing, animal testing, and relevance to human testing. Case studies are used to illustrate study design and methods, interpretation, and risk assessment.

Journals

Archives of Toxicology (1930–)
Berlin/Heidelberg, Germany: Springer.
Web: http://www.springer.com/west/home/biomed?SGWID=4-124-70-1018484-0

Archives of Toxicology emphasizes studies related to mechanisms of toxicity, including toxic activities at the molecular level, in humans and experimental animals. Articles in toxicokinetics, forensics, and new analytic methods as well as review articles of general interest are also published.

Chemical Research in Toxicology (1988–)
Washington, DC: American Chemical Society.
Web: http://pubs.acs.org/journals/crtoec/index.html

Chemical Research in Toxicology is an international journal publishing articles focused on the chemical basis of toxicological responses, e.g., identification of novel toxic agents and reactive intermediates, development of new methods to detect chemical-induced modification of biological macromolecules, studies of alteration of macromolecular structure and function by chemical agents, experimental and theoretical studies of chemical factors that control reactivity with macromolecules, and biotransformation as it relates to biological effects.

Critical Reviews in Toxicology (1971–)
Philadelphia, PA: Taylor and Francis.
Web: http://www.tandf.co.uk/journals/titles/10408444.asp

Critical Reviews in Toxicology publishes reviews of timely and critical topics related to mechanisms, toxic

responses, and assessment of toxicants including chemicals such as industrial chemicals, pesticides, pharmaceutical agents, consumer products (e.g., food additives), and environmental contaminants. Particular attention is given to cancer and developmental effects as responses of special societal concern.

Human and Experimental Toxicology (1990– formerly Human Toxicology)
London: Sage Publications.
Web: http://www.sagepub.co.uk/journalsProdDesc.nav?prodId=Journal201813

Human and Experimental Toxicology publishes experimental and clinical studies of chemical-induced functional, biochemical, and structural alterations. The journal emphasizes studies on causes, antidotes, and therapeutic strategies of chemical-induced disease. Both original and review articles are published.

International Journal of Toxicology (1997– formerly *Journal of the American College of Toxicology*)
Philadelphia, PA: Taylor and Francis.
Web: http://www.tandf.co.uk/journals/titles/10915-818.asp

This journal publishes studies on the assessment of toxic hazards of industrial chemicals, pharmaceutical agents, environmental contaminants, and other entities. Emphasis is placed on mechanisms of action relevant to human health. Topics of particular interest include mechanisms of toxicity, risk assessment and safety evaluation, carcinogenicity, reproductive and genetic toxicology, epidemiology and clinical toxicology, new approaches to toxicological testing, alternatives to animal testing and safety/regulatory toxicology.

Journal of Applied Toxicology (1981–)
Hoboken, NJ: Wiley.
Web: http://www.wiley.com/WileyCDA/WileyTitle/productCd-JAT.html

The *Journal of Applied Toxicology* publishes original research, theoretical and literature reviews relating to the toxicity of drugs and chemicals at the molecular, cellular, tissue, and target organ level. Topics include teratogenesis, carcinogenesis, mutagenesis, pharmacokinetics, environmental toxicology and environmental health, analytical/method development studies, and in vitro techniques/alternatives to animal use.

Journal of Toxicological Sciences (1976–)
Japanese Society of Toxicology.
Web: http://www.jtoxsci.org/

This journal publishes studies evaluating toxicity of drugs, food additives, food contaminants, environmental pollutants and other substances, and their mechanisms, biological responses, safety evaluation, experimental techniques, and analytical methods. Original articles, letters, reports, and reviews are published.

Journal of Toxicology and Environmental Health
Philadelphia, PA: Taylor & Francis.
Web: http://www.tandf.co.uk/journals/titles/15287394.asp
Web: http://www.tandf.co.uk/journals/titles/10937404.asp

Journal of Toxicology and Environmental Health is published in two parts, Part A (Critical Issues, i.e., original research articles) and Part B (Critical Reviews, invited and unsolicited review articles). Part A publishes refereed original research in environmental toxicology in general, as well as areas including target organ toxicity, immunotoxicology, risk assessment, carcinogenesis, mutagenesis, ecotoxicology, environmental factors affecting health, epidemiology, and aquatic toxicology. Part B publishes in-depth reviews on the same topics as emphasized in Part A.

Toxicological Sciences (1998– formerly *Fundamental and Applied Toxicology*)
Oxford, UK: Oxford University Press.
Web: http://www.oxfordjournals.org/our_journals/toxsci/about.html

Toxicological Sciences publishes peer-reviewed, hypothesis-driven, original research articles in all areas of toxicology including structural, biochemical, or functional effects, mechanisms of toxicity, effects of dose, route of exposure, metabolism, or species on toxic responses, statistical or mechanism-based approaches to risk assessment and development of new methods in toxicology.

Toxicology (1973–)
Amsterdam, the Netherlands: Elsevier.
Web: http://www.elsevier.com/wps/find/journaldescription.cws_home/505518/description?navopenmenu=-2

Toxicology is an international journal publishing original articles in all aspects of adverse effects of xenobiotics health of humans, animals, and ecosystems. Emphasis is placed on toxic effects observed at relevant exposure levels with direct impact on safety evaluation and risk assessment practices.

Toxicology and Applied Pharmacology (1959–)
Amsterdam, the Netherlands: Elsevier.
Web: http://www.elsevier.com/wps/find/journaldescription.cws_home/622951/description?navopenmenu=-2

Toxicology and Applied Pharmacology publishes original articles on toxic actions of chemicals, drugs, or natural products in animals or humans, with emphasis on mechanistic approaches to physiological, biochemical, cellular, or molecular understanding of toxicologic/pathologic lesions.

Toxicology Letters (1977–)
Amsterdam, the Netherlands: Elsevier.
Web: http://www.elsevier.com/wps/find/journaldescription.cws_home/505519/description?navopenmenu=-2

Toxicology Letters publishes studies in all areas of toxicology, with an emphasis on rapid publication of research letters having sufficient importance, novelty, and breadth of interest. Papers presenting hypotheses/commentaries addressing current issues of immediate interest as well as mini-reviews are published. Information on forthcoming meetings, symposia, and workshops is also included.

Website

A Small Dose of Toxicology
Steven G. Gilbert/Institute of Neurotoxicity and Neurological Disorders
Web: http://www.asmalldoseof.org/SmDs.poster.03.28.06.pdf

This website contains a remarkable amount of information and resources on the general principles of toxicology and specific material on neurotoxicants and neurological disease. Powerpoint presentations, figures, diagrams, and other online materials represent a great resource for the instructor in general toxicology courses.

CHAPTER

6

Analytical Toxicology

KELLI SELFE AND SHAYNE GAD

INTRODUCTION

Analytical toxicology is the use of the entire range of qualitative and quantitative chemical, immunochemical, and physical techniques used in sample preparation, separation, assay calibration, detection and identification, and quantification for the purposes of toxicological research and testing. Examples of the objectives of such analysis include:

- Determining the levels of exposure to potential toxicants via air, water, or food.
- Verifying exposure levels to doses for animals in experimental studies.
- Determining levels of xenobiotics and their metabolites in animal studies.
- Screening blood and urine for the presence of illicit drugs or their metabolites.
- Screening blood, urine, and tissues for the presence of toxic drugs, agents, or their metabolites.
- Measuring levels of endogenous compounds and molecules to evaluate organ function and damage (clinical chemistry).
- Identifying metabolites and macromolecular adjuncts to identify mechanisms of action.

The diagnosis and treatment of health problems induced by chemical substances and the closely allied field of therapeutic drug monitoring rely on analytic toxicology. Advances in analytic toxicology have added both power and problems to toxicology, with the increases in sensitivity and specificity. Although the analytes are present in matrices identical or similar to those seen in forensic toxicology, the results must be reported rapidly to be of use to clinicians in treating patients. The requirement of a rapid turnaround time limits the number of chemicals that can be measured because methods, equipment, and personnel must all be available for an instant response to toxicological emergencies. Investigations for an 'unknown' drug or poison are usually carried out on specimens of urine, blood, or specific tissues.

Related Topic

Forensic toxicology.

RESOURCES

Books

Baselt RC (2004)
The Disposition of Toxic Drugs and Chemicals in Man
Foster City, CA: Chemical Toxicology Institute.

A single source providing an extensive compilation on the disposition of over 640 drugs and chemicals most frequently encountered in episodes of human poisoning. The data relate to the body fluid concentrations of substances in normal or therapeutic situations, concentrations in fluids and tissues in instances of toxicity and the known metabolic fate of these substances in man. Each drug/chemical is broken down into: Occurrence and Usage; Blood Concentrations; Metabolism and Excretion; Toxicity; and Analysis. This 7th edition has been expanded with an additional 139 drugs or chemicals including a number of animal toxins, antibiotics, antidepressants, antidiabetics, antifungal agents, antihyperlipidemic drugs, antineoplastic drugs, antiseptics,

antiviral agents, diuretics, herbal medicines, herbicides, laxatives, solvents, sedative-hypnotics, pesticides, and drugs used to treat Alzheimer's disease.

Botsoglou NA, Fletouris DJ (2001)
Drug Residues in Foods
New York: Marcel Dekker, Inc.

A volume in the Food Science and Technology series which focuses on veterinary drug residues in food products, their toxicity and analysis.

Bradenberger H, Maes RAA (ed.) (1997)
Analytical Toxicology for Clinical, Forensic and Pharmaceutical Chemists (Clinical Biochemistry)
Berlin, Germany: Walter de Gruyter & Co.

This book will be of use to clinical and forensic toxicologists as well as to pharmacists involved in analytical work. The critical evaluations of the analytical possibilities may help with the choice of methods, the additional information with the determination of the goals of an investigation and the interpretation of its results. In addition to all the analytical and toxicological information the book contains, it also tries to teach the analytical toxicologist to place his technical obligations into a larger context.

Flanagan RJ (2005)
Developing Analytical Toxicology Services: Principles and Guidance
Geneva, Switzerland: WHO/ILO/UNEP.

Flanagan RJ, Braithwaite RA, Brown SS, Widdop B, Wolff FA (eds.) (1995)
Basic Analytical Toxicology
Geneva, Switzerland: World Health Organization.

The aim of this manual is to help hospital laboratories in developing countries to provide a basic analytical toxicology service using a minimum of special apparatus. It is not intended to replace standard texts, but to provide practical information on the analysis of a number of substances frequently involved in acute poisoning incidents. Common pitfalls and problems are emphasized throughout, and basic health and safety precautions for laboratory workers are also discussed.

Gad SC, Wexler P, Anderson BD, et al (eds.) (2005)
Analytical toxicology. In: ***Encyclopedia of Toxicology*** pp. 113–116.
Oxford, UK: Elsevier Inc.

Overview of the definition of analytical toxicology as well as analysis of common toxic substances and analytical techniques.

Gupta SK, Singh U, Velpandian T (eds.) (2002)
Analytical Toxicology for Poisoning Management and Toxicovigilance
New Dehli, India: Narosa Publishing House.

This text covers services of the analytical toxicology laboratory, from common general emergency medicine to specialized treatment units. It defines procedures for critical quantitative analysis in treating acute poisoning cases and is a useful reference for those in poisoning diagnosis, case management, and prevention.

Sue Jickells, Adam Negrusz (eds.) (2008)
Clarke's Analytical Toxicology
London: Pharmaceutical Press.

Mieczkowski T (ed.) (1999)
Drug Testing Technology: Assessment of Field Applications (Methods in Analytical Toxicology)
Boca Raton, FL: CRC Press.

This book covers a wide range of research currently being done in drug analysis, *Drug Testing Technology: Assessment of Field Applications* compares and evaluates various methods used to determine abused drugs taken by individuals. Chapters provide overviews of drug incorporation into hair; the use of hair analysis for compliance measurement in the use of anti-epileptic medications; and the application of drug testing to the psychiatric treatment of substance abuse disorders.

Moffat AC, Osselton MD, Widdop B (2004)
Clarke's Analysis of Drugs and Poisons, 3rd edition
London: Pharmaceutical Press.

This is a two-volume reference set previously known as *Clarke's Isolation and Identification of Drugs*, this practical manual and standard reference work provides the definitive source of analytical data for drugs and poisons. It is intended for use primarily by scientists faced with identifying and quantifying these substances in body fluids, tissue samples, and pharmaceutical and industrial products. Volume 1 includes 31 chapters covering all practice areas and analytical procedures in analytical toxicology as well as applications of analytical toxicology techniques, Volume 2 includes 1730 drug monographs.

NIOSH Manual of Analytical Methods, 4th edition (NIOSJ Manual of Analytical Methods), (1994)
Web: http://www.cdc.gov/niosh/nmam/

Satinder A, Scypinski S (2001)
Handbook of Modern Pharmaceutical Analysis
San Diego, CA: Academic Press.

A modern text on methodology for the analysis of pharmaceutical active ingredients and formulations.

Wong Steven HY, Irving Sunshine (eds.) (1997)
Handbook of Analytical Therapeutic Drug Monitoring and Toxicology
Boca Raton, FL: CRC Press.

This volume facilitates searches for appropriate techniques, describes recent contributions from leading investigators, and provides valuable evaluations and advice. Discover how to use non-invasively obtained specimens to your best advantage. The text features alternative biological specimens such as hair, meconium, saliva, sweat, and vitreous humor, which are not extensively used because they require more sensitive procedures than other biological specimens. How to overcome these limitations is a major topic of the handbook. Experts describe basic principles of innovative techniques and detail how they can be adapted to analyzing alternative biological specimens. The evaluations of the pros and cons of various advances in immunodiagnostics and how they apply to analytes will help you determine their suitability to your own laboratory. The *Handbook of Analytical Therapeutic Drug Monitoring and Toxicology* helps you make the most of innovative procedures that will open the doors to productive laboratory practices.

Venn RF (2000)
Principles and Practice of Bioanalysis
Philadelphia, PA: Taylor and Francis.

A modern text on methodology for the analysis of active pharmaceutical ingredients and their metabolites in biological matrices.

Review Articles

Baars AJ (1996) Analytical toxicology: From environmental monitoring to residue analysis. Arh. Hig. Rada. Toksikol. 47(2): 199–209.

Bost RO (1993) Hair analysis – Perspectives and limits of a proposed forensic method of proof: A review. Forensic Sci. Int. 63: 31–42.

De Zeeuw RA (1998) Recent developments in analytical toxicology: for better or for worse. Toxicol. Lett. 102–103: 103–108.

De Zeeuw RA (2004) Substance identification: the weak link in analytical toxicology. J. Chromatogr. B Analyt. Technol. Biomed. Life Sci. 811(1): 3–12.

Dewan A, Pandva CB, Saiyed HN (1998) Basic analytical toxicology. Indian J. Med. Res. 107: 109–110.

El-Masri HA, Reardon KF, Yang RSH, et al (1997) Integrated approaches for the analysis of toxicologic interactions of chemical mixtures. Crit. Rev. Toxicol. 27(2): 175–197.

Ferrara DS, Tedeschi L, Frison G, Brusini G (1998) Quality control in toxicological analysis. J. Chromatogr. B. Biomed. Sci. 713: 227–243.

Flanagan RJ (1995) The poisoned patient: The role of the laboratory. Br. J. Biomed. Sci. 52: 202–213.

Flanagan RJ (1998) Guidelines for the interpretation of analytical toxicology results and unit of measurement conversion factors. Ann. Clin. Biochem. 35(Pt.2): 261–267.

Flanagan RJ, Widdop B, Ramsey JD, Loveland M (1988) Analytical toxicology. Hum. Toxicol. 7(5): 489–502.

Flanagan RJ, Connally G (2005) Interpretation of analytical toxicology results in life and at postmortem. Toxicol Rev. 24(1): 51–62.

Flanagan RJ, Connally G, Evans JM (2005) Analytical toxicology: guidelines for sample collection postmortem. Toxicol. Rev. 24(1): 63–71.

Flanagan RJ, Morgan PE, Spencer EP, Whelpton R (2006) Micro-extraction techniques in analytical toxicology: short review. Biomed. Chromatogr. 20(6): 530–538.

Hoja H, Marquet P, Verneuil B, et al (1997) Applications of liquid chromatography-mass spectrometry in analytical toxicology. A review. J. Anal. Toxicol. 21(2): 116–126.

Kraemer T, Paul LD (2007) Bioanalytical procedures for determination of drugs of abuse in blood. Anal. Bioanal. Chem. 338: 1415–1435.

Maurer Hans H (2005) Advances in analytical toxicology: The current role of liquid chromatography mass spectrometry in drug quantification in blood and oral fluid. Anal. Bioanal. Chem. 381(1): 110–118.

Maurer HH (2007) Analytical toxicology. Anal. Bioanal. Chem. [Epub ahead of print].

Pragst F (2007) Application of solid-phase microextraction in analytical toxicology. Anal. Bioanal. Chem. 338: 1311.

Smith ML, Vorce SP, Holler JM, et al (2007) REVIEW: Modern instrumental methods in forensic toxicology. J. Anal. Toxicol. 31(50): 237–253.

Tracqui A, Kintz P, Mangin P (1995) Systemic toxicological analysis using HPLC/DAD. J. Forensic Sci. 40(2): 254–262.

Van Bocxlaer JF (2005) Recent trends in analytical procedures in forensic toxicology. Ther. Drug Monit. 27(6): 752–755.

Van Emon JM, Gerlach CL, Bowman K (1998) Bioseparation and bioanalytical techniques in environmental monitoring. J. Chromatogr. B. Biomed. Appl. 715(1): 211–228.

Willie SM, Lambert WE (2007) Recent developments in extraction procedures relevant to analytical toxicology. Anal. Bioanal. Chem. 338: 1381–1391.

Journals

Analytical and Bioanalytical Chemistry
Annals of Clinical Biochemistry
Biomedical Chromatography
Forensic Science International
Journal of Analytical Toxicology
Journal of Chromatography B (formerly known as Journal of Chromatography B: Biomedical Sciences and Applications)
Journal of Forensic Science
Therapeutic Drug Monitoring

Website

World Health Organization (WHO) Analytical Toxicology: http://www.who.int/ipcs/publications/training_poisons/basic_analytical_tox/en/index.html

Database

The NIOSH Manual of Analytical Methods (NMAM®)

The NIOSH Manual of Analytical Methods database is a compilation of methods for sampling and analysis of contaminants in workplace air, and in the bodily fluids of workers who are occupationally exposed to that air. These methods have been developed specifically to have adequate sensitivity to detect the lowest concentrations and sufficient flexibility of range to detect concentrations exceeding safe levels of exposure, as regulated by OSHA and recommended by NIOSH. The Threshold Values (TLV™) and Biological Exposure Indices (BEI™) of the American Conference of Governmental Industrial Hygienists (ACGIH) are also cited.

CHAPTER

7

Animals in Research

ELIZABEHT NORFLEET, AND SHAYNE GAD

INTRODUCTION

The use of animals in experimental medicine, pharmacological study, and toxicological assessment is a well-established and essential practice. It forms the basis of regulatory requirements for evaluating and establishing the safety of drugs, medical devices, agricultural chemicals, and food additives. Whether serving as a source of cells or tissues for culturing, a disease model, or as a prediction for drug or other xenobiotic action in humans, experiments in animals have provided the necessary building blocks that permitted the explosive growth of medical and biological knowledge in the latter half of the twentieth century. Animal experiments also have served rather successfully as identifiers of potential hazards to and toxicity in humans for synthetic chemicals with many intended uses.

Animals have been used as predictive models for centuries to what chemicals and environmental factors would do to humans. The earliest uses of experimental animals are lost in prehistory, and much of what is recorded in early history about toxicology testing indicates that humans were the test subjects. The earliest clear description of the use of animals in the scientific study of the effects of environmental agents appears to be by Priestley (1792) in his study of gases.

The knowledge gained by experimentation on animals has undoubtedly increased the quality of our lives; however, as is the case with many tools, animals have sometimes been used inappropriately. This has encouraged a measure of critical self-appraisal on the part of scientists concerning the issues of the care and usage of animals. The Society of Toxicology and American College of Toxicology, for example, have established Animals in Research committees, and has published guidelines for the use of animals in research and testing. In general, the purpose of this committee is to foster thinking on the four 'Rs' of animal-based research: reduction, refinement, research into replacements, and responsible use.

Globally, regulation of laboratory animal care started in the 1960s, and the United States initially passed the Animal Welfare Act (AWA) in 1966 (amended to date in 1970, 1976, 1985, 1990 and 2002).

RESOURCES

Books

Bennett BT, Abee CR, Henrickson R (ed.) (1995)
Nonhuman Primates in Biomedical Research: Biology & Management Volume I (American College of Laboratory Animal Medicine)
San Diego, CA: Academic Press.

This volume and its companion *Nonhuman Primates in Biomedical Research: Biology and Management* represent the most comprehensive publications of their type on non-human primates. This volume addresses the diseases of non-human primates with an emphasis on the etiological factors, clinical signs, diagnostic pathology, therapy, and management. Its companion volume serves as a general reference for those who provide care for these animals and for those who use them in biomedical research.

Festing MFW, Overend P, Das RG, Borja MC, Manuel Berdoy (2002)
The Design of Animal Experiments: Reducing the Use of Animals in Research Through Better Experimental Design (Laboratory Animal Handbooks)
London, UK: Royal Society of Medicine Press.

This book covers especially the interface between laboratory animal science and experimental design and is written by British biostatisticians with excellent training in animal experiments.

Fox JG, Anderson LC, Loew FM, Quimby FW (eds.) (2002)
Laboratory Animal Medicine, Second Edition (American College of Laboratory Animal Medicine)
San Diego, CA: Academic Press.

A volume in the American College of Laboratory Animal Medicine series, this second edition has over 40% new material, including the addition of six new topics and many others that are completely rewritten. The book comprehensively covers the biological and disease aspects of laboratory animal medicine while examining other aspects such as the biohazards associated with the use of animal experimentation and factors complicating the bioethics of animal research.

Gad SC (2007)
Animal Models in Toxicology, 2nd edition
Boca Raton, FL: CRC Press.

Reflecting a decade's worth of changes, this second edition is a practical guide to the common statistical problems encountered in toxicology and the methodologies that are available to solve them. The book presents a historical review of the use of animal models used in toxicology and an overview of broad considerations of metabolism and its relevance. Chapters covering the eight major species used in toxicology and experimental biology form the core of the book. With contributions from experts in toxicology, toxicological pathology, and species-specific metabolism, each of these chapters provide an excellent introductory 'course' along with guidance to the literature for more detailed understanding.

Jeppsson I (1997)
Animal Modelling in Surgical Research
Malma University Hospital, Uppsala, Sweden: Harwood Academic Publishers.

This book clearly describes animal models used in gastrointestinal, vascular, endocrine, urologic, central nervous system, and transplantation surgery research and highlights their relevance to the study of human disease. Tumor models are also described, including those of the gastrointestinal tract and breast. The fundamental differences between various animal species and the implications for the choice of animal model are explored in an opening chapter on comparative biology, while a system-by-system approach ensures complete coverage of the models used in different surgical fields.

Shafrir E, Sima Anders AF (2000)
Animal Models of Diabetes: Frontiers in Research, 2nd edition
Boca Raton, FL: CRC Press.

This most recent edition of *Animal Models of Diabetes* provides researchers with updated and expanded information regarding the use of models in experiments with both Type 1 and Type 2 diabetes. It compiles relevant time-saving information on most, if not all, current well-recognized models for both types of diabetes, including various mice, rats, minipigs, and Rhesus monkeys, and provides extensive references for more in-depth study. Among several other topics, it discusses nutritionally diabetes-prone animals, and considerations of insulin resistance and obesity. It also addresses the importance of recent findings on pathogenesis of diabetes and its complications in relation to human disease.

Swearengen James R (ed.) (2005)
Biodefense: Research Methodology and Animal Models
Boca Raton, FL: CRC Press.

To ensure that efforts to improve our biodefensive capabilities continue in an efficient manner, this volume presents a thorough review of biodefense research, encouraging researchers to leverage relevant results, rather than duplicate them. Thus, scientists will be able to make the best use of resources and avoid duplication. With contributions from those who have developed the animal models presented, this book examines bacterial, viral, and toxic agents considered to pose the greatest threat. Each section on a specific agent provides background, followed by a description of those animal models employed in research, and a discussion of how the findings translate to human impact.

Tatlisumak T, Fisher M (eds.) (2006)
Handbook of Experimental Neurology: Methods and Techniques in Animal Research
Cambridge, UK: Cambridge University Press.

Basic relevant information on methodologies used in neurological disease models can be extremely hard to find. This major new reference work contains 30 chapters from over 60 internationally recognized scientists and covers every major methodology and disease model used in current neuroscience research. Divided into two major sections, the first deals with general

methodologies in neuroscience research covering topics from animal welfare and ethical issues to surgical procedures, post-operative care and behavioral testing. Section two covers every major disease model including traumatic brain injury, ischemia and stroke, to Parkinson's disease, epilepsy, and sleep disorders. Delivering critical, up-to-the-minute, methodological information and describing small animal models for almost all major neurological diseases, this book forms an essential reference for anyone working in neuroscience, from beginning students to experienced researchers and medical professionals.

Woodhead AD (1989)
Nonmammalian Animal Models for Biomedical Research
Boca Raton, FL: CRC Press.

This book provides essential knowledge and information required to adequately assess useful alternatives from among the lower vertebrates and the invertebrates. This volume highlights unfamiliar and underdeveloped organisms that have the potential to become very satisfactory surrogates for biomedical research. A practical guide aimed at disseminating information to researchers about new models, this work provides comparative biomedical studies at many levels of the phylogenetic ladder.

Review Article

Gad SC, Cassidy CD, Aubert N, Spainhour B, Heide Robbe (2006) Nonclinical vehicle use in studies by multiple routes in multiple species. Int. J. Toxicol. 25(6): 499–521.

Journals

Animal Research

Institute for Laboratory Animal Research (ILAR) Journal and e-Journal

Journal of Animal Science

Journal of Applied Animal Research

Lab Animal

Databases

AGRICOLA
Web: http://agricola.nal.usda.gov/

Animal Welfare Act and Regulations
Web: http://nal.usda.gov/awic/legislat/awa.html

Animal Welfare Information Center (AWIC)
Web: http://awic.nal.usda.gov/nal_display/index.php?tax_level=1&info_center=3

BIOSIS Previews
Web: http://www.biosis.org/products/previews/

Medicina Veterinaria
Web: http://biblioteca.saludnet.com.co/medicina_veterinaria.htm

Organizations

American Association for Laboratory Animal Science (AALAS)
Web: http://www.aalas.org/

American College of Laboratory Animal Medicine (ACLAM)
Web: http://www.aclam.org

Association for Assessment and Accreditation of Laboratory Animal Care International (AAALAC)
Web: http://www.aaalac.org/

Institutional Animal Care and Use Committee
Web: http://www.iacuc.org/

International Council for Laboratory Animal Science (ICLAS)
Web: http://www.iclas.org

Institute for Laboratory Animal Research
Web: http://dels.nas.edu/ilar/

National Institutes of Health (NIH), Office of Laboratory Animal Welfare
Web: http://grants.nih.gov/grants/olaw/olaw.htm

CHAPTER

8

Biomarkers

CECILE M. KREJSA AND JEREMY A. FREEMAN

INTRODUCTION

Drug development scientists are increasingly turning to data-rich technologies ('-omics') to describe the activity of their drugs in biological systems. These methods provide more refined information about the role of drug targets in biomolecular pathways, the specific responses of molecular targets and pathways to drug exposure, and the subset of patients that express certain targets and are likely to respond favorably to a given therapy. At the same time, industry and regulatory agencies have developed initiatives to increase the use of biomarkers in drug development, both to increase the information available for decision-making and to speed the process by aiding in patient selection and response monitoring. Thus biomarker studies have emerged as a rapidly growing field in drug discovery and development sciences over the past few years.

In drug development, a biomarker is an objectively measurable characteristic that relates to normal biological processes, pathogenic processes (disease status), anatomic measurements, or pharmacological responses to therapeutic intervention. Thus a large variety of measurable endpoints can be biomarkers, including clinical laboratory results, data from disease-specific diagnostic tests, in vivo imaging results, and data from intervention-specific assays designed to capture pharmacodynamic responses to treatment. Additionally, genotypes that predict certain phenotypes, such as polymorphisms in drug-metabolizing enzymes or drug targets, may be analyzed. Biomarkers are used for multiple purposes, including mechanistic investigations, early assessment of both beneficial and adverse responses, selecting patient subsets based on predicted responses, or defining alternate response endpoints (surrogate endpoints).

Due to the diversity of these experimental approaches and applications, a mix of expertise will be required to appropriately design a biomarker strategy for the many phases of drug development. Toxicological studies might incorporate pharmacodynamic biomarkers, toxicogenomic and/or proteomic endpoints, and a mixture of clinical pathology and flow cytometry assays. Proof-of-concept studies might incorporate in vivo imaging as a complement to tissue-based response monitoring; and clinical trials could be designed to include a subset of the response biomarkers developed in preclinical studies, in addition to disease diagnostics, tests for therapeutic target, and genetic polymorphism analysis.

The expected use of each biomarker will define its need for qualification; as development progresses from discovery to the clinic, the inclusion of certain types of biomarkers may not be feasible. Ultimately, the goal of incorporating biomarkers in drug development is to provide information suitable for decision-making along the way. In a subset of cases, the development and validation of a new clinical diagnostic assay might become an integral part of the drug development process.

Many new biomarkers have emerged from toxicological investigations, as mechanistic toxicologists have applied gene expression analysis and proteomic techniques to study drug-induced toxicities. Likewise, progress has been made to relate data from studies of model toxicants to the application of composite (profile) markers in mechanistic models for drug effects.

Pathway analysis tools have proven useful in interpreting multivariate data, both to clarify the mechanisms of toxicity and to aid in identification of biomarkers that are likely to be found in accessible tissues.

Biomarker development will benefit from the cross-functional communication about novel discovery methods and the successful translation of these approaches to preclinical and clinical investigations. Thus, this chapter on information resources in toxicology represents a mix of various and complementary views on the subject. The goal of this chapter is to introduce these perspectives, which include both general and specialized texts, in-depth reviews from subject area experts and a number of useful online resources for research and regulatory applications. Due to the multidisciplinary nature of the topic, a comprehensive listing of all information resources is not possible; however we feel that the compiled list will serve to address the diverse aspects of biomarker discovery and application, and to illustrate the growing role for biomarkers in drug development.

RESOURCES

Books

General

Bloom J, Dean RA (eds.) (2003)
Biomarkers in Clinical Drug Development
London, UK: Informa Healthcare.

This publication presents the various applications of biomarkers in clinical drug development and research, including pharmacokinetic/pharmacodynamic modeling and clinical trial simulation.

Burczynski ME, Rocket JC (eds.) (2006)
Surrogate Tissue Analysis: Genomic, Proteomic and Metabolomic Approaches
Boca Raton, FL: CRC Press, Taylor & Francis Group, LLC.

This book addresses the major technologies being applied to biomarker discovery and provides examples of their application to clinically accessible tissues. Chapters address technical issues such as tissue suitability and sample handling, as well as regulatory considerations.

DeCaprio AP (ed.) (2006)
Toxicologic Biomarkers
Boca Raton, FL: Taylor & Francis Group, LLC.

This text includes diverse examples of biomarker applications in toxicology, including preclinical drug safety assessment, environmental, occupational, and public health. Chapters on biomarker validation and statistical analysis of biomarker data are included.

Nakamura RM, Grody WW, Wu JT, Nagle RB (eds.) (2004)
Cancer Diagnostics: Current and Future Trends
Totowa, NJ: Humana Press.

This broad reference surveys the state of the art in cancer diagnostic technology, including serum markers, cell-based analysis, use of sentinel lymph node, mutation, microsatellite, and translocation analysis, and histopathological diagnostics based on molecular changes. The use of multiparameter markers such as gene expression analysis for classifying tumors is discussed.

Rogge MC, Taft DR (eds.) (2006)
Preclinical Drug Development
Boca Raton, FL: Taylor & Francis Group, LLC.

This comprehensive reference covers all major aspects of preclinical drug development. Chapters provide detail from a large number of examples, including use of biomarkers in species and model selection, assessment of pharmacologic activity, interpretation of toxicology and pathology findings, and dose selection for clinical trials.

Taylor DL, Haskins JR, Guiliano KA (eds.) (2007)
High Content Screening
Totowa, NJ: Humana Press.

With its largely methodological focus, this book provides guidance for researchers performing mechanistic toxicology and in vitro pharmacology studies. Many of the high-throughput and high-content techniques described are suitable for further investigation of pathways related to candidate biomarkers.

Trull AW, Demers LM, Holt DW, et al (eds.)
Biomarkers of Disease: An Evidence-Based Approach
Cambridge, UK: Cambridge University Press.

A clearly written text with near-encyclopedic coverage of clinically applied biomarkers of disease in the major organ systems, this handbook also covers composite biomarkers used as diagnostic criteria. Informative chapters on statistical evaluation of biomarkers and the concepts of evidence-based medicine are included.

Proteomics

The field of proteomics is changing so rapidly, that it is difficult to suggest a reference book that will not be outdated within a year. Nevertheless, in order to gain an understanding of the scope of the field, the

following texts will shed some light on this rapidly developing field.

Hamacher M, Marcus K, Stühler K, et al (eds.) (2006)
Proteomics in Drug Research
Weinheim, Germany: John Wiley & Sons, Inc.

Hamdan MH, Pier G, Righetti PG (2005)
Proteomics Today: Protein Assessment and Biomarkers Using Mass Spectrometry, 2D Electrophoresis, and Microarray Technology
Hoboken, NJ: John Wiley & Sons, Inc.

Daniel C Liebler (ed.) (2004)
Proteomics in Cancer Research
Hoboken, NJ: John Wiley & Sons, Inc.

Liu B (ed.) (2007)
Tissue Proteomics: Pathways, Biomarkers, and Drug Discovery
Totowa, NJ: Humana Press, Inc.

Flow Cytometry

Darzynkiewicz Z, Roederer M, Tanke HJ (eds.) (2004)
Cytometry, 4th edition: New Developments Methods in Cell Biology, Vol. 75
San Diego, CA: Elsevier Academic Press.
Web: http://www.darzynkiewicz.com/zbigniew/books/cytometry/preface.htm

Provides updated methods and examples for commonly used flow cytometry analyses, including chapters describing appropriate analysis and presentation of multivariate data. Bead array assays, cell cycle analysis, apoptosis and functional flow cytometry assays are described.

Haugland RP (2005)
The Handbook: A Guide to Fluorescent Probes and Labeling Technologies, 10th edition
Carlsbad, CA: Invitrogen Corp.
Web: http://probes.invitrogen.com/handbook/

This hefty catalogue, originally published by Molecular Probes, Inc., has long served as a resource for the fluorescent labeling of cells based on functional cellular processes. Detailed descriptions of the involved chemistry and examples of applications and expected results are included.

Shapiro Howard (2003)
Practical Flow Cytometry, 4th edition
Hoboken, NJ: John Wiley & Sons, Inc.

A comprehensive text providing a strong foundation in flow cytometry practice, this book introduces the reader to instrumentation, probes, and applications. It also includes a large resource list and extensive references.

Pharmacogenomics

Malcolm S, Goodship J (eds.) (2001)
Genotype to Phenotype, 2nd edition
Oxford, UK: BIOS Scientific Publishers Ltd.

A comprehensive text introducing phenotypic associations with genotype, including methods for identifying genetic associations, phenotype prediction, multigenic traits, and the influence of gene–environment interactions. Examples are provided, and most chapters list external resources.

Rothstein M (ed.) (2003)
Pharmacogenomics: Social, Ethical and Clinical Dimensions
Hoboken, NJ: John-Wiley & Sons.

This text is largely focused on implications of pharmacogenomic testing in medicine, including societal challenges associated with genetic testing. Examples of currently used clinical pharmacogenomic tests are provided, and chapters on intellectual property, diagnostics development, and regulation address issues specific to the use of genomic biomarkers in drug development.

Gene Expression Profiling

Burczynski ME (ed.) (2003)
An Introduction to Toxicogenomics
Boca Raton, FL: CRC Press, Taylor & Francis Group, LLC.

A general text introducing gene expression array technology and analysis, with chapters describing applications to model systems and mechanistic studies. A section on predictive use of gene expression profiles includes examples of in-silico methods and clinical applications.

Hamadeh HK, Afshari CA (eds.) (2003)
Toxicogenomics: Principles and Applications
Hoboken, NJ: John Wiley & Sons.

This text compiles basic principles of toxicological investigation with highly informative descriptions of the platforms used for gene expression analysis, an introduction to proteomics techniques, and experimental design considerations including challenges in the interpretation of transcriptomes. Statistical approaches, modeling and prediction, and the use of databases are covered.

Journals

General

Biomarker Insights (2006–)
Biomarkers (1997–)

London, UK: Taylor & Francis.
Web: http://www.informaworld.com/smpp/title~content=t713693137~db=all

This journal has a broad scope including use of biomarkers in environmental health monitoring, ecological toxicology, and clinical drug development.

BMC Clinical Pathology (2001–)
BMC Clinical Pharmacology (2001–)
London, UK: Biomed Central Ltd.
Web: http://www.biomedcentral.com/browse/journals/

The above are peer-reviewed, open access journals published on the web. Content is diverse and interesting, however present publication volume is still relatively low.

Cancer Biomarkers
Amsterdam, the Netherlands: IOS Press.
Web: http://iospress.metapress.com/(egbpfpzim3se1q55×3pf2u45)/app/home/journal.asp?referrer=parent&backto=browse publications results, 11,74;

Cancer Informatics (2006–)
Clinical Chemistry (1955–)
Washington, DC: American Association for Clinical Chemistry.
Web: http://www.clinchem.org/

Clinical Pharmacology & Therapeutics (1995–)
London, UK: Nature Publishing Group.
Web: http://www.nature.com/clpt/index.html

The International Journal of Biological Markers
Milan, Italy: Wichtig Editore.
Web: http://www.biological-markers.com/index.asp?a=current

Journal of Clinical Pharmacology
Towson, MD: American College of Clinical Pharmacology.
Web: http://jcp.sagepub.com/

Journal of Translational Medicine (2003–)
Nature Reviews Drug Discovery (2002–)
London, UK: Nature Publishing Group.
Web: http://www.nature.com/nrd/index.html

High-impact journal focused on all aspects of drug development. The reviews often consider industry and regulatory perspectives in addition to scientific updates.

Translational Oncogenomics (2006–)
Aukland, NZ: Libertas Academica.
Web: http://la-press.com/index.php

Proteomics

Journal of Proteome Research (2002–)
Washington, DC: American Chemical Society.
Web: http://pubs.acs.org/journals/jprobs/index.html

Molecular and Cellular Proteomics
Bethesda, MD: American Society for Biochemical and Molecular Biology.
Web: http://www.mcponline.org/

Proteomics (2001–)
Weinheim, Germany: Wiley-VCH Verlag GmbH & Co. KgaA.
Web: http://www3.interscience.wiley.com/cgi-bin/jhome/76510741

Mass Spectrometry

International Journal of Mass Spectrometry (1998–)
Amsterdam, the Netherlands: Elsevier BV.
Web: http://www.sciencedirect.com/science/journal/13873806

Journal of the American Society for Mass Spectrometry (1990–)
Santa Fe, NM: American Society for Mass Spectrometry.
Web: http://www.sciencedirect.com/jasms

Journal of Mass Spectrometry
Hoboken, NJ: John Wiley & Sons, Ltd.
Web: http://www3.interscience.wiley.com/cgi-bin/jhome/6043

Rapid Communications in Mass Spectrometry
Hoboken, NJ: John Wiley & Sons, Ltd.
Web: http://www3.interscience.wiley.com/cgi-bin/jhome /4849

Analytic Cytology

Cytometry Part A
Hoboken, NJ: John Wiley & Sons.
Web: http://www3.interscience.wiley.com/cgi-bin/jhome /33945

Cytometry Part B: Clinical Cytometry
Hoboken, NJ: John Wiley & Sons.
Web: http://www3.interscience.wiley.com/cgi-bin/jhome/102019902

Pharmacogenomics

Pharmacogenetics and Genomics
London, UK: Lippincott Williams & Wilkins, London.
Web: http://www.jpharmacogenetics.com

The Pharmacogenomics Journal (2001–)
London, UK: Nature Publishing Group.
Web: http://www.nature.com/tpj/index.html

In Vivo Imaging

Molecular Imaging (2002–)

Hamilton, Ontario: BC Decker, Inc.
Web: http://www.journalsoft.com/molecularimaging/journal/

Molecular Imaging and Biology (2001–)
New York: Springer.
Web: http://www.ami-imaging.org/public/journal.htm

Journal Articles

General

Colburn WA (2003) Biomarkers in drug discovery and development: From target identification through drug marketing. J. Clin. Pharmacol. 43: 329–341.

Floyd E, McShane TM (2004) Development and use of biomarkers in oncology drug development. Toxicol. Pathol. 32: 106–115.

Group BDW (2001) Biomarkers and surrogate endpoints: Preferred definitions and conceptual framework. Clin. Pharmacol. Ther. 69: 89–95.

Kuhlmann J (2007) The application of biomarkers in early clinical drug development to improve decision-making processes. Ernst Schering Res. Found. Workshop 59: 29–45.

Lesko LJ, Atkinson AJ, Jr. (2001) Use of biomarkers and surrogate endpoints in drug development and regulatory decision making: criteria, validation, strategies. Annu. Rev. Pharmacol. Toxicol. 41: 347–366.

Lesko LJ, Woodcock J (2004) Translation of pharmacogenomics and pharmacogenetics: a regulatory perspective. Nat. Rev. Drug Discov. 3: 763–769.

Rolan P, Atkinson AJ, Lesko LJ (2003) Use of biomarkers from drug discovery through clinical practice: Report of the Ninth European Federation of Pharmaceutical Sciences Conference on Optimizing Drug Development. Clin. Pharmacol. Ther. 73: 284–291.

Williams SA, Slavin DE, Wagner JA, Webster CJ (2006) A cost-effectiveness approach to the qualification and acceptance of biomarkers. Nat. Rev. Drug Discov. 5: 897–902.

Wren JD, Chang JT, Pustejovsky J, et al (2005) Biomedical term mapping databases. Nucleic Acids Res. 33: D289–D293.

Proteomics and Immunohistochemistry

Bertone P, Snyder M (2005) Advances in functional protein microarray technology. Febs. J. 272: 5400–5411.

Domon B, Aebersold R (2006) Challenges and opportunities in proteomics data analysis. Mol. Cell Proteomics 5: 1921–1926.

Eguiluz C, Viguera E, Millan L, Perez J (2006) Multitissue array review: a chronological description of tissue array techniques, applications and procedures. Pathol. Res. Pract. 202: 561–568.

Lindon JC, Holmes E, Nicholson JK (2006) Metabonomics techniques and applications to pharmaceutical research & development. Pharm. Res. 23: 1075–1088.

Lindon JC, Keun HC, Ebbels TM, et al (2005) The Consortium for Metabonomic Toxicology (COMET): aims, activities and achievements. Pharmacogenomics 6: 691–699.

Qian WJ, Jacobs JM, Liu T, Camp DG, 2nd, Smith RD (2006) Advances and challenges in liquid chromatography-mass spectrometry-based proteomics profiling for clinical applications. Mol. Cell Proteomics 5: 1727–1744.

Ramos-Vara JA (2005) Technical aspects of immunohistochemistry. Vet. Pathol. 42: 405–426.

Rifai N, Gillette MA, Carr SA (2006) Protein biomarker discovery and validation: the long and uncertain path to clinical utility. Nat. Biotechnol. 24: 971–983.

Uhlen M, Bjorling E, Agaton C, et al (2005) A human protein atlas for normal and cancer tissues based on antibody proteomics. Mol. Cell Proteomics 4: 1920–1932.

Wang X, Zhao H, Andersson R (2004) Proteomics and leukocytes: an approach to understanding potential molecular mechanisms of inflammatory responses. J. Proteome Res. 3: 921–929.

Zolg W (2006) The proteomic search for diagnostic biomarkers: lost in translation?. Mol. Cell Proteomics 5: 1720–1726.

In addition to the articles mentioned above, an entire issue of the *Journal of Proteome Research* has been devoted to this topic: special issue: proteomics and biomarkers J. Proteome Res. 4(4): (August 2005).

Flow Cytometry

Yoshino N, Ami Y, Terao K, Tashiro F, Honda M (2000) Upgrading of flow cytometric analysis for absolute counts, cytokines and other antigenic molecules of cynomolgus monkeys (*Macaca fascicularis*) by using anti-human cross-reactive antibodies. Exp. Anim. 49: 97–110.

Pharmacogenomics

Chang JT, Altman RB (2004) Extracting and characterizing gene-drug relationships from the literature. Pharmacogenetics 14: 577–586.

Johnson AD, Wang D, Sadee W (2005) Polymorphisms affecting gene regulation and mRNA processing: broad implications for pharmacogenetics. Pharmacol. Ther. 106: 19–38.

Koch WH (2004) Technology platforms for pharmacogenomic diagnostic assays. Nat. Rev. Drug Discov. 3: 749–761.

Krejsa C, Rogge M, Sadee W (2006) Protein therapeutics: new applications for pharmacogenetics. Nat. Rev. Drug Discov. 5: 507–521.

Need AC, Motulsky AG, Goldstein DB (2005) Priorities and standards in pharmacogenetic research. Nat. Genet. 37: 671–681.

Salerno RA, Lesko LJ (2004) Pharmacogenomic data: FDA voluntary and required submission guidance. Pharmacogenomics 5: 503–505.

Gene Expression Profiling

Aerts S, Lambrechts D, Maity S, et al (2006) Gene prioritization through genomic data fusion. Nat. Biotechnol. 24: 537–544.

Calin GA, Croce CM (2006) MicroRNA signatures in human cancers. Nat. Rev. Cancer 6: 857–866.

Dillman JF, 3rd, Phillips CS (2005) Comparison of nonhuman primate and human whole blood tissue gene expression profiles. Toxicol. Sci. 87: 306–314.

Duan F, Spindel ER, Li YH, Norgren RB, Jr (2007) Intercenter reliability and validity of the rhesus macaque GeneChip. BMC Genomics 8: 61.

Dupuy A, Simon RM (2007) Critical review of published microarray studies for cancer outcome and guidelines on statistical analysis and reporting. J. Natl Cancer Inst. 99: 147–157.

Hayes KR, Vollrath AL, Zastrow GM, et al (2005) EDGE: a centralized resource for the comparison, analysis, and distribution of toxicogenomic information. Mol. Pharmacol. 67: 1360–1368.

Leighton JK, Brown P, Ellis A, et al (2006) Workgroup report: Review of genomics data based on experience with mock submissions–view of the CDER Pharmacology Toxicology Nonclinical Pharmacogenomics Subcommittee. Environ. Health Perspect. 114: 573–578.

Walker SJ, Wang Y, Grant KA, Chan F, Hellmann GM (2006) Long versus short oligonucleotide microarrays for the study of gene expression in nonhuman primates. J. Neurosci. Methods 152: 179–189.

Wang Z, Lewis MG, Nau ME, Arnold A, Vahey MT (2004) Identification and utilization of inter-species conserved (ISC) probesets on Affymetrix human GeneChip platforms for the optimization of the assessment of expression patterns in non human primate (NHP) samples. BMC Bioinformatics 5: 165.

Applications

Assay Development and Validation

Kingsmore SF (2006) Multiplexed protein measurement: technologies and applications of protein and antibody arrays. Nat. Rev. Drug Discov. 5: 310–320.

Lee JW, Devanarayan V, Barrett YC, et al (2006) Fit-for purpose method development and validation for successful biomarker measurement. Pharm. Res. 23: 312–328.

Lee JW, Figeys D, Vasilescu J (2007) Biomarker assay translation from discovery to clinical studies in cancer drug development: Quantification of emerging protein biomarkers. Adv. Cancer Res. 96: 269–298.

Phillips KA, Van Bebber S, Issa AM (2006) Diagnostics and biomarker development: priming the pipeline. Nat. Rev. Drug. Discov. 5: 463–469.

Pharmacokinetics and Pharmacodynamics

Colburn WA, Lee JW (2003) Biomarkers, validation and pharmacokinetic-pharmacodynamic modeling. Clin. Pharmacokinet. 42: 997–1022.

Rowland M, Balant L, Peck C (2004) Physiologically based pharmacokinetics in drug development and regulatory science: a workshop report (Georgetown University, Washington, DC, May 29–30, 2002). AAPS Pharm. Sci. 6: E6.

Severino ME, DuBose RF, Patterson SD (2006) A strategic view on the use of pharmacodynamic biomarkers in early clinical drug development. IDrugs 9: 849–853.

Workman P, Aboagye EO, Chung YL, et al (2006) Minimally invasive pharmacokinetic and pharmacodynamic technologies in hypothesis-testing clinical trials of innovative therapies. J. Natl Cancer Inst. 98: 580–598.

Toxicology and Safety Assessment

Brott DA, Jones HB, Gould S, et al (2005) Current status and future directions for diagnostic markers of drug-induced vascular injury. Cancer Biomark. 1: 15–28.

Chu WW, Dieter RS, Stone CK (2002) A review of clinically relevant cardiac biochemical markers. WMJ 101: 40–48.

O'Brien PJ (2006) Blood cardiac troponin in toxic myocardial injury: archetype of a translational safety biomarker. Expert Rev. Mol. Diagn. 6: 685–702.

Orr MS (2006) Toxicogenomics and cross-species biomarker discovery: applications in drug discovery and safety assessment. Toxicol. Mech. Methods 16: 79–87.

Rockett JC, Kim SJ (2005) Biomarkers of reproductive toxicity. Cancer Biomark. 1: 93–108.

Shaw M (2005) The use of histologically defined specific biomarkers in drug development with specific reference to the glutathione S-transferases. Cancer Biomark. 1: 69–74.

Vaidya VS, Bonventre JV (2006) Mechanistic biomarkers for cytotoxic acute kidney injury. Expert Opin. Drug Metab. Toxicol. 2: 697–713.

Walker DB (2006) Serum chemical biomarkers of cardiac injury for nonclinical safety testing. Toxicol. Pathol. 34: 94–104.

Application to Clinical Studies

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Organizations

Academy of Molecular Imaging
Box 951735
Los Angeles, CA 90095–1735
Phone: 310 267-2614
Fax: 310 267-2617
E-Mail: ami@mednet.ucla.edu
Web: http://www.ami-imaging.org/index.htm

A professional society for molecular imaging, with a quarterly newsletter and bimonthly journal, *Molecular Imaging and Biology*.

American Association of Pharmaceutical Scientists
2107 Wilson Blvd, Suite 700, Arlington, VA 22201-3042
Phone: 703-243-2800
Fax: 703-243-9650
E-Mail: membership@aaps.org
Web: http://www.aapspharmaceutica.com/

American College of Clinical Pharmacology
3 Ellinwood Court, New Hartford, NY 13413-1105
Phone: 315-768-6117
Fax: 315-768-6119
Web: http://www.accp1.org/

The Clinical Cytometry Society
#5 Revere Drive, Suite 200, Northbrook, IL 60062
Fax: 312.896.5614
E-Mail: admin@cytometry.org
Web: http://www.cytometry.org/

HUPO-The Human Proteome Organization
740 Dr. Penfield Suite 6204
Montreal, Quebec, Canada H3A 1A4
Phone: 514-398-5063
Fax: 514-398-2036
Web: http://www.hupo.org/

An international consortium of proteomics research associations, government researchers, academic institutions, and industry partners. HUPO promotes proteomics research, and sponsors initiatives to promote development and application of proteomics technologies.

International Society for Analytical Cytology
9650 Rockville Pike, Bethesda, MD, USA 20814-3998
Phone: (301) 634-7435
Fax: (301) 634-7429
E-Mail: isac@isac.org
Web: http://www.isac-net.org/

Pharmacogenetics Research Network
National Institute of General Medical Sciences
45 Center Drive MSC 6200, Bethesda, MD 20892-6200
Phone: 301-496-7301
E-Mail: info@nigms.nih.gov
Web: http://www.nigms.nih.gov/Initiatives/PGRN/

A collaboration of medical scientists addressing research questions in the areas of pharmacogenetics and pharmacogenomics. Affiliate membership is available to individuals and groups; funding opportunities and updates on the research of individual consortium members are posted on the website.

The Society for Molecular Imaging
PO Box 293878
Kerrville, TX 78029-3878 USA
Phone: 1-830-257-0112
Fax: 1-830-257-0119
Web: http://www.molecularimaging.org/index.php

An international educational and scientific forum for molecular imaging; with a bimonthly journal, *Molecular Imaging.*

Databases

ADAPT
Patterson Institute for Cancer Research
Web: http://bioinf.picr.man.ac.uk/adapt/Welcome.adapt

A database that associates the sequences from 23 Affymetrix™ array types to expressed transcripts and genes, by directly mapping every probe against publicly available mRNAs/cDNA sequences from RefSeq and Ensembl.

Chemical Effects in Biological Systems
National Institute of Environmental Health Sciences
Web: http://cebs.niehs.nih.gov/cebs-browser/cebsHome.do

Knowledge base compiles information from numerous laboratories studying changes in gene expression, clinical pathology, and histopathology findings following chemical exposure. Currently, data are mainly from model toxicant studies in rodents.

Comparative Toxicogenomics Database
Mount Desert Island Biological Laboratory
Web: http://ctd.mdibl.org/help/siteMap.jsp

Compiles links to chemical search terms, taxonomic references, genes, proteins, and gene ontology tools in addition to a chemical–gene and chemical–protein interaction database with online query capability.

Drug Interaction Table
Indiana University Division of Clinical Pharmacology
Web: http://medicine.iupui.edu/flockhart/

A very useful database of cytochrome P450 mediated drug interactions, listings by drug class and enzyme substrates, inhibitors and inducers, with links to original literature.

Environment, Drugs and Gene Expression (EDGE^2)
University of Wisconsin
Web: http://edge.oncology.wisc.edu/edge.php

Includes hepatic gene expression data from numerous in vivo mouse studies using model toxicants and other treatments, including selected vehicles and inflammatory mediators. Data can be queried by gene, treatment, or both, and some clustering tools are available on the website.

Gene Ontology Database
National Human Genome Research Institute – Gene Ontology Consortium
Web: http://www.geneontology.org/index.shtml

A database of gene annotation terms for describing cellular compartments, biological processes, and molecular function with a controlled vocabulary. Includes annotated databases for numerous species, as well as indexed terms from other databases mapped to the GO terms. Provides links to a variety of tools using GO terms.

Genomics and Bioinformatics Group
Center for Cancer Research, National Cancer Institute
Web: http://discover.nci.nih.gov/index.jsp

Provides access to several datasets developed using the NCI-60 cell lines, and links to tools suitable for microarray or proteomic analysis, along with a publication archive and information about design and analysis of microarray experiments.

Global Proteome Machine Database
Web: http://gpmdb.thegpm.org/

A database of unique protein sequences from numerous taxa, with tools for searching/validating peptides from tandem mass spectrometry proteomics platforms. A free search algorithm and directions for incorporating the database into existing LIMS systems are available.

Human Protein Atlas
Web: http://www.proteinatlas.org/

A database of normal tissues and selected cancers and cell lines, with images of protein localization and expression profiles for over 1500 proteins based on antibody staining (immunohistochemistry). Antibodies used for this project are available for purchase.

iHOP-Information Hyperlinked Over Proteins
Memorial Sloan Kettering Cancer Research Center – Computational Biology
Web: http://www.ihop-net.org/UniPub/iHOP/

A text-mining tool that links literature with other public citations for genes or proteins, iHOP extracts key sentences including the search term from PubMed, and provides links to the original citations from NLM databases.

NIH Nonhuman Primate Reagent Resource
Web: http://nhpreagents.bidmc.harvard.edu/NHP/default.aspx

A database of cross-reactive commercial reagents (antibodies) listing their utility for flow cytometry, ELISA, and other antibody-based assays in several nonhuman primate species. Includes vendor information and several assay protocols and technical notes.

Perlengen Genotype Browser
Web: http://genome.perlegen.com/index.html

Provides genetic variation data for download and tools for viewing and analysis of the extensive SNP database developed by Perlengen for three diverse human populations.

PharmGKB
Pharmacogenetics and Pharmacogenomics Knowledgebase
Stanford University and Pharmacogenetics Research Network
Web: http://www.pharmgkb.org/

A growing searchable repository of reported pharmacogenomic associations with curated information on links between genetic variation and phenotypic categories. Provides links to submitted datasets and literature references.

Stanford Microarray Database
Stanford University
Web: http://smd.stanford.edu/index.shtml

Provides analysis tools and access to annotated microarray datasets from a large number of investigators using a variety of platforms. Both public domain data and registered user access to private domain data are available. Some analysis tools are available only to registered users due to the computational intensity of the jobs.

OTHER RESOURCES

Antibody Resource Page
Web: http://www.antibodyresource.com/

Compiles links to search engines for locating commercially available antibodies and custom antibody service providers. Additional links to educational materials, public databases, journals, and organizations that utilize antibody technology for diagnostics or drug development are also provided.

Center for Integration of Research on Genetics and Ethics
Stanford Center for Biomedical Ethics
Web: http://cirge.stanford.edu/index.html

An extensive resource library has been compiled of policy recommendations for working with genetic and other types of biomarkers in clinical research. Provides documents on informed consent requirements, legal and ethical issues of results disclosure, and links to other websites focused on bioethics and genetics research.

Clinical Proteomics Research Map
Web: http://www.cprmap.com/

An excellent and well-maintained website devoted to the applications of proteomics to clinical research, with links to literature on technologies, diseases and clinical diagnostics projects, publications, ISB courses, and annual symposium.

Computational Proteomics Laboratory
The Fred Hutchinson Cancer Research Center
Web: http://proteomics.fhcrc.org/CPL/home.html

Provides access to several software tools for analysis of proteomics datasets.

Critical Path Initiative Website
Web: http://www.fda.gov/oc/initiatives/criticalpath/

Provides links to Critical Path Initiative documents, including the Critical Path Opportunities List and updates on sponsored projects, a conference archive and other postings relevant to the FDA's 2004 report 'Challenge and Opportunity on the Critical Path to New Medical Products'.

Dako Reference Literature Page
Web: http://www.dako.com/prod_productrelatedinformation?url=support_literature.htm

Provides links to a number of references for immunohistochemistry and cytogenetic analysis of tissues, including a comprehensive guide for immunohistochemical staining methods.

GenomeWeb Daily News
GenomeWeb LLC
Web: http://www.genomeweb.com/

A free electronic newsletter with a focus on business and regulatory news for genomics, proteomics, and metabonomics research institutions. Links to specialized subscription newsletters are provided.

Institute for Systems Biology
Web: http://www.systemsbiology.org/Resources_and_Development

Resource page includes software tools, datasets, and information on current ISB collaboratives.

Microarray Gene Expression Data Society
Web: http://www.mged.org/index.html

An international organization currently focused on establishing standards for microarray data annotation and exchange, database creation, and sharing of microarray data. Web resources include data models (Minimum Information About a Microarray Experiment; MIAME) for many types of experiment including in vivo toxicology studies.

Molecular Imaging Central
Molecular Imaging Program at Stanford
Web: http://www.mi-central.org/index.html

A web resource with focus on molecular imaging and gene therapy. Provides links to major research institutes and organizations, a literature archive, and a large collection of links to sites that describe technologies and biological processes relevant to molecular imaging.

Seattle SNPs
University of Washington, Program for Genomic Applications
Web: http://pga.gs.washington.edu/

Compiles information and tools for genetic variation analysis and provides data from sequencing efforts conducted through the program. Posted resources include tutorials for navigating the major genomic variation databases, and using web-based genomics tools.

Table of Valid Genomic Biomarkers in the Context of Approved Drug Labels
Web: http://www.fda.gov/cder/genomics/genomic_biomarkers_table.htm

ICH Regulatory Guidelines

E15 Terminology in Pharmacogenomics (Draft Guidance; October 25, 2006)
Web: http://www.fda.gov/cder/guidance/7619dft.pdf

FDA Regulatory Guidance

Bioanalytical Method Validation (May 2001)
Web: http://www.fda.gov/cder/guidance/4252fnl.pdf

Class II Special Controls Guidance Document: Drug Metabolizing Enzyme Genotyping System (March 10, 2005)
Web: http://www.fda.gov/cdrh/oivd/guidance/1551.pdf

Clinical Trial Endpoints for the Approval of Cancer Drugs and Biologics (Draft Guidance, April 2005)
Web: http://www.fda.gov/cder/guidance/6592dft.pdf

Drug-Diagnostic Co-Development (Concept Paper; April 2005)
Web:http://www.fda.gov/cder/genomics/pharmaco-conceptfn.pdf

Drug Interaction Studies – Study Design, Data Analysis, and Implications for Dosing and Labeling (Draft Guidance; September 2006)
Web: http://www.fda.gov/cber/gdlns/interactstud.pdf

Drug Metabolism/Drug Interaction Studies in the Drug Development Process: Studies In Vitro (April 1997)
Web: http://www.fda.gov/cder/guidance/clin3.pdf

Estimating the Maximum Safe Starting Dose in Initial Clinical Trials for Therapeutics in Adult Healthy Volunteers (July 2005)
Web: http://www.fda.gov/cder/guidance/5541fnl.pdf

Exploratory IND Studies (January 2006)
Web: http://www.fda.gov/cder/guidance/7086fnl.pdf

Exposure-Response Relationships – Study Design, Data Analysis, and Regulatory Applications (April 2003)
Web: http://www.fda.gov/cber/gdlns/exposure.pdf

In Vivo Drug Metabolism/Drug Interaction Studies – Study Design, Data Analysis, and Recommendations for Dosing and Labeling (November 1999)
Web: http://www.fda.gov/cder/guidance/2635fnl.pdf

Pharmacogenomic Data Submissions (March 2005)
Web: http://www.fda.gov/cder/guidance/6400fnl.pdf

Pharmacogenetic Tests and Genetic Tests for Heritable Markers (Draft Guidance; February 9, 2006)
Web: http://www.fda.gov/cdrh/oivd/guidance/1549.pdf

Recommendations for the Generation and Submission of Genomic Data (Concept Paper; November 2006)
Web: http://www.fda.gov/cder/genomics/concept-paper_20061107.pdf

Joint FDA–EMEA Regulatory Guidance

Guiding principles Processing Joint FDA EMEA Voluntary Genomic Data Submissions (VGDSs) within the framework of the Confidentiality Arrangement
Web: http://www.fda.gov/cder/genomics/FDAEMEA.pdf

CHAPTER

9

Biotechnology

RAFAEL PONCE, AND STEVEN G. GILBERT

INTRODUCTION

Biotechnology-derived therapeutic products represent a diverse class of agents that are categorized by their method of manufacture, typically based on recombinant DNA technology. These products include recombinant proteins and nucleotides as gene therapies, anti-sense therapies, cytokines, monoclonal antibodies, growth factors, soluble receptors, fusion proteins, vaccines, and coagulation factors. Therapeutic targets of these products include genetic deficiency; neurological, cardiovascular, autoimmune and inflammatory disorders; cancer; metabolic disorders; and other conditions.

Given that these molecules are typically derived and produced to mimic endogenous nucleotides and proteins, their toxicity tends to be related to that associated with over-stimulation or suppression of the targeted biological pathways. In addition, unlike potentially active metabolites associated with small molecule therapies, the metabolic by-products of biotechnology-derived therapeutics are generally inactive amino acid and nucleotide fragments. For these reasons, toxicology programs designed to support the development of biologically based therapeutics rely on evidence that the therapeutic agent under evaluation has similar target-binding characteristics and activity in the animal species used for non-clinical testing and humans. These characteristics of toxicity of biologically based therapeutics have led to the development of a harmonized regulatory paradigm between the United States, European Union, and Japan for the non-clinical testing of biotechnology-derived therapeutics (ICH S6 guidance, cited below). In addition, because the toxicity of these agents is dependent on the targeted mechanism of action, the regulatory pathway for an agent in a given therapeutic class is highly dependent on precedence. For these reasons, primary literature on the non-clinical development of a number of molecules is referenced below. However, the reader is advised to review U.S. Food Drug Administration and EU databases (cited below) to obtain the most current summary data on the non-clinical safety programs for specific approved agents.

There is also an accelerating application of biotechnology tools to produce genetically modified organisms (GMOs) that ultimately become part of the food supply or used to produce drugs. Ensuring the safety of products entering the food supply is particularly challenging. The World Health Organization, European Union, and the U.S. government are all working to address GMOs and have developed extensive web-based resources that provide the most current infor-mation.

INFORMATION RESOURCES SECTION

Books

Committee on Identifying and Assessing Unintended Effects of Genetically Engineered Foods on Human Health – National Research Council (2004)
Safety of Genetically Engineered Foods: Approaches to Assessing Unintended Health Effects
National Academies Press

This report addresses some of the unique challenges in addressing safety and other issues related to genetically modified foods and food products derived from

genetically engineered plants and animals. Approaches to evaluating intended and unintended effects are discussed.

Crommelin DJA, Sindelar RD (Eds.) (2002)
Pharmaceutical Biotechnology: An Introductory Text for Pharmacists and Pharmaceutical Scientists, 2nd Edition
Philadelphia, PA: Taylor and Francis, Inc.

Contains 20 chapters that review the basic science of molecular biotechnology, biophysical and biochemical characterization, production, formulation, pharmacokinetics and pharmacodynamics, and other matters of importance to the toxicologist new to this field. Also reviewed are the development of gene therapies, growth factors, cytokines, growth hormones, insulin, vaccines, and other products.

Griffiths SA, Lumley CE (eds.) (1998)
Safety Evaluation of Biotechnology-derived Pharmaceuticals: Facilitating a Scientific Approach
Boston, MA: Kluwer Academic Publishers.

An introductory text that reviews the design and implementation of non-clinical safety programs for biotechnology-derived therapies from the perspectives of the clinician, the toxicologist, and the regulatory (including US, European, and Japanese) authority. Case reviews of growth hormones, cytokines, monoclonal antibodies, gene therapies, and other agents are provided.

Kayser O, Müller RH (eds) (2004)
Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications
Weinheim, Germany: Wiley-VCH Verlag GmbH & Co. KGaA.

Written by international experts from the biotechnology industry, this book covers issues such as drug delivery and targeting, quality and safety management, drug approval and regulatory issues.

Journals

Journal of Biomedicine and Biotechnology (2001–)
Hindawi Publishing Corporation

An international journal publishing original work in all areas of biomedicine (carcinogenesis, epidemiology, gene therapy, mutagenesis, pathology, pharmacology, toxicology, etc.) and biotechnology (microbial, animal, and plant biotechnology).

Web: http://www.hindawi.com/journals/jbb/

Regulatory Toxicology and Pharmacology (1981–)
Amsterdam, the Netherlands: Elsevier.

The journal is devoted to reports of significant developments, public opinion, scientific data, and ideas that bridge the gap between scientific information and the legal aspects of toxicological and pharmacological regulations.

Web: http://www.elsevier.com/wps/find/journaldescription.cws_home/622939/description? navopenmenu=1

Journal Articles

Clarke J, Leach W, Pippig S, et al (2004) Evaluation of a surrogate antibody for preclinical safety testing of an anti-CD11a monoclonal antibody. Regul. Toxicol. Pharmacol. 40: 219–226.

Claude JR (1992) Difficulties in conceiving and applying guidelines for the safety evaluation of biotechnologically-produced drugs: some examples. Toxicol. Lett. 64-65(Spec No): 349–355.

Dean JH (2004) A brief history of immunotoxicology and a review of the pharmaceutical guidelines. Int. J. Toxicol. 23: 83–90.

Dorato MA, Engelhardt JA (2005) The no-observed-adverse-effect-level in drug safety evaluations: use, issues, and definition(s). Regul. Toxicol. Pharmacol. 42: 265–274.

Foulkes R (2002) Preclinical safety evaluation of monoclonal antibodies. Toxicology 174: 21–26.

Kenter MJ, Cohen AF (2006) Establishing risk of human experimentation with drugs: lessons from TGN1412. Lancet 368: 1387–1391.

Klastersky J (2006) Adverse effects of the humanized antibodies used as cancer therapeutics. Curr. Opin. Oncol. 18: 316–320.

MacGregor JT (2003) The future of regulatory toxicology: Impact of the biotechnology revolution. Tox. Sci. 75: 236–248.

Mire-Sluis AR, Barrett YC, Devanarayan V, et al (2004) Recommendations for the design and optimization of immunoassays used in the detection of host antibodies against biotechnology products. J. Immunol. Methods 289: 1–16.

Nakazawa T, Kai S, Kawai M, et al (2004) 'Points to consider' regarding safety assessment of biotechnology-derived pharmaceuticals in non-clinical studies (English translation). J. Toxicol. Sci. 29: 497–504.

Olson H, Betton G, Robinson D, et al (2000) Concordance of the toxicity of pharmaceuticals in humans

and in animals. Regul. Toxicol. Pharmacol. 32: 56–67.

Osterberg RE, See NA (2003) Toxicity of excipients–a Food and Drug Administration perspective. Int. J. Toxicol. 22: 377–380.

Pegram M, Ngo D (2006) Application and potential limitations of animal models utilized in the development of trastuzumab (Herceptin): a case study. Adv. Drug Deliv. Rev. 58: 723–734.

Ponce R, Armstrong K, Andrews K, et al (2005a) Safety of recombinant human factor XIII in a cynomolgus monkey model of extracorporeal blood circulation. Toxicol. Pathol. 33: 702–710.

Ponce RA, Visich JE, Heffernan JK, et al (2005b) Preclinical safety and pharmacokinetics of recombinant human factor XIII. Toxicol. Pathol. 33: 495–506.

Scallon BJ, Snyder LA, Anderson GM, et al (2006) A review of antibody therapeutics and antibody-related technologies for oncology. J. Immunother. 29: 351–364.

Snodin DJ (2004) Regulatory immunotoxicology: does the published evidence support mandatory nonclinical immune function screening in drug development? Regul. Toxicol. Pharmacol. 40: 336–355.

Snodin DJ, Ryle PR (2006) Understanding and applying regulatory guidance on the nonclinical development of biotechnology-derived pharmaceuticals. BioDrugs 20: 25–52.

Thomas PT (2002) Nonclinical evaluation of therapeutic cytokines: immunotoxicologic issues. Toxicology 174: 27–35.

Vial T, Descotes J (2003) Immunosuppressive drugs and cancer. Toxicology 185: 229–240.

Weinberg WC, Frazier-Jessen MR, Wu WJ, et al (2005) Development and regulation of monoclonal antibody products: challenges and opportunities. Cancer Metastasis Rev. 24: 569–584.

Weissinger J (1989) Preclinical and pharmacology and toxicology of hematopoietic growth factors. Biotechnol. Adv. 7: 387–399.

Wierda D, Smith HW, Zwickl CM (2001) Immunogenicity of biopharmaceuticals in laboratory animals. Toxicology 158: 71–74.

Organizations

Biotechnology Industry Organization (BIO)
1225 Eye Street NW, Suite 400
Phone: 202-962-9200
E-Mail: info@bio.org
Web: http://www.bio.org/index.asp?stay=yes

Founded in 1993, BIO is an industry trade organization representing over 500 companies. This organization has a cross-industry working group, BioSafe, focused on safety-related issues of biotechnology-derived therapeutics.

Databases

Agricultural Biotechnology – Laws, Regulations, Policies, and Responsibilities
U.S. Department of Agriculture
Web: http://www.usda.gov/agencies/biotech/laws.html

This site provides information from the three U.S. agencies primarily responsible for regulating biotechnology in the United States – the Department of Agriculture (USDA), the Environmental Protection Agency (EPA), and the Food and Drug Administration (FDA).

Biotechnology Information Directory Section – World Wide Web Virtual Library
Cato Research Ltd
Web: http://www.cato.com/biotech/

This directory, provided by Cato Research Ltd., is a compilation of URLs specific to biotechnology, pharmaceutical development, clinical trials, services, education, and related fields.

EMEA Regulatory Guidance
Web: http://www.emea.europa.eu/htms/human/humanguidelines/nonclinical.htm

The European Medicines Agency (EMEA) is a decentralized body of the European Union with headquarters in London. This website provides a summary of EMEA guidance documents, including guidance on European expectations for safety data and submissions in Europe.

Food Safety – Biotechnology (GM foods)
World Health Organization
Web: http://www.who.int/foodsafety/biotech/en/

This WHO website addresses a wide range of issues in the field of biotechnology and human health, including safety evaluation of vaccines produced using biotechnology, human cloning and gene therapy and specifically addresses food safety issues.

Food Safety – From the Farm to the Fork
European Union
Web: http://ec.europa.eu/food/food/biotechnology/index_en.htm

Address issue of biotechnology applied to produce genetically modified organisms (GMOs) that might be

used by agri-food industries and ultimately in the food production chain.

International Conference on Harmonization of Technical Requirements for Registration of Pharmaceuticals for Human Use (ICH)
Web: http://www.ich.org/cache/compo/276-254-1.html

The ICH began in April 1990 when representatives of the regulatory agencies and industry associations of Europe, Japan, and the USA met in Belgium. Topics selected for harmonization included safety criteria for approving and authorizing new medicinal products.

Internet Resources for Biotechnology
University of Delaware Library
Web: http://www2.lib.udel.edu/subj/biotech/internet.htm

This University of Delaware website covers biotechnology, bioengineering, bioinformatics, molecular databases, and related products and services.

National Center for Biotechnology Information (NCBI)
National Library of Medicine, National Institutes of Health
Web: http://www.ncbi.nlm.nih.gov/

A national resource for molecular biology information, NCBI creates public databases, conducts research in computational biology, develops software tools for analyzing genome data, and disseminates biomedical information through newletters and the website.

U.S. Food and Drug Administration (FDA) Regulatory Guidance
Web: http://www.fda.gov/cder/guidance/index.htm#Pharmacology/Toxicology

This website provides a summary of US Food and Drug Administration guidance documents related to regulatory toxicology. These documents provide guidance on FDA expectations for safety data and submissions.

U.S. Regulatory Agencies Unified Biotechnology Website
National Biological Information Infrastructure
Web: http://usbiotechreg.nbii.gov/

The Federal Government of the United States of America established a formal policy in 1986, the Coordinated Framework for Regulation of Biotechnology, a risk-based system to ensure new biotechnology products are safe for the environment and human and animal health.

Other Resources

Key Guidance Documents

ICH S6: Preclinical Safety Evaluation of Biotechnology-Derived Pharmaceuticals (1997)
EU: Adopted by CPMP, September 97, issued as CPMP/ICH/302/95.
MHLW: Published, PAB/PCD, Notification n° 326, 22 February 2000.
FDA: Published in the Federal Register, Vol. 62, No. 222, November 18, 1997, pages 61515.

This is the primary guidance representing the harmonized regulatory perspective for the non-clinical safety development for biologically derived therapeutics in the US, Europe, and Japan.

FDA CBER (1997)
Points to consider in the manufacture and testing of monoclonal antibody products for human use.

Key guidance representing US FDA regulatory considerations for the manufacture and testing of monoclonal antibodies, including non-clinical safety considerations.

FDA CDER (2006)
Guidance for industry: Non-clinical safety evaluation of drug or biologic combinations.

Recent guidance representing US FDA regulatory considerations non-clinical safety evaluation of drug or biologic combinations, where neither, one, or both of the agents have been previously marketed.

CHAPTER

10

Biotoxins

KENNETH R. STILL, AND ASISH MOHAPATRA

INTRODUCTION

Terminology regarding *biotoxins* is extremely important. A *toxin* is a *toxic agent* that is derived from living organisms. *Toxins* may also be referred to as *biotoxins*, even though this is, in a sense, redundant. *Toxin* and *biotoxin* may thus legitimately be used interchangeably. Such substances need to be differentiated from the broader term, poison, or toxic agent, or toxicant, which can be either a toxin or a chemical not produced from living organisms. A *poison*, *toxic agent*, or *toxicant* is generally any material capable of producing a harmful reaction or effect in a biological system. Thus, although all the above terms are often used as if they had the same meaning, readers should be aware of these subtle distinctions. The term *toxinology* is generally applied to the study of *toxins. Toxinology* should not be confused with toxicology, which is the study of adverse effects caused by any chemical (or, indeed radiation) on living systems. The differentiating feature of these two scientific branches of knowledge lies in whether reference is made to chemicals produced only by living organisms that produce adverse effects (*biotoxins*) or a broader array of perpetrating agents. The following relevant resources are important to understand various plant and animal *toxins* and associated health effects.

RESOURCES

Books

Abbas, Hamed K (2005)
Aflatoxin and Food Safety
Taylor & Francis/CRC Press, Boca Raton, FL, USA.
Food Science and Technology Volume: 151

Contains chapters that provide a comprehensive review of aflatoxins, aflatoxin research and impact worldwide, and the toxicology of aflatoxins.

Barkai-Golan, R. (Ed.) (2008)
Mycotoxins in Fruits and Vegetables
Elsevier/Academic Press.

In 14 chapters this book covers mycological, mycotoxicological, and phytopathological aspects of fruits and vegetables. Risk assessment of mycotoxins in perishable produce is described as is detection, prevention, and control methods for mycotoxigenic fungi and the mycotoxins that they may produce.

Botana, Luis M. (2000)
Seafood and Freshwater Toxins: Pharmacology: Physiology, and Detection
Taylor & Francis/CRC Press.
Food Science and Technology Volume 103

Contains more than two dozen chapters that provide information on the pharmacology, physiology, toxicology, chemistry, ecology, and economics of seafood and freshwater toxins. Information provided covers the diarrhetic shellfish toxins, neurotoxic Cyanobacteria toxins, and the effects of each toxin on human health.

Botana, Luis (2007)
Phycotoxins: Chemistry and Biochemistry
Blackwell Publishing.

Presents 18 chapters that discuss 16 phycotoxins in the area of origin, toxicology, chemistry, biochemistry, and

mechanism of action. Presents information on emerging new toxins. Includes thorough discussion of the Brevetoxins, cyclic imines, and the cyanobacterial neurotoxins.

Botana, Luis M (2008)
Seafood and Freshwater Toxins: Pharmacology, Physiology, and Detection, 2nd edition
Taylor & Francis/CRC Press.
Food Science and Technology Volume: 173

Contains 23 chapters that discuss the chemistry, pharmacology, physiology, and toxicology of seafood toxins. Provides information on new toxins such as pfiesteria, spirolides, ostreocin, and cyclic imines.

Burrows, George E, Tyrl, Ronald J (2001)
Toxic Plants of North America
Wiley and Sons.

Covers both wild and domestic toxic plants and addresses animal and human intoxications from ingestion. Plant morphology, distribution, clinical signs of toxicity, and treatment are provided.

Burrows, George E, Tyrl, Ronald J (2006)
Handbook of Toxic Plants of North America
Wiley and Sons.

This handbook contains 11 chapters that cover plants poisonous to animals. The book is organized by body system affected and provides clinical manifestations of plant ingestion. User-friendly handbook that provides general information on plants and keys for plant identification.

Cary, Jeffrey W, Linz, John E, Bhatnagar, Deepak (1999)
Microbial Foodborne Diseases: Mechanisms of Pathogenesis and Toxin Synthesis
Taylor & Francis/CRC Press.

This book covers Gram-negative and -positive bacterial pathogens, fungal and marine toxins, parasitic protozoa, viruses, and related infectious agents. Detailed discussion of prion-based BSE, Norwalk virus disease, *Fusarium* toxins and PSP toxins are provided.

D'Mello, JP Felix (1997)
Handbook of Plant and Fungal Toxicants
Taylor & Francis/CRC Press.

Contained within 22 chapters is a thorough discussion of the role that plant and fungal toxicants play in carcinogenesis. Secondary plant compounds are discussed in the context of plant protection and human health. Toxicants from bracken fern and ponderosa pine are discussed.

Falconer, Ian Robert (2004)
Cyanobacterial Toxins of Drinking Water Supplies
Taylor & Francis/CRC Press/Marcel Dekker, New York, NY, USA.

Broken down into 12 sections this book addresses the biology, chemistry, toxicology, and human health concerns of the cylindrospermopsins and microcystins.

Gardner, Susan C, Oberdorster, Eva (2005)
Toxicology of Reptiles
Taylor & Francis/CRC Press.

This text covers cutting-edge research in the areas of endocrinology, neurophysiology, immunology, and ecology of reptiles. Information is presented from a target organ perspective.

Gupta, Ramesh C (ed.) (2007)
Veterinary Toxicology
Elsevier/Academic Press.

Contains 19 sections including sections on organ toxicity, nanoparticles and carcinogenesis, bacterial toxins, poisonous and venomous organisms, estrogenic toxicants, poisonous plants, mycotoxins, and estrogenic toxicants. Thoroughly covers diagnosing animal poisoning cases. Information on more than 900 medicinal, biological, herbal and non-medicinal agents and antidotes makes this book an important information resource for interested researchers and toxinologists. Signs and symptoms of drug overdose and its treatment – use, mechanisms, adverse reactions, and drug interactions have been provided. Further, specific data and therapy recommendations for each agent are listed. There is an extensive symptoms index and detailed treatment protocols in the book. Chemical Abstract Services Number and the UN/US Department of Transportation number also provided.

Gutman, Yehuda, Lazarovici, Philip (1997)
Toxins and Signal Transduction
Taylor & Francis/CRC Press.
Cellular and Molecular Mechanisms of Toxic Action
Volume: 1

The book's 10 chapters cover the molecular mechanisms involved in toxin mode of action. Potential therapeutic use of toxins via signal transduction is also covered.

Haschek, Wanda (ed.) (2001)
Handbook of Toxicologic Pathology, Two-Volume Set, 2nd edition
Elsevier/Academic Press.

Volume 1 discusses general toxicologic pathology in three parts: basics, practice, and selected topics. Volume 2 presents organ-specific toxicologic pathology.

Moss Joel, Iglewski Barbara, Vaughan Martha, Tu Anthony T (eds) (1995)
Handbook of Natural Toxins: Bacterial Toxins and Virulence Factors in Disease; Volume 8
Taylor & Francis/CRC Press/Marcel Dekker, New York, NY, USA.

This volume discusses the structure and function of bacterial toxins and includes a comprehensive review of virulence. Significant discussions of toxic proteins associated with diphtheria, cholera, pertussis, shigellosis, tetanus, botulism, and anthrax are provided.

Kastin, Abba (ed.) (2006)
Handbook of Biologically Active Peptides
Elsevier/Academic Press.

Contained within 20 sections are thorough discussions of biologically active peptides in venoms, amphibians, bacteria, and specific organ systems.

Mebs, Dietrich (2002)
Venomous and Poisonous Animals: A Handbook for Biologists, Toxicologists and Toxinologists, Physicians and Pharmacists
Taylor & Francis/CRC Press.

This text discusses both marine and terrestrial animals and their toxins. Presents a discussion of the mode of toxin action from natural products, how poisons work, and how venomous animals use their toxins. Included are discussions on some of the more often overlooked terrestrial organisms such as the centipede.

Menez, A (ed.) (2002)
Perspectives in Molecular Toxinology
Wiley and Sons.

Toxinology as a sub-area of biochemistry is discussed in the 27 chapters including structural genomics in toxinology.

Meier, Jurg, White, Julian (1995)
Handbook of Clinical Toxicology of Animal Venoms and Poisons
Taylor & Francis/CRC Press/Marcel Dekker, New York, NY, USA.

Numerous chapters discuss the details of biology, taxonomy, distribution, venom, epidemiology, pathophysiology, diagnosis, and treatment for each animal group that is covered including terrestrial and marine.

Naidu, Narian (2000)
Lactoferrin: Natural – Multifunctional – Antimicrobial
Taylor & Francis/CRC Press, Boca Raton, FL, USA.

Provides an in-depth discussion on lactoferrin as a natural antimicrobial intervention and microbial-blocking technology that is used to protect food from microbes.

Polya, Gideon (2003)
Biochemical Targets of Plant Bioactive Compounds: A Pharmacological Reference Guide to Sites of Action and Biological Effects
Taylor & Francis/CRC Press, St Louis, MO, USA.

Divided into 14 sections, this book characterizes the nature and targets of bioactive substances in plants and how these substances might be used for medicinal purposes. Provides significant information on herbal medicines.

Preedy, Victor R, Watson, Ronald R (2004)
Reviews in Food and Nutrition Toxicity, Volume 2
Taylor & Francis/CRC Press.
Reviews in Food and Nutrition, Volume: 2

Contained within several chapters are review discussions on ciguatera fish poisoning, contaminants in beer, bacterial toxins as well as pesticide toxicity and contamination episodes.

Rochat, Herve and Martin-Eauclaire, Marie-Francis (2000)
Animal Toxins: Facts and Protocols
Springer Publications, New York, NY, USA.
Methods and Tools in Biosciences and Medicine

Written for molecular/cell biologists and neuroscientists, the 20 chapters of this text discuss the origin, structure, molecular mechanism, cellular and pathogenic effects of toxins.

Rossoff, Irving S (2001)
Encyclopedia of Clinical Toxicology: A Comprehensive Guide to the Toxicology of Prescription and OTC Drugs, Chemicals, Herbals, Plants, Fungi, Marine Life, Reptiles and Insect Venoms, Food Ingredients, Clothing and Environmental Toxins
Taylor & Francis/CRC Press/Marcel Dekker, New York, NY, USA.

This encyclopedic reference discusses 6000 drugs, chemical and environmental toxins. Adverse effects and interactions are discussed that are not routinely covered in PDRs.

Tu, Anthony (1991)
Handbook of Natural Toxins: Reptile Venoms and Toxins
Taylor & Francis/CRC Press/Marcel Dekker, New York, NY, USA.

Contained within 24 chapters is relevant information covering venoms and toxins and their actions and antidotes. Current information on the Gila monster and frog toxins are also covered.

Tu, Anthony (1992)
Handbook of Natural Toxins: Food Poisoning
Taylor & Francis/CRC Press/Marcel Dekker, New York, NY, USA.

Contributions from over 30 experts in the field discuss aspects of food poisoning and the agents contributing to the poisoning, such as bacteria, plant, and fungi.

U.S. Food and Drug Administration (1992)
The 'Bad Bug Book': Foodborne Pathogenic Microorganisms and Natural Toxins Handbook
U.S. Food and Drug Administration, MD, USA.
Center for Food Safety and Applied Nutrition

Discusses six categories of concern related to foodborne pathogenic microorganisms: pathogenic agents (prions).

U.S. Food and Drug Administration (2001)
Fish and Fisheries Products Hazards and Controls Guidance, 3rd edition
U.S. Food and Drug Administration
Center for Food Safety and Applied Nutrition

Contains 21 chapters that discuss the hazards associated with fish, fish products, and controls for hazards associated with fish and fish products.

Wexler, Phillip (ed.) (2005)
Encyclopedia of Toxicology, Four-Volume Set, 2nd edition
Elsevier/Academic Press/Marcel Dekker, New York, NY, USA.

More than 1150 entries in this encyclopedic set discuss the chemicals and core areas of toxicology. Alphabetically arranged these four volumes cover organizations, hazardous chemical incidents, social issues, and laws governing chemicals. Several entries in the area of toxinology can be found in these volumes.

Informa Health Care Publications
Poisoning and Toxicology Handbook 4th edition
Editors: Jerrold B Leikin, Evanston Frank, P Paloucek
ISBN: 9781420044799

Journals

Applied and Environmental Microbiology (AEM)
Publishes current research in the areas of biotechnology, microbial ecology, food microbiology, industrial microbiology, and highlights research findings applicable to the development of new processes or products. This journal is published twice monthly and includes sections on: Genetics and Molecular Biology; Enzymology and Protein Engineering; Physiology and Biotechnology; Mycology; Public Health Microbiology; Environmental Microbiology; Microbial Ecology; Geomicrobiology; Food Microbiology; Plant Microbiology; Invertebrate Microbiology; Biodegradation; and Evolutionary and Genomic Microbiology. Print ISSN: 0099-2240. Online ISSN: 1098-5336. Volume 1, 1953.

Biochemistry
This journal covers the arena where chemistry, biochemistry, and molecular biology interrelate. Print Edition ISSN: 0006-2960; Web Edition ISSN: 1520-4995. Published articles cover structure, function, and regulation of biologically active molecules; gene structure and expression; biochemical mechanisms; protein biosynthesis; protein folding; membrane structure–function relationships; bioenergetics; and immunochemistry. Volume 1: 1962.

The Canadian Veterinary Journal
This is the official journal of the Canadian Veterinary Medical Association. This monthly, peer-reviewed, general scientific publication features a wide variety of articles intended for the veterinary practitioner and includes studies covering natural toxins and their effects on animals particularly. ISSN 0008-5286. Volume 1: 1960.

Clinical Microbiology Reviews (CMR)
This journal offers a variety of reviews of developments in clinical microbiology, immunology, bacteriology, virology, mycology, and parasitology. Published quarterly, CMR includes articles on: Pathogenic Mechanisms; Specific or Groups of Microbial Pathogens; Clinical and Laboratory Aspects of Newly Recognized or Reemerging Infectious Diseases; and Recently Developed Antimicrobial Agents and Their Applications. Print ISSN: 0893-8512. Online ISSN: 1098-6618. Volume 1, Number 1: 1988.

Environmental Health Perspectives
Environmental Health Perspectives (EHP) is the official, monthly, peer-reviewed journal of the National Institute of Environmental Health Sciences. EHP disseminates environmental health information and research findings. *EHP* serves as a forum for the discussion of the interrelationships between the environment and human health by publishing peer-reviewed research and the most current, credible news in the field. Volume 1: April 1972.

The Journal of Clinical Microbiology (JCM)
This journal publishes research studies covering microbiological aspects of human and animal infections and infestations, with particular emphasis on etiologic agents, diagnosis, and epidemiology. Published monthly the JCM includes sections that cover: Bacteriology; Chlamydiology and Rickettsiology; Mycobacteriology and Aerobic Actinomycetes; Mycology; Parasitology;

Virology; Clinical Veterinary Microbiology; and Epidemiology. Print ISSN: 0095-1137. Online ISSN: 1098-660X. Volume 1: 1975.

Journal of Neuroscience
The *Journal of Neuroscience* is the official journal of the Society for Neuroscience. The journal publishes papers on a broad range of topics of general interest to those working on the nervous system. ISSN 0270-6474. It is published weekly by the Society, one volume a year. The *Journal of Neuroscience* publishes rigorously reviewed research across the gamut of behavioral, systems and cognitive neuroscience, cellular and molecular neuroscience, and development, plasticity, and repair neuroscience. *The Journal of Neuroscience* is published weekly, 12 months a year. Published from January 1, 1981 to present.

The Journal of Venomous Animals and Toxins, including Tropical Diseases
ISSN 1678-9199

This is a quarterly publication dedicated to Toxinology and Tropical Diseases. This journal is the official journal of The Center for the Study of Venoms and Venomous Animals (CEVAP) and was first published in 1995.

Marine Drugs
A journal covering research, development and production of drugs from the sea, including marine natural product chemistry. ISSN 1660-3397. Published online quarterly. Volume 1, number 1 published December 2003.

Microbiology and Molecular Biology Reviews (MMBR)
This is the definitive review journal covering the disciplines of microbiology, immunology, and molecular and cellular biology. MMBR keeps readers abreast of the latest findings about bacteria, viruses, parasites, fungi, and other higher eukaryotes. Published quarterly, MMBR presents articles on: Physiology and Enzymology; Molecular Biology; Genetics; Ecology; Host-Parasite Relationships Leading to Disease; Cellular Biology; and Virology. Print ISSN: 1092-2172. Online ISSN: 1098-5557. Volume 1, number 1, December 1937.

Molecular Medicine
This journal publishes original research articles on emerging concepts in the interdisciplinary field of molecular medicine. The journal publishes articles helpful in understanding the molecules key to normal body functioning and the pathogenesis of disease. Volume 1, January, 1995. Published by The Feinstein Institute for medical research, Manhasset, NY.

Natural Toxins
Published by Wiley Interscience from 1992–1995 (no longer being published). However, the published articles provide good references on the effects and mechanisms of natural toxins.

Proceedings of the National Academy of Sciences
PNAS publishes high-impact research reports, commentaries, perspectives, reviews, colloquium papers, and actions of the National Academy of Sciences. ISSN: 00278424. Volume 1 published in 1915.

Toxicological Sciences
Toxicological Sciences is the official journal of the Society of Toxicology, and publishes peer-reviewed, hypothesis-driven, original research articles which are structural, biochemical, or functional in nature; address mechanisms of toxicity; address the effects of dose, route of exposure, metabolism, or species on toxic responses; and, studies that address statistical or mechanism based approaches to risk assessment. Online ISSN 1096-0929. Print ISSN 1096-6080. The journal includes timely review articles. Volume 1, Number 1 published January 1981.

Toxicologic Pathology
This journal focuses on the multidisciplinary elements that constitute toxicologic pathology, including spontaneous and experimentally induced morphological and functional changes, environmental exposures, case reports, and risk assessment. The journal publishes original articles, symposia papers, brief communications, current topic reviews, current issues, and fast-track articles. *Toxicologic Pathology* is the official journal for the Society of Toxicological Pathology and releases seven issues per year. Volume 1, Number 1: 1972.

Toxicon
This interdisciplinary journal addresses toxins derived from animals, plants, and microorganisms and is the official journal of The International Society on Toxinology. The journal publishes articles containing the results of original research on problems related to poisons derived from animals, plants and microorganisms; papers on the chemical, pharmacological, zootoxicological, and immunological properties of natural poisons; clinical observations on poisoning where a new therapeutic principle has been proposed or a decidedly superior clinical result has been obtained; material on the use of toxins as tools in studying biological processes and subjects related to venom–antivenom problems. This journal also publishes review articles on toxinology and abstract current literature on venoms, antivenoms, poisons, and antipoisons. ISSN: 0041-0101. Publication commenced in 1962.

Toxin Reviews

Formerly, the *Journal of Toxicology – Toxin Reviews*, this journal publishes four issues a year. *Toxin Reviews* publishes interdisciplinary findings on toxins and toxin mechanisms and features a dual emphasis on classifying toxins by their mechanisms of action, and on new, underutilized substances. First published in 1982.

Print ISSN: 1556-9543; Online ISSN: 1556-9551

Journal articles

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Berry JP, Reece KS, Rein KS, et al (2002) Are *Pfiesteria* species toxicogenic? Evidence against production of ichthyotoxins by *Pfiesteria shumwayae*. Proc. Natl. Acad. Sci. U.S.A. 99(17): 10970–10975.

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Organizations

Australian Venom Research Unit
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Australia
Phone: +61 3 8344 7753
Fax: +61 3 9348 2048
E-Mail: mail@avru.org
Web: http://www.avur.org

'The Australian Venom Research Unit (AVRU) is an internationally recognised interdisciplinary research unit focused on the problem of venomous injury in Australia and the Asia-Pacific. It was established by Associate Professor Struan Sutherland, formerly of CSL (Commonwealth Serum Laboratories), on the 1st of July 1994 in the Department of Pharmacology at the University of Melbourne. The Unit builds on 70 years of expertise concerning venom and antivenom research and advocacy at CSL. CSL assisted in the establishment of the Unit and initial annual funding came from the Victorian Department of Human Services. Since 2002, the Unit has been mostly funded by the Australian Government through the Department of Health and Ageing as well as the Australia Research Council. The Australian Venom Research Unit aims to provide world-class expertise on the problem of Australia's venomous creatures, their toxins and the care of the envenomed patient.' (excerpted from http://www.avru.org/about_us.html).

This research unit provides relevant information resources on Australian Venom Compendium (http://www.avru.org/compendium/index.html); a list of Exotic Antivenom Holdings (http://www.avru.org/reference/reference_avhold.html); an extensive archive research references of Struan Keith Sutherland (1936–2002): Guide to Records (http://www.avru.org/archives/sutherland/SUTH.htm); and a browser mode and searchable venom bibliography by author and journal names http://www.avru.org/compendium/bib_search.htm. A valuable addition to the database list is a toxinology specific short glossary which would be very helpful to students and reseachers (http://www.avru.org/reference/reference_glossary.html).

Clinical Toxinology Resources
Web: http://www.toxinology.com

'This website was launched in 2002. It contains taxonomic, distribution, venom, clinical effects, first aid, treatment and antidote information on a growing range of venomous and poisonous animals. The list of species covered is planned to cover all significant animal, plant and mushroom species worldwide. Currently the venomous snake section is the most complete, with all Viperid and Elapid species listed and many Atractaspid and Colubrid species. Some information is available to all, but currently the most detailed information is available only to subscribers. Subscriptions help support the cost of building and maintaining the site, most of which is driven by a vast database.'

To contact the website: an online query form should be completed at: http://www.toxinology.com/fusebox.cfm?fuseaction=main.contact_us.contact_us

Guide to Poisonous Plants
Dr. A.P. Knight, College of Veterinary Medicine and Biomedical Sciences, Colorado State University
Web: http://southcampus.colostate.edu/poisonous_plants/index.cfm?countno=NO

The *Guide to Poisonous Plants* has been designed to enable location of a plant by either knowing the common or botanical name of the plant. If the plant is not known, but the disease symptom is known, it is possible to search by the presenting clinical sign, e.g.: abortion, sudden death, photosensitization. (excerpted from: http://southcampus.colostate.edu/poisonous_plants/report/search.cfm)

Indiana Plants Poisonous to Livestock and Pets
Cooperative Extension Service, Purdue University, West Lafayette, IN 47907
Rebecca J. Goetz, writer, extension assistant; Thomas N. Jordan, extension weed scientist; John W. McCain, extension weed scientist; Nancy Y. Su, assistant
Web: http://vet.purdue.edu/depts/addl/toxic/cover1.htm

The above database can be searched by alphabetical plant listing; toxicity rating; species affected; botanical type. A picture index is also provided. For additional information on this database work which is in the developmental stage, contact the webmaster at webmaster@vet.purdue.edu.

International Society of Toxinology (IST)
Secretary: Prof. D Mebs
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Kennedyallee 104
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Web: http://www.toxinology.org

The IST was founded in 1962 by scientists and clinicians interested in advancing the science of toxinology. The first international meeting was held in 1966 in Atlantic City, USA. *Toxicon* is the official journal of the IST. The objective of IST is to advance knowledge

on the properties of toxins and antitoxins and to bring together scholars interested in toxins and toxinology. Membership consists of those who have conducted and published meritorious original investigations in toxinology, while persons who do not qualify for membership but are interested in the field of toxinology are eligible for associate membership. For additonal information, interested persons can contact the current secretary of the IST.

North Coast Water Quality and Biotoxin Program Society

Contact: Pat Lawson, Executive Director
100 1st Avenue East, Prince Rupert, British Columbia, Canada V8J 1A6
Approx. hours: 9:00 am–6:00 pm closed 12–1 for lunch and stat holidays
Phone: 1 (250) 627-5135
Fax: 1 (250) 627-8493
E-Mail: Eby@biotoxinprogram.com
Web: http://www.biotoxinprogram.com

It is based in the city of Prince Rupert, British Columbia, Canada. The society coordinates biotoxin and water quality monitoring and testing services for shellfish harvesting and growing interests on the North Coast mainland and Haida Gwaii (Queen Charlotte Islands) in British Columbia, Canada.

The Biotoxin program is a non-governmental organization (NGO) that consists of representatives from local First Nations and non-First Nations communities, shellfish farmers, scientists, economic development groups, and local, provincial and federal governments. Coastal British Columbia has endemic paralytic shellfish poisoning (PSP) blooms that are of particular concern to local First Nations who harvest shellfish regularly as part of their traditional heritage. Monitoring stations tend to be very remote, so the North Coast Water Quality & Biotoxin Program faces a complex set of challenges.

This society is supported by the Canadian Food Inspection Agency (CFIA), Nechako Kitamaat Development Fund Society, Skeena-Queen Charlotte Regional District and Western Economic Partnerships Agreement (BC MAFF & WEDC).

Databases from Universities and Other Institutions

Animal Toxin Database (ATDB)

Director: Prof. Song-Ping Liang Ph. D
College of Life Sciences, Hunan Normal University
Changsha 410081, China
Phone: +86-731-8872556
Fax: +86-731-8861304
E-Mail: liangsp@hunnu.edu.cn
Web: http://protchem.hunnu.edu.cn/toxin/Browse/Species.htm

ATDB is a uni-database platform designed to store chemical structures and annotation data of all animal toxins and presents a new terms system (Toxin Ontology) standardize functional annotations of toxins. For additional information on Toxin Ontology (TO), access http://protchem.hunnu.edu.cn/toxin/Ontology/Introduction.htm

The database focuses on answering four basic questions about animal toxins:

What is the category of the toxin(s)? (e.g. Neurotoxin, cytotoxin or others);

What is the biological activity of the toxin(s)? (e.g. Vesicle transport regulation or channel inhibition);

What are the symptoms induced by the toxins(s)? (e.g. Hemolysis, Hemorrhage or Death); and,

What is the target of the toxin(s) (e.g. Muscle, Nervous systems or Blood)

The author of this database has claimed that ATDB may be the most comprehensive toxin database which has 3235 peptide toxins from 379 species. Most of them are annotated manually using more than 9166 TO terms by trained biologists. To cite information from the database, readers can use the following bibliographic reference. Quan-Yuan He, Quan-Ze He, Xing-Can Deng, Lei Yao, Er Meng, Zhong-Hua Liu, and Song-Ping Liang (2007) ATDB : a uni- database platform for animal toxins Nucleic Acids Res., In press; doi: doi:10.1093/nar/gkm832.

Canadian Poisonous Plants Information System – Canadian Biodiversity Information Facility (CBIF)

E-Mail: cbif@agr.gc.ca <cbif@agr.gc.ca >
Web: http://www.cbif.gc.ca/pls/pp/poison? p_x=px

The Canadian Poisonous Plants Information System (CPPIS) provides data on plants that cause poisoning in livestock, pets, and humans. The plants include native, introduced, and cultivated outdoor plants as well as indoor plants that are found in Canada. Some food and herbal plants are also included that may cause potential poisoning problems. Although, the information resources available on this website are oriented primarily to a Canadian audience, they can be used elsewhere. For examples, the plants grown in and around homes can be grown throughout the temperate regions of the world. Also, many houseplants are tropical in origin. Other plant species included here have been introduced to North America as well as other temperate regions of the world. The information on the native plant species is applicable wherever they grow

in North America (excerpted from http://www.cbif.gc.ca/pls/pp/ppack.html_doc?p_type=434&p_x=px)

Cornell University Poisonous Plants Informational Database
Web: http://www.ansci.cornell.edu/plants/toxicagents/

This database lists toxic agents associated with plants such as alkaloids, alcohols and ketones, carbohydrates, chealating poisons, glycosides, lipids, metals, mycotoxins, phenolic toxicants, proteins and amino acids, resins and vitamins and other miscellenious toxic agens. For additional information access Cornell University Poisonous Plants Database at http://www.ansci.cornell.edu/plants/index.html and College of Animal Science at http://www.ansci.cornell.edu/index.html.

Global Toxin Review – A web portal
Web: http://globaltoxinreview.com

This is an interactive web community that features a journal, databases, and emerging research and topics in toxinology. Interested members can post articles, join in discussions on various toxin-related issues, and submit articles and research results to the editorial board to be considered for featured articles for a given month. Upon registration, one can participate and gain access to their natural toxin database and share information with other toxinologists and related researchers from all over the world.

At this time, registration is free. The objective of this online publication is to help the field of toxinology and to build a better future through effective information sharing, research collaboration and understanding this emerging field (excerpted from http://globaltoxinreview.com/portal/).

The database section of the website has doctoxin – a natural toxin searchable database. Further, relevant information resources, research articles, and publications have been listed under several other categories such as Arthropod Toxins, Microbial Toxins, Reptile Toxins, Plant Toxins, Marine Toxins, Clinical/Diagnostic Toxinology, General Toxicology, and Historical Toxinology (excerpted from http://globaltoxinreview.com/portal/index.php?page=article&cmd=searchform_tox).

For contact information of the Executive Director/Editor (Dr. Mitchell E Fadem) and other board members, click on information on the web page.

International Veterinary Information Service (IVIS) – Drug Databases and Toxin Databases
P.O. Box 4371 Ithaca NY 14852, USA
E-Mail: info@ivis.org (preferred)
Web: http://www.ivis.org

IVIS is an online publisher of veterinary books and proceedings. The IVIS website currently includes 1673 book chapters and proceeding articles. Access to this page is free but restricted to animal health professionals only. Information resources on toxins, drugs databases, and other databases can be accessed by becoming a member.

Plant Toxic to Animals Database
Mitsuko Williams, Veterinary Medicine Librarian
University of Illinois at Urbana-Champaign
Web: http://www.library.uiuc.edu/vex/toxic/toxic.htm

A brief explanation of the structure of the database is provided below. Within the Toxic Plant Database, two alphabetical lists of plant names, one by common names and the other by scientific names are provided. When a plant is selected in either of the lists, the description of the plant contains a representative plant image at the height of its growth and a brief description for identifying the plant. This section may also contain links to other images of the same plant at different growth stages.

From the description, five other parts of the same plant entry can be accessed such as: 1. Distribution (geographical and the type of area); 2. Conditions of poisoning (how animals are most often poisoned, i.e., time of year, weather conditions, etc. 3. Control (controlling plant growth to prevent poisoning); 4. Toxic principle (chemical principle of the plant which causes the poisoning); 5. Clinical signs (displayed by animals that may have been poisoned by the plant). (excerpted from http://www.library.uiuc.edu/vex/toxic/format.htm).

US FDA/CFSAN Poisonous Plants Database
5100 Paint Branch Parkway, College Park Maryland 20740-3835
Web: http://www.cfsan.fda.gov/~djw/plantox.html

According to USFDA-CFSAN, the information in this database is meant to be used only for scientific exchange. It has not been approved by the USFDA for publication nor does it have any official status. The information resources database available on this website is continuously increasing and being modified. Readers can utilize this new searchable database by 'plant name' or 'plant toxins'. This database replaces the static pages of bibliographic information and the vascular plant list previously available. It contains references to the scientific literature describing studies of the toxic properties and effects of plants and plant parts.

WCH Clinical Toxinology Resources
Web: http://www.toxinology.com

The web portal from the University of Adelaide, Australia provides relevant information resources on

venoms and toxins from snakes, spiders, scorpions, marine and terrestrial invertebrates and vertebrates, and mushrooms are provided. It covers the whole world, with both general information and information about particular organisms, located through a searchable database, which allows users to look for an animal, plant, or mushroom, based on a common name, a scientific name or family, a country or region. Subscribers have access to the full information resources from the system. Information resources are primarily designed for health professionals looking for information on diagnosis and treatment of envenoming and poisoning and other related information. For each organism information resource, there are details on the taxonomy, description (how to identify it), distribution (often with maps), general biology, venom or poison details, summarizing published research, clinical effects, summary of clinical case reports from the medical and scientific literature, treatment guidelines, and available antivenoms and how to obtain them from the producer. It is possible to search not only by animal type and location, but by clinical findings. Thus it acts as a variety of 'expert system' to aid diagnosis. Subscribers can contribute directly by submitting case reports, which will be used to update clinical effects and treatment guidelines. Non-health professionals will also find the site invaluable, for finding taxonomic information, including descriptions of animals. This may be useful for herpetologists, arachnologists, marine biologists, and colleagues. People keeping or studying these animals may also find the subscriber-level data useful, especially amateur herpetologists and zoos keeping venomous snakes. Poisons centers and toxicologists may find it useful as a source of information for acute cases and for information on available antivenoms and producers. Educators may find it useful for sourcing information for lectures, or for assignments.

To contact, access the online form at: http://www.toxinology.com/fusebox.cfm?fuseaction=main.contact_us.contact_us.

CHAPTER

11

Cancer

ANNA M. FAN

INTRODUCTION

The study and evaluation of carcinogenicity of environmental agents is a major focus in the field of toxicology and the protection of environmental and human health. These involve an understanding of the underlying biological system relating to carcinogenesis and developing and evaluating human and animal testing data. The elements involve origins, causes, and incidences of cancer; basic science of cancer; principles in carcinogenesis and carcinogenesis testing; mechanisms of action; human epidemiological investigations and experimental animal or short-term testing: design, quality control, validation, correlation between animal and human data, prediction and epidemiological evidence, exposure, factors affecting carcinogenesis, and data on specific chemicals and agents. The activities involve researching, generating, storing, managing and disseminating data; developing guidelines for generating data and related methodologies; and evaluating and interpreting data for quantitative carcinogenic risk assessment. The parties involved include researchers, government agencies, other public and private parties and other organizations. The availability and accessibility of information and data are critical to achieve the above. This chapter provides a resource list of the major books, journals and journal articles, organizations and databases that represent the up-to-date literature and resources on current issues in studying and evaluating the wide spectrum and diverse toxicological aspects in cancer.

RESOURCES

Books

Adami HO, Hunter D, Trichopoulos D (eds.) (2002)
A Textbook of Cancer Epidemiology
New York: Oxford University Press

This book provides an overview of cancer epidemiology. It examines risk factors such as environmental exposure, lifestyle choices, and genetic susceptibilities. The background section contains basic information on descriptive cancer data, genetics, biomarkers, and causal inferences. The site-specific chapters include clinical synopsis, epidemiology, inherited susceptibility and somatic mutations; and risk factors such as tobacco, alcohol, diet, reproductive and hormonal factors, infections, ionizing radiation, occupation, medical conditions, physical activity, and anthropometric measures. Part I covers Background. The chapters include: Burden of cancer; The origin of cancer; Genetic epidemiology of cancer; Biomarkers of cancer epidemiology; and Concepts in cancer epidemiology and etiology. Part 2 covers Cancer epidemiology and site-specific cancers. The chapters include: Oral and pharyngeal cancers; esophageal cancer; stomach cancer; colorectal cancer; Cancer of the liver and biliary tract; Pancreatic cancer; Cancer of the lung, larynx, and pleura; skin cancer; Breast cancer; Cervical cancer; Endometrial cancer; Ovarian cancer; Prostate cancer; Testicular cancer; Urinary bladder cancer; Kidney cancer; Brain cancer; Thyroid cancer; Hodgkin's lymphoma; non-Hodgkin's lymphoma; and Leukemias.

Acros JC, Argus MS, Woo YT (eds.) (1995)
Chemical Induction of Cancer: Modulation and Combination Effects. An Inventory of the Many Factors Which Influence Carcinogenesis
Boston, MA: Birkhauser.

This book systematically discusses exogenous and endogenous factors that can influence the outcome of carcinogenesis. The multifactor interaction network of carcinogenesis is first discussed followed by a focus on the interactive relationships of the factors. It reviews the elements of the network – initiation process and beyond, repositories of heritable epigenetic information, mixed function oxidases, promoters vs. epigenetic carcinogens, promoters, inhibitors, calories intake vs. rate of cell proliferation, neuroendocrine interface, neuroimmunoendocrine interface, effect of aging, reactive radical species, aging, cancer, and loss of homeostasis. The book provides references for cancer research, prevention measures, and adjuvant therapies.

Benigni R (ed.) (2003)
Quantitative Structure-Activity Relationship (QSAR) Models of Mutagens and Carcinogens
Boca Raton, FL: CRC Press

This book presents QSAR studies on chemical mutagens and carcinogens. It provides a general introduction to QSAR theory and a review of existing QSAR models. It shows how QSAR can contribute to the elucidation of mechanisms, to identifying toxic chemicals solely by their chemical structure, and to the design of safer chemicals. The chapters include: General introduction to QSAR; Mechanisms of action of chemical carcinogens and their role in structure-activity (SAR) relationship analysis and risk assessment; QSAR for individual classes of chemical mutagens and carcinogens; QSARs for the mutagenicity and carcinogenicity of aromatic amines; Public sources of mutagenicity and carcinogenicity data: Use in structure-activity relationship models; SAR in the assessment of carcinogenesis: the MUTIcase approach; Predicting mutagenicity of congeneric and diverse sets of chemicals using computed molecular descriptors: A hierarchial approach; Quantitative structure-activity relationships for acute aquatic toxicity: the role of mechanism of toxic action in successful modeling; and SARs and QSARs of mutagens and carcinogens: Understanding action mechanism and improving risk assessment.

Choy WN (ed.) (2001)
Genetic Toxicology and Cancer Risk Assessment
New York: Marcel Dekker

This book reviews roles of genetic toxicology in human cancer risk assessment, examines predictive values of genotoxicity tests and associated testing requirements and guidelines, and discusses structure-activity relationship, does-response, molecular epidemiology and biomarkers. The chapters include: Human cancer genetics; Genetic toxicity tests for predicting carcinogenicity; Genotoxic and non-genotoxic mechanisms of carcinogenesis; Structure-activity relationship and its role in cancer risk assessment; Regulatory genetic toxicology tests; Complementary genetic toxicology assays; the mouse lymphoma assay (MLA) using the microwell method; the in vitro micronucleus assay; ICH guidelines on genotoxicity and carcinogenicity: scientific background and regulatory practice; New OECD genetic toxicology guidelines and interpretation of results; Does-response relations in chemical carcinogenesis and cancer risk assessment; Molecular epidemiology and biomarkers; Quantitative cancer risk assessment of non-genotoxic carcinogens; and Risk assessment of genotoxic carcinogens.

Clayson D (Author) (2000)
Toxicological Carcinogenesis
Boca Raton, FL: Lewis Publishers

This book provides a discussion of the causes of cancer; detection of carcinogens in humans using epidemiology, bioassays, and alternative approaches; exposure factors such as occupation, cigarette smoking, diet and nutrition; carcinogenesis mechanisms; and controlling exposures. The book starts with the chapter Introduction: What causes cancer? Part I covers the investigation of cancer causation. The chapters include: Epidemiology – Studies of cancer causes in humans; Standard animal bioassays for carcinogens; and Other methods for the identification of carcinogens: Are they quick, less expensive, and as reliable? Part II covers possible human exposures to carcinogens. The chapters include: Exposures in the workplace; Cigarette smoking: a modern plaque; Diet and nutrition; Pharmaceuticals; The General Environment; Rodent carcinogenesis bioassay as a predictor for human cancers; Part III covers reducing the risk of cancer. The chapters include: Carcinogenesis mechanisms; Carcinogenesis risk assessment; Legislation, regulation, and education; and Major goals of research.

DeVita VT, Hellman S, Rosenberg SA (eds. and contributors) (2004)
Cancer: Principles and Practice of Oncology, Seventh Edition
Philadelphia, PA: Lippincott Williams & Wilkins

This book discusses molecular biology, etiology of cancer, principles and practice of oncology, cancer prevention, multimodality treatment and various cancer types. It examines molecular biologic techniques that

include proteomics, genomics, targeted therapies, RNA interference, cDNA arrays, and tissue arrays. It discusses bioinformatics and societal issues in oncology, including regulatory issues, telemedicine, and international differences in oncology. The book consists of Parts 1 to 4 in two volumes, a total of 75 chapters and 3034 pages.

Part I covers molecular biology of cancer. The chapters include: Cancer: a conceptual framework; Genomics and proteomocs; Destabilization of the cancer genome; Teleomere, teleomerase, and cell immortalization; Cell signalling; Cell cycle; Programmed cell death; Angiogenesis; Invasion and metastasis; and Cancer stem cells. Part II covers principles of oncology. The chapters include: Etiology of cancer: Tobacco; Etiology of cancer: cancer susceptibility syndromes; Etiology of cancer: Viruses; Etiology of cancer: inflammation; Etiology of cancer: Chemical factors; Etiology of cancer: Physical factors; Etiology of cancer: Dietary factors; Etiology of cancer: obesity and physical activity; Epidemiology of cancer; Principles of surgical oncology; Principles of radiation oncology; Principles of medical oncology; Principles of immunotherapy; Principles of health services research; Pharmacology of cancer chemotherapy; Pharmacology of cancer biotherapeutics; Pharmacology of endocrine manipulation; Design and analysis of clinical trials. Part III covers practice of oncology. The chapters include: Cancer prevention: Tobacco dependence and its treatment; Cancer prevention: chemoprevention; Cancer prevention: Role of surgery in cancer prevention; Genetic counselling; Cancer screening; Specialized techniques in cancer management; Role of endoscopy in cancer management; Cancer of the heck and neck; Cancer of the lung; Neoplasms of the mediastinum; Cancers of the gastrointestinal tract; Cancers of the genitourinary system; Cancer of the testis; Gynecologic cancers; Cancer of the breast; Cancer of the endocrine system; Sarcomas of the soft tissue and bone; Benign and malignant mesothelioma; Cancer of the skin; Melanoma; Neoplasms of the central nervous system; Cancers of childhood; Lymphomas; Acute leukemias; Chronic leukemias; Plasma cell neoplasms; Paraneoplastic syndromes; Cancer of unknown primary site; Diagnosis and treatment of peritoneal carcinomatosis; Immunosuppression: related malignancies; oncologic emergencies; Treatment of metastatic cancers; Stem cell transplantation; Infections in the cancer patient; Management of adverse effects of treatment; Supportive care and quality of life; Rehabilitation of the cancer patient; Societal issues in oncology; Information systems in oncology; and Complementary, alternative, and integrative therapies. Part 4 covers new approaches in cancer treatment. The chapters include: Gene therapy; Cancer immunotherapy, focused ultrasound; RNA inhibition; Charged particle therapy; Robotic surgery; and Nanotechnology.

Edler L, Kitsos C (eds.) (2005)
Recent Advances in Quantitative Methods in Cancer and Human Health Risk Assessment (Wiley Series in Probability and Statistics)
Hoboken, NJ: John Wiley & Sons

The book begins with the introduction of quantitative risk assessment playing a lead role in the development of quantitative methods. The birth of risk assessment was motivated and guided by the wish to determine threshold doses or exposures to set regulatory limits. The outcome of risk assessment is now increasingly becoming the basis of risk management decisions. The discussion recognizes that risk assessment is a complex field with many aspects to be discussed in the chapters to follow.

Part I covers cancer and human health risk assessment. The chapters include: Principles of cancer risk assessment; The risk assessment paradigm. Part II cover the biological aspects of carcinogenesis. The chapters include: Molecular epidemiology and cancer research; Genetic polymorphism in metabolic enzymes as lung cancer risk factors; Biological carcinogenesis: theories and models; Biological and mathematical aspects of multistage carcinogenesis; and Risk assessment and chemical and radiation hormesis: a short commentary and bibliographic review. Part III covers modeling for cancer risk assessment. The chapters include: Modeling exposure and target organ concentrations; Stochastic carcinogenesis models; A unified modeling approach: from exposure to disease endpoints; Modeling lung cancer screening; and Optimal regimens of cancer screening. Part IV covers statistical approaches for carcinogenesis studies. The chapters include: Analysis of survival data with non-proportional hazards and crossings of survival functions; Does-response modeling; Benchmark does approach; Uncertainty analysis: the Bayesian approach; and Optimal designs for bioassays in carcinogenesis. Part V covers specific modeling approaches for health risk assessment. The chapters include: Cancer risk assessment for mixtures; Designs and models for mixtures; Assessing cumulative risk; and Estimating the natural history of breast cancer from bivariate data on age and tumor size on diagnosis. Part VI covers case studies. The chapters include: Statistical issues in the search for biomarkers of colorectal cancer using microarray experiments; Optimal experimental designs for prediction of morbidity after lung resection; Logistic regression methods and their implementation; The use of logistic regression, discriminant analysis and classification trees in predicting persistent remission

in childhood leukemia; Non-melanoma skin and lung cancer incidence is relation to arsenic exposure: 20 years of observation; and Thyroid cancer incidence rates in Zaragoza.

Frank SA (2007)
Dynamics of Cancer: Incidence, Inheritance, and Evolution (Princeton Series in Evolutionary Biology)
Princeton, NJ: Princeton University Press

This book provides an analysis of how particular genetic and environmental causes influence the age of onset of cancer. It uses molecular, demographic and evolutionary level of analysis and a unique conceptual and historical framework for understanding the causes of cancer. The introduction chapter presents aim and summaries of the chapters. Part I covers background. The chapters include: Age of cancer incidence; Multistage progression; History of theories. Part II covers dynamics. The chapters include: progression dynamics; Theory I; Theory II; Genetics of progression; Carcinogens; and Aging. Part III covers evolution. The chapters include: Inheritance; Stem cells: tissue renewal; Stem cells: population genetics; Cell lineage history; and Conclusions.

Fraumeni JF, Eduardo El, Rohan (eds.) (2002)
Cancer Precursors
New York: Springer-Verlag

This book presents a critical review of the current understanding of cancer precursors. An emphasis is given to various cancers on the etiology and natural history, including the role of environmental factors and heritable factors that provoke normal cells to undergo malignant transformation. Epidemiological data are linked wherever possible to molecular and classical cellular pathology for a better understanding of the causal events and mechanisms that initiate the carcinogenic process. It covers epidemiology, detection methods and preventive strategies for cancer precursors. The book has Parts I to V. Part I cover the biological basis of carcinogenesis. Chapters include: Mechanism and biological markers of carcinogenesis; and Morphology of cancer precursor lesions. Part II covers issues related to measurement and interpretation of cancer precursors. The chapters include: Collection, processing, and analysis of preneoplastic specimens; Intermediate markers of cancer research; theoretical and practical issues in the use of surrogate endpoints; and Assessing epidemiological relations and the role of measurement errors. Part III covers site specific precancerous conditions. The Chapters include: Upper aerodisgestive tract; Eesophagus; Stomach; Colon and rectum; Anus; Liver; Pancreas; Lung; Skin; Breast; Cervix; Endometrium; Ovary; Vulva and vagina; Prostate; and Bladder. Part IV covers control of cancer precursors. The chapters include: Screening; Chemoprevention; and Evidenced-based policy recommendations on screening and prevention. Part V covers conclusion and it contains a chapter on Prospects.

Gabriel JA (2007)
The Biology of Cancer
New jersey: John Wiley and sons Inc.

The book consists of three parts. Part I covers understanding cancer. Part II covers the science of cancer. Part III covers from research to treatment. Part I includes the following chapters: What is cancer? Predisposing factors to developing cancer; Cancer: What does a diagnosis mean for an individual and what are the implications for society? Part II includes the following chapters: The cell; Cytotoxic chemotherapy; What are DNA and RNA; Genetics and cancer; The immune system; Tumour markers; Monoclonal antibodies. Part III includes the following chapters: What is translational oncology research? The application of research methodology to cancer research; and Research ethics related to cancer

IARC (2008)
World Cancer Report
Lyon, France: International Agency for Research on Cancer

This report provides a global view of cancer. The sections include global cancer control, etiology of cancer, mechanisms of carcinogenesis, acting for prevention, and cancer site by site. It addresses cancer control in all resource settings, modifiable risk factors that have been identified, prospects for prevention via vaccination for certain cancers (liver cancer, hepatitis B; cervix cancer, human papillomavirus), and the importance of translational research (i.e., translating scientific discovery into new approaches to cancer treatment to translating information about cancer risk factors into changes in population behavior) while a complete understanding of the mechanisms of cancer development is unlikely to come about in the foreseeable future. The last section includes 25 chapters on different cancer types, plus chapters on cancer in children, cancer in adolescents and rare cancers.

Khan M, Pelengaris S. (2006)
The Molecular Biology of Cancer
Malden, MA: Blackwell Publishing

The introductory chapter starts with the burden of cancer and it identifies 11 key points about cancer, a genetic disease. It introduces and summarizes the concepts and topics covered in the book, with an emphasis on new thinking and key novel models for oncogenesis.

The remaining chapters include: Nature and nurture in oncogenesis; DNA replication and the cell cycle; Regulation of growth: growth factors, receptors, and signaling pathways; Oncogenes; Tumor suppressor genes; Apoptosis; Telomeres an scenescence; Genetic instability, chromosomes and repair; Cancer is more than a genetic condition; Cell-matrix adhesion, cell-cell interactions and malignancy; Tumor immunity and immunotherapy; Angiogenesis; Diagnosis of cancer; Treatment of cancer: Chemotherapy and radiotherapy; Caring for the cancer patient; and Genomics and proteomics in cancer research and diagnosis.

Kitchin KT (ed.) (1999)
Carcinogenicity. Testing, Predicting, and Interpreting Chemical Effects
New York: Marcel Dekker, Inc.

This book provides an overview of knowledge and information on carcinogenicity and how to build on it by compiling and evaluating data. It is divided into three parts, on testing, predicting and interpreting carcinogenicity. The first part addresses carcinogenicity testing protocols and how and why the studies are carried out (Chapters 1–5). The second part discusses animal predictive systems, rat liver foci systems, full rodent bioassays, transgenic animal models, animal parameters system (DNA damage, cell toxicity, cell proliferation), hepatic enzyme pyruvate kinase, and short-term tests (Chapters 6–14). The third part presents human, mouse, and rat data for organs with high and low rates (Chapters 15–29). An integrative attempt was made on carcinogenic mechanisms, interspecies differences and interorgan differences in carcinogenesis.

Knowles MA, Selby PJ (2005)
Introduction to the Cellular and Molecular Biology of Cancer (Fourth edition)
New York: Oxford University Press

The chapters include: What is cancer? The causes of cancer; Inherited susceptibility to cancer; DNA repair ad cancer; Epigenetic events in cancer; Molecular cytogenetics of cancer; Oncogenes; Tumour suppressor genes; Cellular immortalization and telomerase activation in cancer; Growth factors and their signaling pathways in cancer; Apoptosis: Molecular physiology and significance for cancer therapeutics; Mechanisms of viral carcinogenesis; Cytokines and cancer; Hormones and cancer; The spread of tumours; Tumour angiogenesis; Stem cells, haemopoiesis, and leukaemia; Animal models of cancer; The immunology of cancer; The molecular pathology of cancer; From transcriptome to proteome; Local treatment of cancer; Chemotherapy; Radiotherapy and molecular radiotherapy; Monoclonal antibodies and therapy; Immunotherapy of cancer; Cancer gene therapy; Screening; and Conclusions and prospects.

Macdonald F (2004)
Molecular Biology of Cancer (Advanced Text)
New York: Garland Science/BIOS Scientific Publishers

This book provides an overview of cancer biology, scientific aspects of genes involved with cancer, applications – molecular testing, and cancer genes as therapeutic targets, and gene analysis techniques. The chapters include: General principles; Oncogenes; Tumour suppressor genes; Cell cycle control genes and mismatch repair genes; Hereditary cancers; Lung cancer; Colorectal cancer; Gastrointestinal cancer; Breast cancer; Genitourinary cancer; Leukemia and lymphoma; Childhood solid tumours; Therapeutic applications; and Molecular techniques for analysis of genes.

McKinnell RG, Parchment RE, Perantoni AO, Pierce GB (2006)
The Biological Basis of Cancer
New York: Cambridge University Press

This book provides discussions in the following chapters: The pathology of cancer; Invasion and metastasis; Carcinogenesis, Genetics and heredity; Cancer associated genes; Cancer in non-human organisms; Epidemiology; Lifestyle: Is there anything more important? The stem cell basis of cancer treatment: concepts and clinical outcomes; Oncology: The difficult task of eradicating caricatures of normal tissue renewal in the human patient. An Introduction is entitled Letters illustrating clinical aspects of cancer. An appendix provides a description of the following selected tumors: Adenocarcinoma of the breast, adenocarcinoma of the prostate, adenocarcinoma of the colon, squamous cell carcinoma, teratocarcinomas, liver cell carcinoma, lung cancer, malignant melanoma, retinoblastoma, neuroblastoma, Wilms tumor (nephroblastoma), sarcomas, and lymphoma and leukemia.

Preziosi L (2003)
Cancer Modelling and Simulation (Chapman & Hall/Crc Mathematical Biology & Medicine Series)
Boca Raton, FL: CRC Press

This book presents mathematical models and computer simulation techniques for understanding the dynamics of tumour development and growth. It provides an overview of the processes involved in tumour development and growth, including angiogenesis, subcellular mechanisms, and the basic mechanisms of diffusion in avascular and vascular tumours. The chapters include: Biological aspects of tumour angiogenesis; Novel directions in tumour biology: from basement membrane-directed polarity to DNA methylation;

Interstitial transport in solid tumours; Modelling avascular tumour growth; Mechanical models in tumour growth; Modelling tumour induced angiogenesis; Multiscale analysis of angiogenic dynamics and therapy; Adhesion mechanisms in cancer metastasis; Static and dynamic interaction between endothelium and circulating cells in cancer; Mathematical modeling of tissue invasion; Cancer immune system competition: Modelling and bifurcation problem; Analyzing hypersensitivity to chemotherapy in a cellular automata model of the immune system; and Reaction-diffusion systems: A mathematical biology approach.

Ruddon RW (2007)
Cancer Biology
New York: Oxford University Press

This book provides an overview of the nature of cancer and cancer research, including a history of cancer biology, with an emphasis on the mechanics and characteristics of different forms of cancer and stages of cancer. The chapters include: Characteristics of human cancer, Causes of human cancer, The epidemiology of human cancer, The biochemistry and cell biology of cancer, Molecular genetics of cancer; Tumor immunology, Cancer diagnosis, Sequelae of cancer and its treatment, and Cancer prevention.

Schottenfeld D and Fraumeni J (2006)
Cancer Epidemiology and Prevention)
New York: Oxford University Press

The book starts with a discussion of the evolution of the concepts of causation and theories of carcinogenesis. It consists of Parts I to V. Part I covers basic concepts. The chapters include: Causation and causal inference; Experimental studies in the assessment of human risk; Morphologic classification of human cancer; Morphology and natural history of cancer precursors; Stages in neoplastic development; Molecular and genetic events in neoplastic transformation; Molecular epidemiology in cancer prevention; Quantitative risk assessment; and Mathematical models in cancer epidemiology. Part II covers the magnitude of cancer. The chapters include: International patterns of cancer; Cancer incidence, mortality, and patient survival in the United sSates; Cancer incidence: mortality, and survival among racial and ethnic minority groups in the United States; Migrant studies; and Economic impact of cancer in the United States. Part II covers the causes of cancer. The chapters include; Tobacco; Alcohol; ionizing radiation; Solar radiation; Occupation; Air pollution; Water pollution; Diet and Nutrition; Exogenous hormones; Pharmaceuticals other than hormones; Viruses; Immunologic factors, including AIDS; Familial aggregation; Inherited susceptibility; Cancers of the nasal cavity and paranasal sinuses; Nasopharyngeal cancer; Laryngeal cancer; Cancers of the lung and pleura; Cancers of the oral cavity and pharynx; Esophageal cancer; Stomach cancer; Pancreatic cancer; Liver cancer; Biliary tract cancer; Cancers of the small intestine; Cancers of the large intestine; The leukemias; Hodgkin's disease; non-Hodgkin's lymphoma; Multiple myeloma; Bone cancer; Soft tissue sarcoma; Thyroid cancer; Breast cancer; Ovarian cancer; Endometrial cancer; Cervical cancer; Cancers of the vulva and vagina; Choriocarcinoma; Renal cancer; Bladder cancer; Prostate cancer; Testicular cancer; Penile cancer; Neoplasms of the nervous system; cutaneous malignant melanoma; Nonmelanoma skin cancer; Cancers in children; and Multiple primary cancers. Part V covers cancer prevention and control. The chapters include: Principles and applications of cancer prevention; Health education and health promotion in cancer prevention; Intervention studies; Fundamental issues in screening for cancer; and Environmental regulation and policy making.

Schulz WA (2007)
Molecular Biology of Human Cancer: An Advanced Student's Textbook
The Netherlands: Springer

The book is divided into three parts. Part I covers molecules, mechanisms, and cells. Part II covers human Cancers. Part III covers prevention, diagnosis, and therapy. Part I contains the following chapters: An introduction to human cancers; Tumor genetics; DNA damage and DNA repair; Oncogenes; Tumor suppressor genes; Cancer pathways; Apoptosis and replicative senescence in cancer; cancer epigenetics; and invasion and metastasis. Part II contains the following chapters: Leukemia and lymphomas; Wilms tumor (nephroblastoma), Cancers of the skin; Colon cancer; bladder cancer; Renal cell carcinoma; Liver cancer; Stomach cancer; breast cancer; and prostate cancer. Part III contains the following chapters: Cancer Prevention: Cancer diagnosis, and Cancer therapy. Each chapter provides additional information for further reading.

Shields PG (ed.) (2005)
Cancer Risk Assessment (Basic and Clinical Oncology)
Boca Raton, FL: Taylor and Francis Group

This book discusses how cancer develops, individual genetic and acquired susceptibilities, assessing cancer risk, assessment and use of biomarkers, and cancer by organ types. It provides molecular, epidemiological and biomarker data on breast, gynecological, liver, brain and prostate cancers. The chapters include: Carcinogenesis

and molecular genetics; Epidemiological approaches to studying cancer I: study design, confounding variables, misclassification and cancer clusters; Epidemiological approaches to studying cancer II: Molecular epidemiology; Methods for genetic testing I: assessing mutations and cancer; Methods for genetic testing II: new methods for assessing acquired DNA damage in humans without cancer; Quantitative cancer risk assessment; Cancer risk assessment I: How regulatory agencies determine what is a carcinogen; Cancer risk assessment II: Methods for determining cancer etiology: assessing risk in individuals; cancer epidemiology; Cancer susceptibility genes and common gene variants that increase cancer risk; Chemical causes of cancer; Viral causes of cancer; Uncertainty in the estimation of radiation related cancer risk; Occupational cancer; Quantification of occupational and environmental exposures in epidemiological studies; Cancer risk for tobacco and alcohol use; Hormones and cancer; Cancer in multiracial and multiethnic populations; Respiratory tract cancers; Heck and neck cancers; Breast cancer; gynecological cancer – ovarian, endometrial, cervical. The natural history of esophageal cancer; Liver cancer – Risk factors and prevention; Brain cancer; New perspectives on epidemiology of haematological malignancies and related disorders; Bladder cancer; and Molecular and biochemical approaches to the etiology of prostate cancer.

Tan WY, Hanin L (2008)
Handbook Of Cancer Models With Applications (Series in Mathematical Biology and Medicine)
Hackensack, NJ: World Scientific Publishing Company

This book discusses cancer models in the following chapters: Oncogenetic trees; Stochastic multistage cancer models: a fresh look at an old approach; Cancer biology, cancer models, and some new approaches to carcinogenesis; Some general stochastic models of carcinogenesis; Modeling the effect of radiation on cell cycle regulation and carcinogenesis; Cancer models, ionizing radiation, and genomic instability: A review; Distribution of the sizes of metastasis: mathematical and biomedical considerations; Mathematical models of cancer and their relevant insights; Major epigenetic hypothesis of carcinogenesis revisited; Induction and repair of DNA damage formed by energetic electrons and light ions; Radiation bystander effects; A stochastic model of human colon cancer involving multiple pathways; Cancer risk assessment of environmental agents by stochastic and space models of carcinogenesis; Stochastic models for preneoplastic lesions and their application for cancer risk assessment; Drug resistance in cancer models; Bladder cancer screening by magnetic resonance imaging; Mathematical framework and wavelets applications in proteomics for cancer study; Advanced statistical models for the design and analysis of tumor xenograft experiments; and Analysis of occult tumor studies.

Warshawsky D, Landolph JR Jr (eds.) (2006)
Molecular Carcinogenesis and the Molecular Biology of Human Cancer
New York: CRC/Taylor and Francis.

This book is intended to be a graduate textbook in molecular carcinogenesis. It contains 24 chapters and a detailed index at the end. The content covers the basic science of cancer, including a historical overview of cancer and chemical carcinogenesis, chemical carcinogenesis, viral carcinogenesis, radiation carcinogenesis, oncogenes, tumor suppressor genes, and genomics and proteonomics approaches to understand the molecular nature of cancer. It includes an overview of human cancer induction and human exposure to carcinogens, complex mixtures of chemical carcinogens, tumors of various human organs, including breast cancer, prostate cancer, skin cancer, cancer of the brain, and cancer of the thyroid. It continues with chemoprevention of chemical carcinogenesis and human cancer, exposure assessment and biomarkers, carcinogenic risk assessment, and the regulation of carcinogens.

Wodarz D, Komarova NL (2005)
Computational Biology Of Cancer: Lecture Notes And Mathematical Modeling
Hackensack, NJ: World Science Publishing Company Ltd.

This book shows how mathematical and computational models can be used to study cancer biology. It introduces the concept of mathematical modeling and then applies it to a variety of topics in cancer biology such as initiation and progression, somatic evolution of cells, genetic instability, and angiogenesis. The book discusses the use of mathematical models for therapeutic approaches. The chapters include: Cancer and somatic evolution; mathematical modeling of tumorigenesis; Cancer initiation – one-hit and two-hit stochastic models; Microsatellite and chromosomal instability in sporadic and familial cancers; Cellular origins of cancer; Costs and benefits of chromosomal instability; DNA damage and genetic instability; tissue aging and the development of cancer; Basic models of tumor inhibition and promotion; Mechanisms of tumor neovascularization; Cancer and immune responses; and Therapeutic approaches: viruses as anti-tumor weapon. An appendix provides exact formula for total probability of double mutations.

Journals

Carcinogenesis (archives of online issues Jan 1, 1980–Oct 1, 2006)
Oxford Journals, Oxford University Press.
Web: http://carcin.oxfordjournals.org

Carcinogenesis is a multidisciplinary journal that brings together all the varied aspects of research that will ultimately lead to the prevention of cancer in humans. The journal publishes papers that warrant prompt publication (or research) in the areas of Cancer Biology, Molecular Epidemiology and Cancer Prevention, and Carcinogenesis. Cancer Biology includes the processes of promotion, progression, signal transduction, apoptosis, genomic instability, growth factors, cell and molecular biology, mutation, DNA repair, and genetics. Molecular Epidemiology and Cancer Prevention includes molecular dosimetry, epidemiology, genetic predisposition to cancer, chemoprevention, nutrition, and cancer. Carcinogenesis includes viral, chemical, and physical carcinogenesis, metabolism of carcinogens, and the formation, detection, and identification and quantification of environmental carcinogens.

Journal of Carcinogenesis
BioMed Central
Web: http://www.biomedcentral.com

The journal receives papers on all aspects of physical and chemical carcinogenesis and mutagenesis. It is an open-access, peer-reviewed, online journal designed to bring together many aspects of research to develop the understanding of carcinogenesis. It considers manuscripts in the areas of carcinogenesis that include physical and chemical carcinogenesis and mutagenesis; processes influencing or modulating carcinogenesis, such as DNA repair, genetics, nutrition, and metabolism of carcinogens; the mechanism of action of carcinogens and modulating agents; epidemiological studies; and the formation, detection, identification, and quantification of environmental carcinogens. The publications include commentaries, original research findings, review articles, and short papers.

Journal of Environmental Science and Health, Part C, Environmental Carcinogenesis and Ecotoxicology Reviews
Marcel Dekker/Taylor and Francis.
Web: http://www.tandf.co.uk/journals/titles/10590501.asp

Environmental Carcinogenesis and Ecotoxicology Reviews is a multidisciplinary journal for the rapid publication of integrative, critical reviews on timely and important subjects in various areas of environmental carcinogenesis. The subjects covered include risk assessment of chemical/physical agents, biological factors of environmental significance, basic research and methodology, theoretical modeling, host susceptibility and mechanistic studies, and protection of environment and ecosystems.

Journal of the National Cancer Institute (Full text coverage January 1999 – present)
Oxford University Press.

The *Journal of the National Cancer Institute* (JNCI) publishes peer-reviewed original research from around the world. It includes broad subjects in clinical medicine and specific subjects in oncology and hematology. For the past several years, the Institute of Scientific Information in its annual Journal Citation Reports has ranked the JNCI as the most-cited original-research cancer journal.

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Yu SH (2006) Arsenic carcinogenesis in the skin. J. Biomed. Sci. 13(5): 657–666.

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Government/public reports

IARC (1999)
Epidemiology of Childhood Cancer
IARC Scientific Publications, No. 149
Lyon, France: International Agency for Research in Cancer.

This report summarizes the descriptive epidemiology and critically appraises analytical epidemiologic data on childhood cancer. It includes data on childhood neoplasms from cancer registries, using protocols comparable to those employed in the collection of data previously published in the *International Incidence of Childhood Cancer*. This database reveals intriguing patterns of geographical variations in incidence, which point to causation by different etiological factors. The chapters include design issues (case-control studies, cohort studies); hypothesis involving considerations of different routes of exposure; and descriptive epidemiology for leukemias, lymphomas, and other reticuloendothelial neoplasms, neoplasms of the central nervous systems and miscellaneous intracranial and intraspinal neoplasms, and other neoplasms. In addition, it discusses genetic factors and familial aggregation; ionizing radiation; electromagnetic fields; exposures to chemicals and dusts; infection; lifestyle; maternal reproductive history, maternal illness and related drug use; and medical history of the index child.

U.S. EPA (2005)
Guidelines for Carcinogen Risk Assessment
Risk Assessment Forum, U.S. Environmental Protection Agency Washington, DC.
EPA/630/P-03/001F
Web: http://www.epa.gov/cancerguidelines

This document provides a revised set of principles and procedures to guide EPA scientists in assessing cancer

risk from exposures to chemicals or other agents in the environment. It reflects EPA's evolving approach to cancer risk assessment last revised in 1986 and 1999. The guidelines are prospective only and will apply to the agency's current and future risk assessments of environmental pollutants. The guidelines are also used to inform agency decision-makers and the public about risk assessment procedures.

The Health Consequences of Involuntary Exposure to Tobacco Smoke: A Report of the Surgeon General (2006)
U.S. Department of Health and Human Services
Centers for Disease Control and Prevention
National Center for Chronic Disease Prevention and Health Promotion
Office on Smoking and Health

The report concluded that many millions of Americans, both children and adults, are still exposed to secondhand smoke in their homes and workplaces despite substantial progress in tobacco control. A chemical called cotinine is a biomarker of secondhand smoke exposure. Secondhand smoke contains hundreds of chemicals known to be toxic or carcinogenic (cancer-causing), including formaldehyde, benzene, vinyl chloride, arsenic, ammonia, and hydrogen cyanide. Secondhand smoke has been designated as a known human carcinogen (cancer-causing agent) by the U.S. Environmental Protection Agency, National Toxicology Program and the International Agency for Research on Cancer (IARC). The National Institute for Occupational Safety and Health has concluded that secondhand smoke is an occupational carcinogen. Exposure of adults to secondhand smoke has immediate adverse effects on the cardiovascular system and causes coronary heart disease and lung cancer. Concentrations of many cancer-causing and toxic chemicals are higher in secondhand smoke than in the smoke inhaled by smokers. Nonsmokers who are exposed to secondhand smoke at home or at work increase their risk of developing lung cancer by 20–30%.

U.S. EPA (1997)
Health Effects Assessment Summary Tables, FY 1997 Update. EPA 540/R-97-036
Washington, DC: Office of Research and Development and Office of Emergency and Remedial Response.

The Health Effects Assessment Summary Tables (HEAST) is a comprehensive listing consisting almost entirely of provisional risk assessment information relative to oral and inhalation routes for chemicals of interest to Superfund, the Resource Conservation and Recovery Act (RCRA), and the EPA in general.

Mohr U (ed.) (1992–1997)
IARC International Classification of Rodent Tumours. Part I: The rat. 10. Digestive System
IARC Scientific Publications, No. 122
Lyon, France: International Agency for Research in Cancer.

This report on international classification of rodent tumors is part of a series of 10 fascicles to provide information and guidelines especially adapted for international use in practical toxicologic pathology. Included in the classification are tumors and relevant pre-neoplastic lesions of the rat for all organ systems. Hyperplastic and metaplastic changes are only considered in association in as far as they are known to be clearly pre-neoplastic, i.e., incidentally and pathogenetically associated with corresponding tumors. Other reactive hyperplastic lesions, which, for example, develop secondarily to inflammation, are not included. Also, only lesions are considered for which histopathological slides are available or which have been documented with pictures in the literature. The goal is to harmonize and standardize the nomenclature and diagnostic categories to be used worldwide for regulatory purpose. The complete range of organ systems is covered in ten fascicles, the latest of which was published in 1997.

IARC (2006)
IARC Monographs on the Evaluation of Carcinogenic Risks to Humans. Preamble. International Agency for Research on Cancer
Lyon, France: World Health Organization.

The preamble discusses the principles and procedures used in developing the IARC monographs (described above), including the scientific criteria that guide the working group's evaluations. In the IARC evaluation process, the strength of the evidence that any carcinogenic effect observed is due to a particular mechanism is evaluated, and designated as 'weak', 'moderate', or 'strong'. Whether the particular mechanism is likely to be operative in humans is then assessed. In the classification process, mechanistic data are used to evaluate evidence of carcinogenicity, help in assessing the relevance and importance of findings of cancer in animals and in humans, and to further determine the final classification of a chemical under evaluation. The initial two partial evaluations are combined into a preliminary default evaluation and designated in one of the categories that classify whether the agent is 'carcinogenic to humans' (group 1), 'probably carcinogenic to humans' (group 2A), 'possibly carcinogenic to humans' (group 2B), 'not classifiable as to its carcinogenicity to humans' (group 3), or 'probably not carcinogenic to humans' (group 4). Then the mechanistic

and other relevant data are considered to determine the need for modification of the default evaluation. In considering all relevant scientific data, the working group may assign the agent to a higher or lower group than the default would indicate.

International Agency for Research on Cancer
International Agency for Research on Cancer (IARC) Monograph series on the Evaluation of Carcinogenic Risks to Humans
Lyon, France: World Health Organization.

The IARC monographs are scientific evaluations of carcinogenic risks to humans of chemicals, complex mixtures, occupational exposures, lifestyle factors, physical and biologic agents, and other potentially carcinogenic exposures. Each monograph includes a critical review of the pertinent peer-reviewed scientific literature as the basis for an evaluation of the weight of the evidence that an agent may be carcinogenic to humans.

The IARC is part of the World Health Organization whose mission is to coordinate and conduct research on the causes of human cancer, the mechanisms of carcinogenesis, and to develop scientific strategies for cancer control. The Agency is involved in both epidemiological and laboratory research and disseminates scientific information through publications, meetings, courses, and fellowships. National health agencies use this information as scientific support for their actions to prevent exposure to potential carcinogens. Since 1971, more than 900 agents have been evaluated, of which approximately 400 have been identified as carcinogenic or potentially carcinogenic to humans.

National Toxicology Program (NTP) Report on Carcinogens
National Toxicology Program
Bethesda, MD

The NTP Report on Carcinogens provides a listing of substances which either are known to be human carcinogens or may reasonably be anticipated to be human carcinogens and to which a significant number of persons residing in the United States are exposed. It is an informational scientific and public health document first ordered by Congress in 1978 that identifies and discusses agents, substances, mixtures, or exposure circumstances that may pose a hazard to human health by virtue of their carcinogenicity. The report is published biennially and serves as a meaningful and useful compilation of data on the following: (1) The carcinogenicity (ability to cause cancer), genotoxicity (ability to damage genes), and biologic mechanisms (modes of action in the body) of the listed substance in humans and/or animals; (2) The potential for human exposure to these substances; and (3) federal regulations to limit exposures.

Driscoll T, Steenland K, Prüss-Üstün A, et al (2004)
Occupational carcinogens: Assessing the environmental burden of disease at national and local levels. Environmental Burden of Disease Series No. 6.
Geneva, Switzerland: World Health Organization.

This guide provides practical advice for assessing the current burden of disease from past and current occupational exposures to carcinogens. The outcomes of such exposures include lung cancer, leukemia, and malignant mesothelioma. The disease burden is measured in terms of the number and proportion of deaths from these conditions, as well as in terms of total disability (using disability-adjusted life years, or DALYs). Exposure at national level is estimated using workforce data for the country, as well as exposure data for carcinogens in different industries (based on European data). The relative risk for cancer for each carcinogen is estimated from international literature. This information is combined to estimate the impact in each country of occupational exposures to carcinogens. This figure is termed the population attributable fraction (AF), and AF estimates are presented as fractions of the deaths and disability that are caused by occupational exposures to carcinogens. The number of deaths attributable to the occupational exposures to carcinogens can then be estimated by multiplying the AF by the number of deaths in the country. The extent of disability can also be estimated by multiplying the AF by disease-specific estimates of DALYs.

U.S. EPA (2005)
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens
Risk Assessment Forum, U.S. Environmental Protection Agency Washington, DC 20460
EPA/630/R-3/003F
Web: http://www.epa.gov/cancerguidelines

This Supplemental Guidance describes possible approaches that the EPA could use in assessing cancer risks from exposures to children from 0 to 16 years of age. It includes a review of existing scientific literature on chemical effects in animals and humans. It also summarizes the results of the cancer studies that investigated early-life exposure, EPA's analysis of those studies, and analysis to strengthen the scientific basis for adjusting from studies conducted in adults to children. This document is consistent with the National Research Council's 1994 recommendation that 'EPA assess risks to infants and children whenever it appears that their risks might be greater than those of adults.'

Survey of Compounds Which Have Been Tested for Carcinogenicity (1997–1998)
U.S. Public Health Service, under contract to National Cancer Institute

This three-volume set is the 20th edition of U.S. Public Health Service Publication No. 149, *Survey of Compounds Which Have Been Tested for Carcinogenic Activity*, and covers literature published in 1997–98. It is published under contract to the Chemical and Physical Carcinogenesis Branch, Division of Cancer Biology, National Cancer Institute.

Survey of Compounds Which Have Been Tested for Carcinogenic Activity. Cumulative Indexes (1991)
Bethesda, MD: National Cancer Institute.
DHHS-N01-CP-71114, PB92-143767

The volume includes a Cumulative Chemical Name Index containing all chemical names, both common names and CAS preferred names, used in all volumes of the Public Health Service (PHS-149) series in alphabetical order. The chemical accession numbers for the PHS-149 volumes in which each chemical appears accompany each chemical name. In addition to the Cumulative Chemical Name Index, the volume includes a Cumulative CAS Registry Number Index. The index includes all available CAS Registry Numbers listed sequentially with the chemical accession number for each PHS-149 volume in which the chemical is found. Thus, the user can use both chemical name and/or CAS Registry Number to search the PHS-149 volumes for information on a compound.

Stewart BW, Kleihues P (2003)
World Cancer Report
IARC Nonserial Publication
Geneva, Switzerland: World Health Organization.

This report provides a global view of cancer as it documents the frequency of cancer in different countries, trends in cancer incidence and mortality. It describes the known causes of human cancer and the molecular and cellular basis of the multistep process of malignant transformation. It contains an overview of cancer prevention, including screening programs for early diagnosis, as well as advances in surgical and medical oncology, including novel drugs targeting tumor-specific signaling pathways. The efforts of the World Health Organization in the fight against cancer are detailed, together with strategies for cancer control.

Organizations

American Conference of Governmental Industrial Hygienists (ACGIH)

ACGIH (American Conference of Governmental Industrial Hygienists) is an organization devoted to the administrative and technical aspects of occupational and environmental health. The *Documentation of the Threshold Limit Values and Biological Exposure Indices* is the source publication for the TLVs and BEIs issued by ACGIH every year. The categories for carcinogenicity are: (1) Group A1 – confirmed human carcinogen; (2) Group A2 – suspected human carcinogen; (3) Group A3 – confirmed animal carcinogen with unknown relevance to humans; (4) Group A4 – Not classifiable as a human carcinogen; (5) Group A5 – Not suspected as a human carcinogen.

California Environmental Protection Agency, Office of Environmental Health Hazard Assessment
Oakland/Sacramento
Web: vwww.oehha.ca.gov

The California Environmental Protection Agency's (Cal/EPA) Office of Environmental Health Hazard Assessment (OEHHA), as lead agency for the implementation of the Safe Drinking Water and Toxic Enforcement Act of 1986, maintains the Proposition 65 list of chemicals that have been identified by the State to cause cancer, birth defects, or other reproductive harm. One of the mechanisms by which a chemical can be put on the Proposition 65 list is when the chemical has been identified as causing cancer by an organization that has been designated as 'authoritative' for purposes of Proposition 65. The listing can be reconsidered under certain situations. A Carcinogen Identification Committee (CIC) makes recommendations regarding chemical carcinogen status.

National Cancer Institute (NCI)
There are NCI-designated Cancer Centers in 30 states
National Institute of Health
Bethesda, Maryland 20892
Web: http://www.cancer.gov

The National Cancer Institute (NCI) was established under the National Cancer Act of 1937. It is the Federal Government's principal agency for cancer research and training and is a component of the National Institutes of Health (NIH), one of eight agencies that compose the Public Health Service National Cancer Institute (NCI) (PHS) in the Department of Health and Human Services (DHHS). The National Cancer Act of 1971 broadened the scope and responsibilities of the NCI and created the National Cancer Program. The NCI coordinates the National Cancer Program, which conducts and supports research, training, health information dissemination, and other programs with respect to the cause, diagnosis, prevention, and treatment of cancer, rehabilitation from cancer, and the

continuing care of cancer patients and the families of cancer patients.

National Toxicology Program (NTP)
Located administratively at the NIEHS/NIH
Web: http://ntp.niehs.nih.gov/

The NTP is an interagency program whose mission is to evaluate agents of public health concern by developing and applying tools of modern toxicology and molecular biology. The program maintains an objective, science-based approach in dealing with critical issues in toxicology and is committed to using the best science available to prioritize, design, conduct, and interpret its studies. To that end, the NTP is continually evolving to remain at the cutting edge of scientific research and to develop and apply new technologies. NTP was established in 1978 and it was granted permanent status in 1981. The program was created as a cooperative effort to coordinate toxicology testing programs within the federal government, strengthen the science base in toxicology, develop and validate improved testing methods, provide information about potentially toxic chemicals to health, regulatory, and research agencies, scientific and medical communities, and the public. The three agencies that form the core of the NTP are National Institute of Environmental Health Sciences of the National Institutes of Health (NIEHS/NIH), National Institute for Occupational Safety and Health of the Centers for Disease Control and Prevention (NIOSH/CDC), and National Center for Toxicological Research of the Food and Drug Administration (NCTR/FDA). The NTP relies upon three external groups for advice on its activities and special emphasis panels for independent scientific peer review and advice on targeted issues.

Occupational Safety and Health Association (OSHA)

Under OSHA, carcinogens are addressed in specific standards for the general industry, shipyard employment, and the construction industry. The Identification, Classification, and Regulation of Carcinogens are specified under 29 Code of Federal Regulations (CFR) 1990. The criteria for identification, classification, and regulation of potential occupational carcinogens are described in two categories: Category I Potential Carcinogens and Category II Potential Carcinogens, unless the Secretary considers evidence in provisions under subpart of 1990 and determines that such evidence warrants an exception to these criteria.

World Health Organization (WHO)
Web: http://www.who.int/en/

The World Health Organization, established in 1948, is the United Nations specialized agency for health. WHO's objective is set out in its Constitution which is the attainment by all peoples of the highest possible level of health. Health is defined in WHO's Constitution as a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity. WHO is governed by 193 Member States through the World Health Assembly which is composed of representatives from WHO's Member States. The main tasks of the assembly are to approve the WHO program and the budget for the following biennium and to decide major policy questions. WHOLIS is the WHO's library database available on the web. WHOLIS indexes all WHO publications from 1948 onwards and articles from WHO-produced journals and technical documents from 1985 to the present. An on-site card catalogue provides access to the pre-1986 technical documents.

Databases

California Environmental Protection Agency (Cal/EPA) toxicity values
Web: http://www.oehha.ca.gov/risk/chemicalDB/index.asp

This database provides various toxicity values for chemicals that have undergone evaluations or risk assessments by various programs within the Office of Environmental Health Hazard Assessment, Cal/EPA. They are searchable by chemical name, CAS number or highlighting from a list of chemicals provided. The criteria include Cancer Potency Factors, Acute Reference Exposure Levels (RELs), Chronic Reference Exposure Levels (RELs), Public Health Goals (PHGs), No Significant Risk Levels (NSRL), and Maximum Allowable Daily Levels (MADL). Full documentation can be obtained from the Office's website.

Carcinogenic Potency Database (CPDB)
Web: http://potency.berkeley.edu/text/methods.html

The Carcinogenic Potency Database (CPDB) is a systematic and unifying analysis of chronic, long-term animal cancer tests. It standardizes the published literature and creates a resource containing results reported in 1426 papers in the general literature through 1997 and 429 Technical Reports of the National Cancer Institute/National Toxicology Program (NCI/NTP) through 1998. Results reported for 6153 experiments on 1485 chemical agents are displayed in a plot format organized by chemical name. Detailed information important in the interpretation of bioassays is reported on each experiment (whether positive or negative for carcinogenicity). This includes: qualitative information on strain, sex, route of compound administration, target organ, histopathology,

author's opinion about carcinogenicity, and reference to the published paper, as well as qualitative information on daily dose-rate, duration of dosing, length of experiment, tumor incidence, and dose–response curve shape. A measure of carcinogenic potency, TD_{50} (tumorigenic dose-rate for 50% of experimental animals), its confidence limits, and statistical significance are estimated for each site reported in the database. References for the original published paper are provided. The experiments were not evaluated by CPDB staff regarding whether or not a compound induced tumors in any given experiment; rather, the opinion of the published author is presented for each target site as well as the statistical significance of the TD_{50} calculated from the experimental results.

Chemical Carcinogenesis Research Information System (CCRIS)
Toxicology Data Network
U.S. Library of Medicine

CCRIS is a toxicology data file of the National Library of Medicine's (NLM) Toxicology Data Network (TOXNET®). It is a scientifically evaluated and fully referenced data bank, developed and maintained by the National Cancer Institute (NCI). It contains over 9000 chemical records with carcinogenicity, mutagenicity, tumor promotion, and tumor inhibition test results. Data are derived from studies cited in primary journals, current awareness tools, NCI reports, and other special sources. Test results have been reviewed by experts in carcinogenesis and mutagenesis. CCRIS is accessible via TOXNET at: http://toxnet/nlm.nih.gov. Users can search by chemical or other name, chemical name fragment, Chemical Abstracts Service Registry Number (RN), and/or subject terms. Search results can easily be viewed, printed or downloaded. Search results are displayed in relevancy ranked order. Users may select to display any combination of data from the following broad groupings: (a) Carcinogenicity Studies; (b) Tumor Promotion Studies; (c) Mutagenicity Studies; and (d) Tumor Inhibition Studies. Users can easily conduct their CCRIS search strategy against other databases: Hazardous Substances Data Bank®, Integrated Risk Information System, and GENE-TOX.

ESIS (European Chemical Substances Information System)
Web: http://ecb.jrc.it/esis/

The European Chemical Substances Information System is an IT System which provides information on chemicals related to: EINECS (European Inventory of Existing Commercial Chemical Substances); ELINCS (European List of Notified Chemical Substances); NLP (No-Longer Polymers); HPVCs (High Production Volume Chemicals) and LPVCs (Low Production Volume Chemicals), including EU Producers/Importers lists, C&L (Classification and Labelling), Risk and Safety Phrases, Danger etc.; IUCLID Chemical Data Sheets, IUCLID Export Files, OECD-IUCLID Export Files, EUSES Export Files; and Priority Lists, Risk Assessment process and tracking system in relation to Council Regulation (EEC) 793/93 also known as Existing Substances Regulation (ESR).

Integrated Risk Information System (IRIS)
U.S. EPA
Web: http://www.epa.gov/iris/intro.htm

The Integrated Risk Information System (IRIS) is an electronic database prepared and maintained by the U.S. EPA that contains information on human health effects that may result from exposure to environmental chemicals, including both carcinogens and non-carcinogens. For carcinogens, the chemical files contain descriptive and quantitative information on hazard identification, oral slope factors, and oral and inhalation unit risks for carcinogenic effects. The information is intended for use in public health protection through risk assessment and risk management. Whereas a complete risk assessment consists of hazard identification, dose–response assessment, exposure assessment, and risk characterization, the last step of risk characterization is the transitional step to risk management. IRIS is a tool that provides hazard identification and dose–response assessment information, but does not provide situational information on individual instances of exposure. The information contained in Section II (Carcinogenicity Assessment for Lifetime Exposure) of the chemical files represents a consensus opinion of EPA health scientists representing the Program Offices and the Office of Research and Development. (Section I contains information on Chronic Health Hazard Assessment for Noncarcinogenic Effects.)

International Toxicity Estimates for Risk Database (ITER)
Toxicology Excellence for Risk Assessment (TERA)
Web: http://iter.ctcnet.net/publicurl/pub_search_list.cfm
Web: http://toxnet.nlm.nih.gov

ITER is a database providing human health risk values and cancer classifications for over 600 chemicals of environmental concern from multiple organizations worldwide. It presents risk data in a tabular format for easy comparison, along with a synopsis explaining differences in data and a link to each organization for more information. The information is compiled from Agency for Toxic Substances and Diseases Registry (ATSDR, of the U.S. Centers for

Disease Control and Prevention), Health Canada, U.S. EPA, IARC, National Science Foundation (NSF) International; National Institute of Public Health and the Environment of the Netherlands (Rijksinstituut voor Volksgezondheid en Milieu, RIVM), and independent parties.

OncoLogic™ – A Computer System to Evaluate the Carcinogenic Potential of Chemicals

U.S. Environmental Protection Agency

Web: http://www.epa.gov/opptintr/newchems/tools/oncologic.htm

OncoLogic™ is a desktop computer program that evaluates the likelihood that a chemical may cause cancer, released by U.S. EPA. It predicts cancer-causing potential by: (1) applying the rules of structure–activity relationship (SAR) analysis; (2) mimicking the decision logic of human experts; and (3) incorporating knowledge of how chemicals cause cancer in animals and humans. The chemical classes currently evaluated by OncoLogic™ subsystems include fibers, metals, polymers, and more than 48 classes of organic chemicals. A Miscellaneous Class and a Functional Analysis component are available. Data sources used to build the Knowledge Rules in OncoLogic™ include cancer bioassay data from the following sources to develop the rule packages: (1) six-volume series of monographs entitled 'Chemical Induction of Cancer'; (2) International Agency for Research on Cancer (IARC) monograph series; (3) U.S. National Cancer Institute (NCI)/National Toxicology Program (NTP) technical report series; (4) U.S. Public Health Service Publication series 149 entitled 'Survey of Compounds Which Have Been Tested for Carcinogenic Activity'; and (5) non-classified chemical industry and U.S. EPA research data. Publicly available scientific literatures and external domain experts were also used or consulted whenever necessary.

Risk Assessment Information System (RAIS)

Web: http://rais.ornl.gov/tox/tox_values.shtml

This is a database on sources of chemical-specific toxicity values sponsored by the U.S. Department of Energy (DOE), Office of Environmental Management, Oak Ridge Operations (ORO) Office through a contract with Bechtel Jacobs Company LLC. It recommends the hierarchy of sources in evaluating chemical toxicity for Superfund sites as indicated by U.S. EPA (see above): IRIS, PPRTV, and cited references developed for the EPA OSWER Office of Superfund Remediation and Technology Innovation (OSRTI) programs, and other toxicity values. The 'other' level of the hierarchy includes several sources of toxicity values that are commonly consulted by the EPA Superfund program when a relevant toxicity value is not available from either of the above two databases. They include the Cal/EPA toxicity values, the ATSDR MRLs (addressing non-cancer effects only), and the U.S. EPA HEAST database and cited references; and additional sources of toxicity values.

U.S. EPA OPPTS Harmonized Test Guidelines, Series 870

Office of Prevention, Pesticides and Toxic Substances

Washington, DC: U.S. Environmental Protection Agency.

Web: http://www.epa.gov/opptsfrs/publications/OPPTS_Harmonized/870_Health_Effects_Test Guidelines/Series/

This is a set of guidelines that include a description of the study design for cancer bioassays. Rodents, usually both rats and mice, are commonly used (U.S. EPA test 870.4200). For each species, at least 50 animals/sex/dose are recommended, with the test chemical administered for at least three dose groups plus concurrent controls. Treatment is daily or 5 day/week exposures from just past weaning for at least 18 months in mice, and 24 months in rats. Test chemical may be administered in the food or water, by gavage, by inhalation, or via dermal application. The highest dose tested should produce visible toxic signs, and the lowest dose tested should produce no toxicity. Shortening of lifespan due to tumors is considered acceptable, as long as survival is adequate for acceptable statistical analysis. In addition to parameters examined in non-cancer studies, a much more detailed histopathological examination for tumors is performed. The incidence of tumors is evaluated in a wide variety of tissues, with classification of tumor type (dysplasia, benign, malignant), probable tissue of origin, and sometimes, a severity grade. Other pathological lesions and changes are also noted.

U.S. EPA Toxicity Values (IRIS, PPRTV, HEAST)

Web: http://www.epa.gov/region8/r8risk/hh_toxicity.html

This contains toxicity values for use in Superfund human health risk assessments available from several sources. The recommended hierarchy for these alternative sources is described by U.S. EPA in *Human Health Toxicity Values in Superfund Risk Assessments* (Memorandum, OSWER 9285.7-53, December 2003), also presented below.

Tier 1, IRIS (Integrated Risk Information System, see description above). Most values in this database have undergone thorough review and validation both within and outside EPA. Tier 2, PPRTVs, or EPA's Provisional

Peer Reviewed Toxicity Values, is not available to the general public, but is accessible to EPA risk assessors via EPA's intranet or one may contact the Region 8 Superfund toxicologists for assistance with these values. Tier 3, Other Toxicity Values. Tier 3 includes additional EPA and non-EPA sources of toxicity information, including: (1) the California Environmental Protection Agency's (Cal/EPA) *Toxicity Criteria Database* that contains toxicity values that are peer-reviewed and address both cancer and non-cancer effects; (2) the Agency for Toxic Substances and Disease Registry (ATSDR)'s *Minimal Risk Levels (MRLs) for Hazardous Substances* that are peer-reviewed estimates of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse non-cancer health effects over a specified duration of exposure; (3) toxicity values in EPA's Health Effects Assessment Summary Tables (HEAST) (EPA-540-R-97-036, July 1997). The HEAST values on chemical contaminants are not currently available on EPA's internet site, but may be obtained by contacting a Superfund risk assessor. For radionuclides, the slope factors have been adopted by EPA in its *Preliminary Remediation Goals for Radionuclides Calculator* and the *Soil Screening Guidance for Radionuclides* documents.

CHAPTER

12

Chemical Compendia

ANTOINETTE HAYES

INTRODUCTION

Chemical compendia are collections, whether in print or digital format, of information about a broad array of chemicals. The ones listed in this chapter focus on the chemicals' properties and toxicities. Such compendia typically offer a sweeping look at the chemical and often include recent references to the technical literature. They are a good place to begin researching the effects of chemicals on living organisms and the environment. Many of those here are established standards, with the most recent edition or revision listed. Below are highlighted two examples.

The Agency for Toxic Substances and Disease Registry (ATSDR) offers numerous publications on a broad range of topics from heavy metals to solvents. Their site offers a number of databases and a new section called the 'Toxic Substances Portal' which gives the viewer a 'one click' access to the most current research on a variety of substances. The portal will be updated on an ongoing basis and new topics will be posted in groups of 20 substances at a time. The ATSDR also offers a web section on hazardous waste sites which maps the geography of these sites in the context of schools, roads, and politics. This area might be of particular use to toxicologists working in the field of epidemiology and risk assessment.

Also of interest in this chapter, are the critical reviews prepared by the ECETOC (European Chemical Industry Ecology and Toxicology Centre) in Belgium. The ECETOC began writing these reviews in 1983. The reviews are published on a need basis and relate to chemicals that are mass produced by the ton by many companies and have widespread uses. For example, the latest review concerns trifluoroethane which is used as a propellant in canned air products or as a refrigerant in combination with other chemicals.

RESOURCES

Books, Web Resources

Agency for Toxic Substances and Disease Registry (ATSDR)
Web: http://www.atsdr.cdc.gov

The ATSDR publishes a variety of valuable chemical-specific documents. They have published or have under development more than 289 *Toxicological Profiles* for hazardous substances found at National Priorities List (NPL) sites. These are thorough technical manuals characterizing the toxicology of chemicals (available on CD-ROM from CRC Press: http://www.crcpress.com). ATSDR's *Fact Sheets on Hazardous Substances* are one-page summaries on hazardous substances condensed from the Profiles' Public Health Statement sections. ATSDR's *Case Studies in Environmental Medicine* are self-instructional educational materials designed to guide health professionals through the diagnosis, treatment, and surveillance of persons exposed to hazardous substances. Copies of some of these documents are available at no charge to qualified (determined by ATSDR) individuals by writing to ATSDR, 1600 Clifton Road, Atlanta, GA 30333. Many of these documents are also available for sale through the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 2161 (Phone: 800-553-6847 or 703-487-4650). ATSDR's *Toxicological Profiles* (with annual updates) are

available for sale from CRC Press as part of their CRC-netBase through a variety of CD-ROM products.

Baselt RC (1999)
Disposition of Toxic Drugs & Chemicals in Man, 5th edition
Foster City, CA: Chemical Toxicology Institute.

Contains information on the disposition of hundreds of chemicals and drugs implicated in human poisoning. The types of information include; normal tissue concentrations, concentrations of chemicals after toxic exposures, metabolic distribution of chemicals in human tissues and known metabolites.

Bretherick L (2006)
Handbook of Reactive Chemical Hazards, 7th edition
Burlington, MA: Academic Press.
Web: http://www.books.elsevier.com

Covers a large amount of information (2680 pages) on potential hazards in laboratories from chemical use and exposure. This is a two-volume set primarily focused on chemical reactivity of individual chemicals and chemical mixtures. It is intended for those conducting chemical synthesis and general research involving chemicals. The entries are listed in order of empirical formula and include an index and cross-reference of CAS numbers and chemical formulas. Toxicities that arise from the products of unanticipated side reactions are also described.

Chemie BG (1990–1999)
Toxicological Evaluations: Potential Health Hazards of Existing Chemicals
New York: Springer-Verlag.
Web: http://www.springer.com

English edition of the German BG Chemie toxicological assessments of widely used chemicals. These evaluations are based on documentation found in the scientific literature, on experimental studies commissioned by the BG Chemie, and on experience of the expert panel. Each evaluation includes a summary and assessment, physical properties, and results of toxicity testing. Volume 15 was published in 1999.

Cooper AR (ed.) (1996)
Cooper's Toxic Exposures Desk Reference
Boca Raton, FL: CRC Press.
Web: http://www.crcpress.com

Contains up-to-date summations of hundreds of the most hazardous substances used in industry and found in the workplace. The book and CD-ROM are arranged alphabetically and contain the physical properties and warnings, health hazards, exposure routes and effects, protective equipment, medical management, and workplace monitoring for commonly encountered chemicals.

Cooper AR (1998)
Properties of Hazardous Industrial Materials and Cooper's Chemical Dictionary and Spell Check Database
Boca Raton, FL: Lewis Press.
Web: http://www.crcpress.com

A CD-ROM listing of over 25 000 hazardous materials, including details on their health hazards, storage, and handling. It contains an electronic chemical dictionary and spell checker. The CD-ROM has over 10 000 terms that are cross referenced with chemical data.

Davis DJ, Davis JA (1996)
Hazardous Material Reference Book Cross Index
New York: Van Nostrand–Reinhold.
Web: http://www.wiley.com

Tool to help locate information in case of a hazardous material incident or accident. The book is an index and is streamlined by inclusion of chemical synonyms and also directs the user to the specific source of the detailed information.

Environmental Protection Agency, U. S. (EPA)
Web: http://www.epa.gov

The U.S. EPA publishes an extensive variety of paper and online documents on individual chemicals. Among these documents are the *IRIS Toxicological Reviews.* Recent chemicals covered in this series are acetonitrile, barium and compounds, bentazon, beryllium and compounds, chlordane, chromium (III) insoluble salts, chromium (VI), cumene, methyl methacrylate, methylene diphenyl diisocyanate, naphthalene, and tributyltin. For more information on EPA chemical compilations, visit their website at http://www.epa.gov.

European Chemical Industry Ecology & Toxicology Centre (ECETOC) (1983–)
ECETOC AISBL
Joint Assessment of Commodity Chemicals Series
Web: http://www.ecetoc.org
Brussels, Belgium: ECETOC.

Produced by the ECETOC program for preparing critical reviews of the toxicology and ecotoxicology of existing industrial commodity chemicals. Commodity chemicals (i.e., chemicals produced in large tonnage by several companies and having widespread and multiple uses) are jointly reviewed by an expert panel. Summary data and conclusions of the expert panel are included. The reports go back to 1983, below are some recent reports:

JACC No. 42, Tetrafluoroethylene, 12/03
JACC No. 42a, Corrigenda to JACC No. 42 Tetrafluoroethylene
JACC No. 43, Sec-Butanol, 3/04

JACC No. 44, 1,1,1,3,3-pentafluoropropane, 6/04
JACC No. 45, 1,1-difluoroethane, 10/04
JACC No. 46, 1-chloro-1,2,2,2-tetrafluoroethane, 11/04
JACC No. 47, 1,1-Dichloro-2,2,2-trifluoroethane, 7/05
JACC No. 48, Hexafluoropropylene, 10/05
JACC No. 48a, Corrigenda to JACC No. 48, Hexafluoropropylene
JACC No. 49, Vinylidene Flouride, 11/05
JACC No. 50, 1,1,1,2-Tetrafluoroethane
JACC No. 51, Synthetic Amorphous Silica, 9/06
JACC No. 52, Trifluoroethane, 10/06

Gangolli S (ed.) (1999)
The Dictionary of Substances and Their Effects (DOSE), 3rd edition (2005)
Cambridge, UK: Royal Society of Chemistry.
Web: http://www.rsc.org.

A major compilation of data on chemicals with environmental impact, providing a unique combination of all the data required for the assessment of risks associated with the use of those chemicals. Includes new data from toxicity and ecotoxocity studies; results of recent carcinogenicity, mutagenicity, and environmental fate studies; occupational exposure data for France, Germany, Sweden, and Japan, as well as the UK and USA; new risk and safety phrases; and recent relevant legislation. In seven volumes.

Howard PH, Meylan WM (eds.) (1997)
Handbook of Physical Properties of Organic Chemicals
Boca Raton, FL: Lewis.
Web: http://www.crcpress.com

Contains data of physical and chemical properties on approximately 13 000 organic chemicals. Data include chemical structure, formula, molecular weight, melting/freezing point, boiling point, water solubility, octanol water partition coefficient, vapor pressure, acid dissociation constant, Henry's law constant, and atmospheric hydroxyl radical reaction rate constant.

Lewis Richard J Sr. (2000)
Rapid Guide to Hazardous Chemicals in the Workplace
New York: Wiley.
Web: http://www.wiley.com

Covers chemicals commonly encountered in the workplace. Details ACGIH and OSHA guidelines for exposure. Lists TLVs, TWAs, and PELs for 750 chemicals.

Lewis Sr., RJ (2002)
Hazardous Chemicals Desk Reference, 5th edition
New York: Wiley.
Web: http://www.wiley.com

Offers access to over 6000 compounds commonly used in industry, manufacturing, laboratories, and the workplace. Provides new or updated profiles for each chemical, assessing their hazard potential as poisons, irritants, corrosives, explosives, and carcinogens.

Lewis RJ (2004)
Sax's Dangerous Properties of Industrial Materials, 11th edition
New York: Van Nostrand–Reinhold.Web: http://www.wiley.com

Continues to promote safety by providing up-to-date hazard information on a chemical-by-chemical basis. Over 20 000 materials are included in alphabetical order. The information is cross-referenced and complete bibliographic citations are included for further reading. A 1998 CD-ROM version is also available.

Lewis RJ Sr., Lewis RJ (2007)
Hawley's Condensed Chemical Dictionary with CD-ROM
New York: Wiley-Interscience.
Web: http://www.wiley.com

Dictionary of industrial chemicals containing information on toxicity, reactivity, reactions, terminology, and flammability data. The listings are arranged by chemical name and the chemical information includes; physical properties, source of occurrence, CAS number, potential hazards, chemical formula, and synonyms. This edition has a companion CD-ROM.

Lide DR (ed.) (2006)
CRC Handbook of Chemistry and Physics, 87th edition
Boca Raton, FL: CRC Press.
Web: http://www.crcpress.com

Perhaps the world's most widely used scientific reference, the handbook contains all the most frequently used data in science. Everything from aqueous solubility of organic compounds to flash point data of common substances. Now available in CD-ROM as part of CRCnetBase.

Mackay Donald 1999 edition (2000)
Environmental Fate and Degradation Handbook
Boca Raton, FL: CRC Press.
Web: http://www.crcpress.com

Part of CRC's CRCnetBase, an electronic product available either via a CD-ROM subscription product with annual updates, as a site license program, or as a CD-ROM stand-alone product. Brings together physical-chemical data for similarly structured groups of chemical substances. Synthesizes and continues the *Illustrated Handbook of Physical–Chemical Properties of Environmental Fate for Organic Chemicals.*

Mackay D, Shiu WY, Ma KC (1992–1998)
Illustrated Handbook of Physical–Chemical Properties of Environmental Fate for Organic Chemicals

Boca Raton, FL: CRC Press.
Web: http://www.crcpress.com

Volume I – Monoaromatic Hydrocarbons, Chlorobenzenes, and PCBs, Volume II – Polynuclear Aromatic Hydrocarbons, Polychlorinated Dioxins, and Dibenzofurans, Volume III – Volatile Organic Chemicals, Volume IV – Oxygen, Nitrogen, and Sulfur-Containing Compounds, Volume V – Pesticides. There is a non-illustrated version of this book and a CD-ROM version published by CRC Press in 2006.

Milne GWA (ed.) (1999)
Gardner's Chemical Synonyms and Trade Names, 11th edition
Hoboken, New Jersey: Wiley.
Web: http://www.wiley.com

Includes industrial chemicals, polymers, plastics, resins, elastomers, plastic, resin, elastomer additives, coating and paints, adhesives, inks, pigments, dyes, textiles, surfactants, fillers and fibers, pharmaceuticals, agricultural chemicals, food additives, and cosmetic additives.

Montgomery JH (2007)
Groundwater Chemicals Desk Reference, 4th edition
Boca Raton, FL: CRC Press.
Web: http://www.crcpress.com

The 4th edition of this volume is updated with more than 1700 added references. There is a wealth of toxicity data for over 1100 compounds, degradation products cross-referenced to parent compounds, and physical and chemical properties and constants in over 1700 pages of indexed data.

National Research Council (2006)
Human Biomonitoring of Environmental Chemicals
Washington, DC: National Academy Press.
Web: http://www.nap.edu

This volume contains information on biomonitoring and exposure assessment of toxic chemicals in the environment.

National Toxicology Program (NTP)
1996 North American Emergency Response Guidebook
U.S. Department of Transportation, Washington, DC

Developed jointly by the U.S. Department of Transportation, Transport Canada, and the Secretariat of Communications and Transportation of Mexico for use by firefighters, police, and other emergency services personnel who may be the first to arrive at the scene of a transportation incident involving a hazardous material. It may be purchased from the U.S. Government Printing Office, Superintendent of Documents, Stop: SSMB, Washington, DC 20402 (Fax: 301-489-8995). A new version is planned for publication in the year 2000.

National Toxicology Program (NTP), Division of Toxicology Research and Testing
Management Status Report
Research Triangle Park, NC: NTP.

A periodical publication that provides the status of chemicals studied by the NTP. For copies, contact the Central Data Management, Mail Drop E1-02, NIEHS, P.O. Box 12233, Research Triangle Park, NC 27709 (Phone: 919-541-3419; Fax: 919-541-3687; e-mail: CDM @NIEHS.NIH.GOV). Also available through the NTP web site (http://ntp-server.niehs.nih.gov)

National Toxicology Program (NTP), Division of Toxicology Research and Testing
Report on Carcinogens 11th edition
Research Triangle Park, NC: NTP.

A listing of chemicals that are either known carcinogens or suspected to be carcinogenic based on their chemical profiles. This list is limited to chemicals to which a significant number of people living within United States might be exposed.

O'Neil MJ (ed.) (2006)
The Merck Index, 14th edition
New York: John Wiley and Sons.
Web: http://www.wiley.com

The Merck Index, published continuously since 1899, is the definitive encyclopedic reference for chemicals, drugs, and biologicals. Some of the types of compounds included are drugs used in the pharmaceutical industry, organic chemicals, dyes, pesticides, natural products, and veterinary drugs. A companion CD-ROM is included with this edition.

Patnaik P (2007)
A Comprehensive Guide to the Hazardous Properties of Chemical Substances, 3rd edition
New York: Wiley-Interscience.
Web: http://www.wiley.com

Compendium of hazardous drugs and chemicals (over 1500 chemical structures) that correlates chemical structure to toxicity, making it a valuable resource for both the pharmaceutical and chemical industries. This volume includes chapters on metals, alkaloids, alcohols, particulates, and nerve agents.

Pohanish RP (1997)
Rapid Guide to Hazardous Chemicals in the Environment
New York: Wiley.Web: http://www.wiley.com

Collects in one place detailed guidance on regulations, standards, and other pertinent information on chemicals of environmental concern. Approximately 1500

chemicals are covered and the applicable regulations are identified and cross-referenced for ease of use. A CD-ROM version is available.

Pohanish RP (ed.) (2002)
Handbook of Toxic and Hazardous Chemicals and Carcinogens, 4th edition
Park Ridge, NJ: Noyes.
Web: http://www.knovel.com

Presents concise chemical, health, and safety information on approximately 1500 toxic and hazardous chemicals in the pharmaceutical, energy, plastics, cleaning, and agricultural industries. Data are furnished on exposure, permissible limits in air, permissible concentrations in water, routes of entry, harmful effects and symptoms, first air, personal protective methods, storage, shipping, etc. This edition contains an expanded chemical synonym and tradename index and an extensive synonym listing that is cross-referenced to the generic name of the chemical.

Pohanish RP, Green SA (2003)
Wiley Guide to Chemical Incompatibilities, 2nd edition
New York: Wiley.
Web: http://www.wiley.com

This is a unique resource that provides data on the incompatibility of thousands of commonly used chemical compounds. The second edition of this volume contains data on over 11 000 chemical compounds listed in alphabetical order (with CAS numbers). There is a glossary of general chemical terminology located at the end of the book.

Prager JC (1997)
Environmental Contaminant Reference Databook
New York: Wiley.
Web: http://www.wiley.com

In three volumes, identifies regulated chemicals and chemicals of special interest to environmental professionals. Provides information such as CAS number, sampling, analysis, detection limits, manufacturers, odor thresholds, firefighting procedures, and remediation methods. It is available in hardback (1997), paperback (1998), and a CD-ROM version (1998).

Prager JC (1997)
Pohanish RP, Green SA (1997)
Hazardous Materials Handbook
New York: Van Nostrand-Reinhold.Web: http://www.wiley.com

Covers more than 1240 substances and presents technical data as well as chemical properties for widely used and transported industrial materials. This easy-to-use text also includes a CAS and synonym section. A CD version is available from Wiley.

Proctor NH, Hathaway GJ (2004)
Proctor and Hughes' Chemical Hazards of the Workplace, 5th edition
New York: Van Nostrand–Reinhold.
Web: http://www.wiley.com

Information on over 625 individual compounds, arranged alphabetically. For each chemical there is a monograph and a chemical profile that includes the chemical formula, CAS No., TLV, synonyms, physical properties, exposure sources and routes, information on dose–responses, target organs, and signs and symptoms of exposure (acute and chronic). References are included.

Review Office
NTP Technical Report Series
Web: http://www.ntp.niehs.nih.gov
Research Triangle Park, NC: NTP.

Studies of chemicals designed and conducted to characterize and evaluate the toxicologic potential, mainly carcinogenic activity, of selected chemicals in laboratory animals (primarily rodents). Chemicals selected for NTP toxicology and carcinogenesis studies are chosen primarily on the bases of human exposure, level of production, and chemical structure. The interpretive conclusions presented in the reports are based only on the results of the NTP studies. The NTP studies are not limited to carcinogenicity studies. They also conduct long-term and short-term toxicity studies, chemical disposition and toxicokinetic studies, genetically modified model studies, immunological studies, and developmental and reproductive toxicity studies. The NTP also investigates the use of alternative models in toxicity research such as the use of non-mammalian species, in vitro methods, and in silico models for predictive toxicology. The abstracts and other study information for 13-week and 2-year studies are available at the NTP's World Wide Web site: http://ntp.niehs.nih.gov.

Ryan R, Terry CE (eds.) (1999–2000)
Toxicology Desk Reference: The Toxic Exposure and Medical Monitoring Index, 5th edition
New York: Taylor & Francis.
Web: http://www.tandf.co.uk

In three volumes, with an extensive cross-reference index. Intended to provide a comprehensive source of medical, legal, and technical information concerning human exposure to metals and chemicals and to be a first resource for professionals involved in medical

monitoring, industrial hygiene, environmental control, and toxic tort litigation. Information provided on the listed chemicals includes air monitoring reference ranges, kinetics, clinical effects, critical sites of toxicity, biological monitoring tests, laboratory tests and interpretation, federal and state requirements, and case reports. Available on CD-ROM (2000) loose leaf (1997) and paperback (1997).

Urben P (ed.) (2006)
Bretherick's Handbook of Reactive Chemical Hazards, Two Volume Set, 7th edition
Burlington, MA: Academic Press.
Web: http://www.academicpress.com

This two-volume edition contains information concerning all reported risks that result from chemical reactions. The potential risks covered include fire, explosions, and toxic exposures. The book covers the reactivity risk of chemicals and chemical combinations and is widely used in laboratory safety protocols.

Verschueren K (2001)
Handbook of Environmental Data on Organic Chemicals, 4th edition
New York: Wiley-Interscience.
Web: http://www.wiley.com

Contains over 2000 pages of in-depth information on organic chemicals and chemical mixtures. This edition is updated to include the latest research on chemical mixtures and new organic compounds. Coverage includes control measures to reduce the impact of dangerous organic compounds on the ecosystem. Each substance (alphabetically) is categorized by physical and chemical properties, air pollution factors, water and soil pollution factors, and biological effects. There is also information on proposed biodegradation pathways, aquatic toxicity data, odor thresholds, sampling and analysis information, and structural formulas. Also issued in paperback (1996) and as a CD-ROM (2001).

World Health Organization (WHO) (1976–)
Poison Information Monographs (PIM)
Geneva, Switzerland: WHO.

The PIMs (over 300 published) contain information on poisonous chemicals, pharmaceuticals, plants, and animals. Each monograph contains details on the compound that includes synonyms, CAS number, physico-chemical properties, uses, toxicology and ADME information (absorption, distribution, metabolism, and elimination).

World Health Organization (WHO) (1976–2006)
Environmental Health Criteria
Geneva, Switzerland: WHO.
Avenue Appia 20
Ch-1211 Geneva 27
Switzerland
Web: http://www.who.int

A distinguished series of over 230 monographs intended to provide critical reviews on the effects on human health and the environment and of chemicals and physical and biological agents. It is published under the joint sponsorship of the United Nations Environment Programme, the International Labour Organisation, and the World Health Organization. Monographs were recently completed on human exposure assessment, zinc, vinyl chloride, flame retardants, dinitro-ortho-cresol, biomarkers in risk assessment, and betonite. Available from WHO Distribution and Sales, WHO Headquarters, CH-1211 Geneva 27, Switzerland (email: bookorders@who.ch). Also note that these criteria documents, the chemical assessment documents below, and many others produced by WHO's International Programme on Chemical Safety and available on the 'IPCS INCHEM' CD-ROM (for a subscription fee) and for free on the web (http://www.inchem.org.).

World Health Organization (WHO) (2006)
Concise International Chemical Assessment Documents (CICAD)
Geneva, Switzerland: WHO.

Begun in 1998 and produced within the framework of the Inter-Organization Programme for the Sound Management of Chemicals. CICADs are concise documents providing summaries of relevant scientific information concerning the potential effects of chemicals on human health and the environment. They are based on selected national or regional evaluation documents or existing WHO *Environmental Health Criteria* documents. Their primary objective is to characterize hazard and dose–response from exposure to a chemical. The most recent CICADs published were on heptachlor, tribromophenol, tin, butoxyethanol, and cobalt.

CHAPTER

13

Chemicals: Cosmetics and Other Consumer Products

PERTTI J. HAKKINEN

INTRODUCTION

People can use many consumer products during a typical day, starting from the moment they wake up in the morning, e.g., brush teeth, use soap and shampoo during a shower, etc. Over the rest of a day, people could use (or be exposed to other people using) products such as air fresheners, ammonia, antifreeze, antiperspirants and deodorants, bleach, cosmetics, detergents, disinfectants, drain cleaners, glues, insecticides and pesticides, oven cleaners, paints, and toys. Some products can contain several hundred chemicals, many of which (e.g., fragrance and flavor ingredients) might not be listed individually on product labels.

RESOURCES

Books

Baker S, Driver J, McCallum D (eds) (2001)
Residential Exposure Assessment
A Sourcebook. Kluwer Academic/Plenum Publishers.

This book is a compendium of information about predictive methods and tools, monitoring methods, data sources, and key variables that characterize exposure in and around all types of residences. Includes chapters on a general framework for assessing residential exposures to chemical, biological, and physical agents, chapters about the assessment of dermal, inhalation, and oral exposures in and around residences, a chapter on assessment of consumer products and related sources, and chapters about data (e.g., exposure factors) and other information sources (e.g., software to model exposures).

Gosselin RE, Smith RP, Hodge HC, Braddock J (eds.) (1984)
Clinical Toxicology of Commercial Products, 5th edition
Williams & Wilkins.

Although the content is now over 20 years old, it still provides very useful information on the types of chemicals that many types of consumer products can contain, and information about the safety of those chemicals.

Wexler P, et al (eds.) (2005)
Encyclopedia of Toxicology, 2nd edition
Academic Press, Elsevier.

Includes several chemicals in consumer product-related topics: Bleach by J. Weber, Consumer Products by N. Linde, Cosmetics and Personal Care Products by P. Sterchele, Deodorants and Antiperspirants by Z. Cai and P. J. Hakkinen, Detergents by Z. Cai and P. J. Hakkinen, Fragrances and Perfumes by A. M. Api and P. J. Hakkinen, and Safety Testing, Clinical Studies by A. Pagnoni.

Review Articles

Bickers DR, Calow P, Greim HA, et al (2003) The safety assessment of fragrance materials. Regul. Toxicol. Pharmacol. 37(2): 218–273.

Cosmetic Ingredient Review (CIR) Expert Panel. Safety Assessment of Cosmetic Ingredients. Published in the Journal of the American College of Toxicology and elsewhere, these reports present the results of expert panel reviews of toxicology and exposure data for hundreds of cosmetic ingredients. www.cir-safety.org/

Denmark, Environmental Protection Agency. Chemicals in consumer products 'Surveys'. The Danish EPA has developed exposure and risk assessments for substances in many consumer products. http://glwww.mst.dk/homepage/. One example is: Survey of Chemical Substances in Consumer Products, No. 86 (2007). Survey and risk assessment of chemical substances in deodorants. http://www2.mst.dk/common/Udgivramme/Frame.asp?pg=http://www2.mst.dk/Udgiv/publications/2007/978-87-7052-625-8/html/default_eng.htm.

Hakkinen PJ, Kelling CK, Callender JC (1991) Exposure assessment of consumer products: human body weights and total body surface areas to use, and sources of data for specific products. Vet. Hum. Toxicol. 33(1): 61–65.

The Netherlands, National Institute for Public Health and the Environment (RIVM). Product Factsheets. Searchable via: http://demo.openrepository.com/rivm/. One example is: Prud'homme de Lodder LCH, Bremmer HJ, van Engelen JGM (2006) Cleaning products fact sheet. To assess the risks for the consumer. RIVM Report 320104003. www.rivm.nl/bibliotheek/rapporten/320104003.html

Journals

Environmental Science & Technology

Food and Chemical Toxicology

Journal of Exposure Science and Environmental Epidemiology

Regulatory Toxicology and Pharmacology

Risk Analysis

Toxicological Sciences

Toxicology

Toxicology Letters

Newsletters

Product Safety Newsletter
This is an independent weekly newsletter for executives concerned with consumer product safety regulations, legislation, and standards. The first focus of the newsletter is the U.S. Consumer Product Safety Commission, but it also covers the regulation of certain consumer products by other government agencies, and the injury prevention activities of government organizations and others. It also provides readers with information about U.S. state and international activities, including injury prevention, and the development of standards and testing methods. A limited version of the content is available for free by email five day a week. http://www.productsafetyletter.com/profile/.

General Interest Works

1001 Chemicals in Everyday Products, 2nd edition
Rose Lewis G
Wiley-Interscience, 1998

A Consumer's Dictionary of Cosmetic Ingredients: Complete Information About the Harmful and Desirable Ingredients Found in Cosmetics and Cosmeceuticals
Winter R
Three Rivers Press, 2005

Skin Care and Cosmetic Ingredients Dictionary (Milady's Skin Care and Cosmetics Ingredients Dictionary), 2nd edition
Michalun N, Michalun V
Milady, 2000

Databases

Environmental Working Group (EWG)
Skin Deep Cosmetic Safety Database
This database provides the ingredients in nearly 25 000 cosmetic and personal care products, and links them to information in toxicity and regulatory databases. www.cosmeticsdatabase.com.

GREENGUARD Environmental Institute (GEI)
GEI is an industry-independent, non-profit organization that oversees the GREENGUARD Certification Program. As an ANSI Authorized Standards Developer, GEI establishes acceptable indoor air standards for indoor products, environments, and buildings. GEI's mission is to improve public health and quality of life through programs that improve indoor air. www.greenguard.org.

Human and Environmental Risk Assessment (HERA) Project
HERA included European producers of household cleaning products and their ingredients, and their website provides access to risk assessment documents with information about the safety and exposures

associated with various types of ingredients used in household cleaning products. http://www.heraproject.com

Project on Emerging Nanotechnologies
Established in 2005 as a partnership between the Woodrow Wilson International Center for Scholars and the Pew Charitable Trusts. The Inventory of Nanotechnology Consumer Products provides a look at the several hundred nanotechnology-based consumer products currently on the U.S. market. www.nanotechproject.org/44

(U.S.) National Institutes of Health, National Library of Medicine
The 'Household Products Database' contains formula information for several thousand U.S. consumer products, together with access to their Material Safety Data Sheets (MSDSs) provided by the manufacturers. http://hpd.nlm.nih.gov.

(U.S.) National Institutes of Health, National Library of Medicine
'ToxMystery' introduces students and others online to potential everyday environmental health hazards as they move from room-to-room in a house. http://toxmystery.nlm.nih.gov/.

(U.S.) National Institutes of Health, National Library of Medicine
'ToxTown' contains information on chemicals and environmental health risks that might be encountered in everyday life, in everyday places. The neighborhoods that are currently included cover suburban, urban, rural, the U.S. and Mexico border areas, and coastal health risks, and selecting a neighborhood will provide information on chemical and environmental concerns for that type of location. This includes the types of chemicals that might be found in a location. http://toxtown.nlm.nih.gov.

(US) Soap and Detergent Association
This website provides information about the history, chemistry, ingredients, and safety of soap and detergent products. http://www.cleaning101.com.

Organizations

European Commission, Health and Consumer Protection Directorate General
Web: http://ec.europa.eu/consumers/index_en.htm

International Consumer Product Health and Safety Organization (ICPHSO)
Web: http://www.icphso.org/

(U.S.) Consumer Product Safety Commission (CPSC)
Web: www.cpsc.gov/

(U.S.) Personal Care Products Council (PCPC, formerly the Cosmetic, Toiletry, and Fragrance Association, CTFA)
Web: www.personalcarecouncil.org

(U.S.) Soap and Detergent Association (SDA)
Web: www.cleaning101

CHAPTER

14

Drugs

TODD STEDEFORD AND CHING-HUNG HSU

INTRODUCTION

The use of therapeutic agents as a means of preventing or attenuating organ system deficits and/or dysfunction is a global, multibillion-dollar business. Beyond prescription drugs (i.e., those requiring the assistance of a healthcare practitioner for appropriate selection, 'safe' use, and monitoring), a vast market for over-the-counter (OTC) products and dietary supplements exists. However, as with any useful product having biologic, pharmacologic, or physiologic activity, whether it is a prescription drug or a dietary supplement, adverse effects are a potential risk.

With the advent of the internet, the form and speed with which individuals communicate drug discovery findings or adverse event reporting for post-marketed products have resulted in greater access to key documents, such as the Physicians Desk Reference (PDR), via electronic sources, as well as online journals, databases, and books.

This chapter provides resources on prescription drugs, OTC products, and dietary supplements. A selection of books and journal articles is provided, along with a listing of international organizations devoted to the research and regulation of such products. In addition, an assortment of open access and fee-for-service databases, which provide full-text information on drugs, over-the-counter medications, and supplements, has been compiled.

RESOURCES

Books

Baselt RC (2004)
Disposition of Toxic Drugs and Chemicals, 7th edition
Foster City, CA: Biomedical Publications.
Web: http://www.biomedicalpublications.com/dt7.htm

Presents the current essential information on the disposition of the chemicals and drugs frequently encountered in human poisoning episodes; includes body fluid concentrations of substances in normal or therapeutic situations, concentrations in fluids and tissues in instances of toxicity and the metabolic fate of these substances in man.

Cupp MJ (2000)
Toxicology and Clinical Pharmacology of Herbal Products, 1st edition
Totowa, NJ: Humana Press.
Web: http://www.humanapress.com

Describes detailed pharmacology and toxicology of widely used herbal medicines, including clinical and pathological findings from clinical trials and case reports of adverse effects, pharmacokinetics, methods of chemical and biofluids analysis, and the known pharmacologic and toxicologic effects arranged by organ, organ system, or therapeutic/toxicologic effect.

Gad SC (2002)
Drug Safety Evaluation, 1st edition
New York: Wiley-Interscience.
Web: http://www.wiley.com/WileyCDA/WileyTitle/productCd-0471407275.html

Covers a wide variety of topics, specifically relevant to the pharmaceutical and biotechnology industries, including: acute toxicity testing in pharmaceutical safety evaluation, genotoxicity, safety assessment of inhalant drugs, immunotoxicology in pharmaceutical development, large animal studies, and evaluation of human tolerance and safety in clinical trials.

Gad SC, Brock WJ (2007)
Safety Evaluation: International Regulations for Drug and Medical Device Approval
United Kingdom: Taylor & Francis CRC Press.

Web: http://crcpress.co.uk/

Analyzes international drug laws and regulations that pertain to safety and prescribes how safety procedures can be implemented. This text describes the development process for products in various markets, outlining those aspects of drug and device regulation related to evaluating safety. Reviews the major regulatory bodies responsible for approval of new products, particularly in the United States, European Union, and Japan, and provides a clear understanding of the regulation requirements.

Kahn CM, Line S (2005)
The Merck Veterinary Manual, 9th edition
Hoboken, NJ: John Wiley & Sons.
Web: http://www.wiley.com/WileyCDA/WileyTitle/productCd-0911910506.html

A comprehensive and reliable source of information on all aspects of animal healthcare, includes information on new and emerging animal diseases, emergency and critical care, exotic and laboratory animals, animal-to-human disease transmission, etc.

Krinsky DL, LaValle J, Hawkins E, Pelton R, Ashbrook-Willis N (2003)
Natural Therapeutics Pocket Guide, 2nd edition
Hudson, OH: Lexi-Comp, Inc.
Web: http://www.lexi.com/web/index.jsp

Provides condition-specific information on the use of herbs, nutritional supplements, nutraceuticals, homeopathy, and lifestyle modification. Over 175 natural products are covered in addition to information on the natural treatment to 75 medical conditions and patient advisory leaflets on top 100 natural products.

Lacy CF, Armstrong LL, Goldman P, Lance LL (2006)
Drug Information Handbook, 14th edition
Hudson, OH: Lexi-Comp, Inc.
Web: http://www.lexi.com/web/index.jsp

Contains 1380 monographs, each of which includes up to 33 fields of information, with details on dosage by age group, indication, and route of administration, drug interactions by enzyme system and effect, and adverse reactions by affected organ system and incidence. Also included are labeled and unlabeled/investigational uses, pharmacodynamics/kinetics data, dosing adjustments for organ dysfunction, and other key content.

Brunton L Lazo, Parker K (eds.) (2005)
Goodman & Gilman's The Pharmacological Basis of Therapeutics
New York: McGraw-Hill Medical Publishing Division.
Web: http://www.mhprofessional.com/product.php?isbn=0071468048

Available as a hardcover or in digital format, this book provides detailed information on pharmacological and toxicological effects.

McKenna DJ (2002)
Botanical Medicines: The Desk Reference for Major Herbal Supplements, 2nd edition
Binghamton, NY: Haworth Press.
Web: http://haworthpress.com/store/product.asp?sku=4527

Covers pharmacological studies on the main medicinal plants used in clinical practice and sold in pharmacies in the Western world; provides information such as botanical data (classification and nomenclature, common names, geographic occurrence, and botanical characteristics), history and traditional uses, chemistry, therapeutic applications, pre-clinical studies, clinical studies, recommended dosages, safety profiles (including toxicology), side effects and contraindications, drug interactions and special precautions, and safety recommendations during pregnancy and lactation.

Milne GWA (2002)
Veterinary Drugs: Synonyms & Properties
Hoboken, NJ: John Wiley & Sons.
Web: http://www.wiley.com/

Provides over 700 unique veterinary agents, their chemical structures, and exhaustive listings of product tradenames and manufacturers. Organizes drugs by therapeutic category, with each main entry including the following information: the commonly adopted chemical name, three internationally used identifiers of the compound (CAS, EINECS, and Merck), physical properties and acute toxicity, along with its known biological activity and FDA-labeled applications.

Rossoff IS (2001)
Encyclopedia of Clinical Toxicology: A Comprehensive Guide to the Toxicology of Prescription and OTC Drugs, Chemicals, Herbals, Plants, Fungi, Marine Life, Reptiles and Insect Venoms, Food Ingredients, Clothing and Environmental Toxins
United Kingdom: Taylor & Francis, CRC Press.
Web: http://www.crcpress.co.uk/

Describes adverse effects and interactions that may not be reported by manufacturers and may not be published in physician desk references and the other standard compendia; provides information about the effects, interactions, and lethal doses of thousands of toxic substances that can destroy health, seriously endanger health, or cause death.

Woolf TF (1999)
Handbook of Drug Metabolism, 1st edition
United Kingdom: Taylor & Francis, CRC Press.
Web: http://www.crcpress.co.uk/

Describes xenobiotic oxidation reactions, exhibits lung metabolism, cytochrome P450 regulation, and molecular and biochemical aspects of enzyme inhibition, explores metabolic-based drug interactions, surveys intersubject variabilities in drug response, examines practical applications of in vitro methodologies for studying toxicities, and discusses expressed human drug-metabolizing enzymes.

Approved Drug Products with Therapeutic Equivalence Evaluations (the 'Orange Book'), 27th edition (2007)
United States: U.S. Food and Drug Administration
Web: http://www.fda.gov/cder/orange/obannual.pdf

A text compiled by the U.S. Food and Drug Administration's Center for Drug Evaluation and Research that provides a list of products that have been approved under Section 505 of the Federal Food, Drug, and Cosmetic Act. A companion document titled the 'Cumulative Supplement' is published monthly and provides updated information on newly approved drugs, changes and revisions to current data including therapeutic equivalence evaluations, and updated patent and exclusivity data, http://www.fda.gov/cder/orange/default.htm.

PDR for Nonprescription Drugs, Dietary Supplements, and Herbs, 2nd edition (2006)
United States: Thomson Healthcare.
Web: https://estore.thomsonlearning.com/tl1/en/ US/storefront/pdr

An essential guide to over-the-counter medications, dietary supplements, and herbs. This book provides complete descriptions of the most commonly used over-the-counter medications, including information such as: ingredients, indications, and interactions of hundreds of over-the-counter drugs; administration and dosage recommended for symptomatic relief; color photographs of over-the-counter drugs for quick identification; and organization by therapeutic categories for fast access.

Physicians' Desk Reference, 61st edition (2007)
United States: Thomson Healthcare
Web: https://estore.thomsonlearning.com/tl1/en/US/storefront/pdr

Provides complete data on more than 4000 drugs by name (brand and generic), manufacturer, product category, usage information, warnings, and drug interactions, plus more than 2000 full-size, full-color photos cross-referenced to the drug.

Red Book: Pharmacy's Fundamental Reference, 111th edition (2007)
United States: Thomson Healthcare.
Web: https://estore.thomsonlearning.com/tl1/en/US/storefront/pdr

A reliable source for accurate product information and prices on prescription drugs, over-the-counter items and reimbursable medical supplies. Includes valuable clinical and pharmaceutical reference information on over 100 000 prescription and over-the-counter items but also includes the broad spectrum of healthcare information.

Wiley Handbook of Current and Emerging Drug Therapies, Volumes 1–4 (2006)
Hoboken, NJ: John Wiley & Sons, Inc.
Web: http://www.wiley.com/WileyCDA/WileyTitle/productCd-047004098X.html

Provides a general overview of the etiology and pathophysiology of important disease indications within every major therapeutic area. Includes a comprehensive analysis of currently approved drugs for targeting specific diseases, and information on mechanism of action, efficacy, side effects, and future prospects.

Wiley Handbook of Current and Emerging Drug Therapies, Volumes 5–8 (2007)
Hoboken, NJ: John Wiley & Sons, Inc.
Web: http://www.wiley.com/WileyCDA/WileyTitle/productCd-0470040998.html

Provides a general overview of the etiology and pathophysiology of important disease indications within every major therapeutic area. This book includes a comprehensive analysis of currently approved drugs for targeting specific diseases, and information on mechanism of action, efficacy, side effects, and future prospects.

Journals

American Journal of Therapeutics (AJT) (1994–)
United States: Lippincott Williams & Wilkins.
Web: http://www.americantherapeutics.com

Includes articles relating to the latest therapeutic approaches and drug approval process, as well as therapeutic reviews covering pharmacokinetics, regulatory affairs, pediatric clinical pharmacology, hypertension, metabolism, and drug delivery systems.

Annual Review of Pharmacology and Toxicology (1961–)
United States: Annual Reviews.
Web: http://arjournals.annualreviews.org/loi/pharmtox

Filters and synthesizes primary research to identify the principal contributions in the fields of pharmacology and toxicology.

Anti-Cancer Drugs (1990–)
United Kingdom: Lippincott Williams & Wilkins.
Web: http://www.anti-cancerdrugs.com/

A journal devoted to publication of innovative investigations on therapeutic agents against cancer, and aims to stimulate and report research on both toxic and non-toxic anticancer agents. The scope on the journal covers both conventional cytotoxic chemotherapy and hormonal or biological response modalities.

Biopharmaceutics & Drug Disposition (1979–)
United States: John Wiley & Sons, Inc.
Web: http://www3.interscience.wiley.com/

Publishes original reports and review articles of studies in biopharmaceutics, drug disposition, pharmacokinetics and pharmacodynamics, especially those which have a direct relation to the therapeutic use of drugs.

Clinical Drug Investigation (1995–)
New Zealand: Adis International.
Web: http://www.ingentaconnect.com/content/adis/cdi

Provides coverage on clinical trials, outcomes research, clinical pharmacoeconomic studies, pharmacoepidemiology studies, and clinical pharmacodynamic and pharmacokinetic studies.

Current Drug Metabolism (2000–)
United States: Bentham Science Publishers, Ltd.
Web: http://www.bentham.org/cdm/index.htm

Covers the latest and outstanding developments in drug metabolism and disposition and serves as an international forum for the publication of timely reviews in drug metabolism.

Drug and Chemical Toxicology (1977–)
United Kingdom: Taylor & Francis.
Web: http://www.tandf.co.uk/journals/journal.asp?issn=0148-0545&linktype=1

Includes articles relating to a broad spectrum of toxicological data relevant to risk assessment and harmful effects due to exposure, e.g., descriptive and mechanistic research that illustrates the risk assessment and harmful effects due to exposure. New findings and methods, along with safety evaluations are also included.

Drug Metabolism and Drug Interactions (1988–)
Israel: Freund Publishing House, Ltd.
Web: http://www.freundpublishing.com/index.html

Devoted to the mechanisms by which drugs and other foreign compounds are metabolized, the mechanisms by which drugs may interact with each other as well as with biological systems, and the pharmacological and toxicological consequences of such metabolism and interactions.

Drug Metabolism Reviews (1972–)
United Kingdom: Taylor & Francis.
Web: http://www.tandf.co.uk/journals/titles/03602532.asp

Provides critically needed reviews of drug metabolism research covering established, new, and potential drugs; environmentally toxic chemicals; absorption; metabolism and excretion; and enzymology of all living species.

Drug Safety (1990–)
New Zealand: Adis International.
Web: http://www.ingentaconnect.com/content/adis/dsf

Provides coverage on the disciplines of pharmacovigilance, pharmacoepidemiology, benefit–risk assessment and risk management.

Drugs of the Future (1976–)
Spain: J.R Prous S.A Publishers.
Web: http://journals.prous.com/journals/servlet/xmlxsl/

Publishes comprehensive drug monographs containing product information on new compounds in development, including synthesis, pharmacological action, pharmacokinetics and metabolism, toxicology and clinical studies.

European Journal of Pharmaceutical Sciences (1993–)
Sweden: European Federation for Pharmaceutical Sciences (EUFEPS).
Web: http://www.elsevier.com/

Publishes reports in medicinal chemistry, pharmacology, drug absorption and metabolism, pharmacokinetics and pharmacodynamics, pharmaceutical and biomedical analysis, drug delivery including gene delivery, drug targeting, pharmaceutical technology, pharmaceutical biotechnology, and clinical drug evaluation.

Expert Opinion on Drug Metabolism & Toxicology (2005–)
United Kingdom: Informa Healthcare.
Web: http://www.expertopin.com/loi/emt

Provides a forum for the commentary and analysis of current and emerging research approaches on the absorption, distribution, metabolism, and excretion arena, as well as metabolic, pharmacokinetic, and toxicological issues relating to specific drugs or drug classes.

Expert Opinion on Drug Safety (2002–)
United Kingdom: Informa Healthcare.
Web: http://www.expertopin.com/loi/eds

Each issue covers articles focused on the following key issues: occurrence, management, and prevention of drug-associated adverse events; risk–benefit analyses of individual drugs and drug classes; safety in 'at-risk' patient populations; comparative tolerability studies; and pharmacovigilance and pharmacoepidemiological studies.

Journal of Pharmacology and Experimental Therapeutics (JPET) (1909–)
United States: American Society for Pharmacology and Experimental Therapeutics.
Web: http://jpet.aspetjournals.org/

Covers aspects of the interactions of chemicals with biological systems, including autonomic, behavioral, cardiovascular, cellular, clinical, developmental, gastrointestinal, immuno-, neuro-, pulmonary, and renal pharmacology, as well as analgesics, drug abuse, metabolism and disposition, chemotherapy, and toxicology.

Journal articles

Amacher DE (2006) Reactive intermediates and the pathogenesis of adverse drug reactions: the toxicology perspective. Curr. Drug Metab. 7: 219–229.

Baillie TA (2006) Future of toxicology-metabolic activation and drug design: challenges and opportunities in chemical toxicology. Chem. Res. Toxicol. 19: 889–893.

Boelsterli UA (2003) Animal models of human disease in drug safety assessment. J. Toxicol. Sci. 28: 109–121.

Caprino L (1990) Evaluation of drug safety by toxicological test procedures as provided by regulatory laws: an overview. Pharmacol. Res. 22: 253–262.

Dorato MA, Engelhardt JA (2005) The no-observed-adverse-effect-level in drug safety evaluations: use, issues, and definition (s). Regul. Toxicol. Pharmacol. 42: 265–274.

Gore ER (2006) Immune function tests for hazard identification: a paradigm shift in drug development. Basic Clin. Pharmacol. Toxicol. 98: 331–335.

Izzo AA, Ernst E (2001) Interactions between herbal medicines and prescribed drugs–A systematic review. Drugs 61: 2163–2175.

Jacobs A, Jacobson-Kram D (2004) Human carcinogenic risk evaluation, Part III: Assessing cancer hazard and risk in human drug development. Toxicol. Sci. 81: 260–262.

Johnson DE, Rodgers AD (2006) Computational toxicology: heading toward more relevance in drug discovery and development. Curr. Opin. Drug Discov. Devel. 9: 29–37.

Li AP (2004) A comprehensive approach for drug safety assessment. Chem. Biol. Interact. 150: 27–33.

Liebler DC, Guengerich FP (2005) Elucidating mechanisms of drug-induced toxicity. Nat. Rev. Drug Discov. 4: 410–420.

Lin J, et al (2003) The role of absorption, distribution, metabolism, excretion and toxicity in drug discovery. Curr. Top. Med. Chem. 3: 1125–1154.

Lord PG, Nie A, McMillian M (2006) Application of genomics in preclinical drug safety evaluation. Basic Clin. Pharmacol. Toxicol. 98: 537–546.

Mayne JT, Ku WW, Kennedy SP (2006) Informed toxicity assessment in drug discovery: systems-based toxicology. Curr. Opin. Drug Discov. Devel. 9: 75–83.

Moch RW, Dua PN, Hines FA (1997) Food and Drug Administration risk assessment--process and toxicologic pathology. Toxicol. Pathol. 25: 61–67.

Park BK, Pirmohamed M (2001) Toxicogenetics in drug development. Toxicol. Lett. 120: 281–291.

Perazella MA (2005) Drug-induced nephropathy: an update. Expert Opin. Drug Saf. 4: 689–706.

Robert J, et al (2005) Predicting drug response and toxicity based on gene polymorphisms. Crit. Rev. Oncol. Hematol. 54: 171–196.

Wolfgang GH, Johnson DE (2002) Web resources for drug toxicity. Toxicology 173: 67–74.

Wu KM, et al (2004) Regulatory toxicology perspectives on the development of botanical drug

products in the United States. Am. J. Ther. 11: 213–217.

Yang Y, Blomme EA, Waring JF (2004) Toxicogenomics in drug discovery: from preclinical studies to clinical trials. Chem. Biol. Interact. 150: 71–85.

Organizations

American Association of Pharmaceutical Scientists
2107 Wilson Boulevard, Suite 700
Arlington, VA 22201-3042
Phone: 703-243-2800
Fax: 703-243-9650
Web: http://www.aapspharmaceutica.com/

AAPS Pharmaceutica is the web portal for the American Association of Pharmaceutical Scientists, a professional, scientific society of more than 12 000 members employed in academia, industry, government, and other research institutes worldwide. Founded in 1986, AAPS provides a dynamic international forum for the exchange of knowledge among scientists to enhance their contributions to public health. AAPS offers timely scientific programs, ongoing education, information resources, opportunities for networking, and professional development.

The American Society for Pharmacology and Experimental Therapeutics (ASPET)
E220
9650 Rockville Pike
Bethesda, MD 20814-3995
USA
Phone: 301-634-7060
Fax: 301-634-7061
E-Mail: info@aspet.org
Web: http://www.aspet.org/

ASPET aims to promote pharmacological knowledge and its application and to conduct research pertaining thereto. The society also publishes scientific journals, including *Drug Metabolism and Disposition*, *Journal of Pharmacology and Experimental Therapeutics*, *Molecular Pharmacology*, and *Pharmacological Reviews*.

Center for Drug Evaluation and Research (CDER)
United State Food and Drug Administration
Division of Drug Information
5600 Fishers Lane, HFD-240
Rockville, MD 20857
USA
Phone: 301-827-4570
Online contact: http://www.fda.gov/cder/comment.htm
Web: http://www.fda.gov/cder/

CDER evaluates new drugs before they can be sold in the United States by reviewing new drug applications. CDER also ensures that safe and effective drugs are available to improve the health of consumers, and that prescription and over-the-counter drugs, both brand name and generic, work correctly and that the health benefits outweigh known risks.

Center for Food Safety and Applied Nutrition (CFSAN)
United State Food and Drug Administration (U.S. FDA)
5600 Fishers Lane
Rockville, Maryland 20857
USA
Phone: 888-463-6332
Web: http://www.cfsan.fda.gov/~dms/supplmnt.html

CFSAN, in conjunction with the U.S. FDA's field staff, is charged to promote and protect the US public's health by ensuring that the nation's food supply is safe, sanitary, wholesome, and honestly labeled, and that cosmetic products are safe and properly labeled. CFSAN regulates dietary supplements under a different set of regulations (e.g., Dietary Supplement Health and Education Act of 1994) than those covering 'conventional' foods and drug products (prescription and over-the-counter).

European Medicines Evaluation Agency (EMEA)
7 Westferry Circus
Canary Wharf
London E14 4HB
United Kingdom
Phone: 44-20 74 18 84 00
E-Mail: info@emea.europa.eu
Web: http://www.emea.europa.eu

http://www.emea.eu.int/htms/aboutus/organigramme.htm EMEA is a decentralized body of the European Union. Its main duty is to protect and promote public and animal health, through the evaluation and supervision of medicines for human and veterinary use. It is responsible for the scientific evaluation of applications for European marketing authorization for medicinal products.

Health Canada
Drugs and Health Department
Address Locator 0900C2
Ottawa, Ontario
Canada
K1A 0K9
Phone: 613-957-2991 or (866) 225-0709
Fax: 613-941-5366
E-Mail: Info@hc-sc.gc.ca
Web: http://www.hc-sc.gc.ca/dhp-mps/index_e.html

Health Canada is the federal regulator and the Department strives to maintain a balance between the potential health benefits and risks posed by all drugs and health products with the highest priority in determining the balance is public safety. It endeavors to minimize the health risk factors and maximize the safety provided by the regulatory system for these products.

Japan Pharmaceutical Manufacturers Association (JPMA)
Torii Nihonbashi Blug.
3-4-1 Nihonbashi-Honcho
Chuo-Ku, Tokyo 103-0023
Japan
Phone: 03-3241-0326
Fax: 03-3242-1767
Online contact: https://ssl.g-02.jp/jpma/cgi-bin/ques/ques.cgi
Web: http://www.jpma.or.jp/english/

JPMA is a voluntary organization of research-based pharmaceutical manufacturers which has 74 members including 20 overseas affiliates. JPMA aims to support the sound development of the industry by proactively establishing policies and recommendations, responding to globalization, and reinforcing public relations.

National Institute on Drug Abuse (NIDA)
National Institutes of Health
6001 Executive Boulevard, Room 5213
Bethesda, MD 20892-9561
USA
Phone: 301-443-1124
E-Mail: information@nida.nih.gov or (240-221-4007 en español)
Web: http://www.nida.nih.gov/

NIDA is charged to lead the United States in bringing the power of science to bear on drug abuse and addiction with critical components such as the strategic support and conduct of research across a broad range of disciplines, and ensuring the rapid and effective dissemination and use of the results of that research to significantly improve prevention, treatment, and policy as it relates to drug abuse and addiction.

Pharmaceutical Research and Manufacturers of America (PhRMA)
950 F Street, NW
Suite 300
Washington, DC 20004
Phone: 202-835-3400
Fax: 202-835-3414

PhRMA represents the leading pharmaceutical research and biotechnology companies in the United States. Its mission is to conduct effective advocacy for public policies that encourage discovery of important new medicines for patients by pharmaceutical/biotechnology research companies.

Society of Toxicology (SOT)
1821 Michael Faraday Drive, Suite 300
Reston, Virginia 20190
Phone: 703-438-3115
Fax: 703-438-3113
E-Mail: sothq@toxicology.org
Web: http://www.toxicology.org

SOT is a professional and scholarly organization of scientists from academic institutions, government, and industry representing the great variety of scientists who practice toxicology in the U.S. and abroad. It is the leading global force in advancing science to enhance human, animal, and environmental health with the mission to advance health through the science of toxicology. The society also has a scientific journal entitled *Toxicological Sciences*.

Therapeutic Goods Administration (TGA)
Department of Health and Ageing
P.O. Box 100, Woden ACT 2606
Australia
Phone: 02 6232 8444
Fax: 02 6232 8605
E-Mail: info@health.gov.au
Web: http://www.health.gov.au/tga

The TGA conducts various assessment and monitoring activities to ensure therapeutics available in Australia are acceptable, with the goal that the Australian community has access, within a reasonable time, to therapeutic advances.

Databases

The CDER Handbook
Center for Drug Evaluation and Research (CDER), U.S. Food and Drug Administration
Web: http://www.fda.gov/cder/handbook/

An online resource with information on the following: new drug development and review, generic drug review, over-the-counter drug review, post drug approval process, communicating with CDER, and other activities.

Clinicians Ultimate Guide to Drug Therapy
GlobalRPh, Inc.
Web: http://www.globalrph.com/index.htm

GlobalRPh.com was officially launched in December of 2000. This open-access site is based on a hospital-wide intranet that is located at the VA Medical Center

in Detroit Michigan. The site contains a wealth of information including but not limited to databases on the following: drug abbreviations, drug searches, drug/food reactions, and new drugs.

DEA, Drug Information
U.S. Drug Enforcement Administration
Web: http://www.dea.gov/concern/concern.htm

An open-access, online database maintained by the U.S. Drug Enforcement Administration, which contains the following information on a variety of drugs: description/overview, control status, street names, short-term effects, long-term effects, trafficking trends, use/user population, arrests/sentencing, drug seizures, legislation, treatment resources, photos, and related news releases.

Drug Information and Supplement Information – MayoClinic.com
Mayo Foundation for Medical Education and Research
Web: http://www.mayoclinic.com/health/drug-information/DrugHerbIndex

An open-access, online database with alphabetical listings for drugs and supplements, containing the following information on each entry: U.S. brand names, description, before using, proper use, precautions, and side effects.

Drugs@FDA
U.S. Food and Drug Administration
Web: http://www.accessdata.fda.gov/scripts/cder/drugsatfda/index.cfm

An open-access, searchable database that allows users to find information by drug name, active ingredient, or application number. The website contains a demo that provides the user with a basic understanding of how to search Drugs@FDA.

European Medicines Agency (EMEA) – Authorised medicines for human use
Web: http://www.emea.europa.eu/htms/human/epar/a.htm

An alphabetized, online listing of European Public Assessment Reports (EPAR) that provide scientific conclusions reached by the Committee for Medicinal Products for Human Use (CHMP) after the completion of centralized evaluation processes.

European Medicines Agency (EMEA) – Authorised medicines for veterinary use
Web: http://www.emea.europa.eu/htms/vet/epar/eparintro.htm

An alphabetized, online listing of European Public Assessment Reports (EPAR) that provide scientific conclusions reached by the Committee for Medicinal Products for Veterinary Use (CMPVU) after the completion of centralized evaluation processes.

Inactive Ingredient Search for Approved Drug Products
U.S. Food and Drug Administration
Web: http://www.accessdata.fda.gov/scripts/cder/iig/index.cfm

The Inactive Ingredients Database provides information on inactive ingredients present in FDA-approved drug products. Users can search the Inactive Ingredients Database by entering any portion of the name of an inactive ingredient. The search must contain at least three characters. Search results are displayed alphabetically, sorted first by ingredient, then by the route of administration and dosage form.

Index to Drug-Specific Information
U.S. Food and Drug Administration
Web: http://www.fda.gov/cder/drug/DrugSafety/DrugIndex.htm

An online, alphabetized list of drugs with information provided in one of three different formats: (1) Patient Information Sheet (with and without FDA Alerts); (2) Consumer Information Sheet (for drugs approved since 1998; these will all be eventually converted to Patient Information Sheets); and (3) Drug Information Page (may include a Patient or Consumer Information Sheet, Healthcare Professional Sheet, approval information, FDA press releases, questions and answers about a drug, and other related information).

International Bibliographic Information on Dietary Supplements (IBIDS) Database
National Institutes of Health, Office of Dietary Supplements
Web: http://dietary-supplements.info.nih.gov/Health_Information/IBIDS.aspx

Provides open access to bibliographic citations and abstracts from published, international, and scientific literature on dietary supplements. Users can choose to search the Full IBIDS Database, a subset of Consumer Citations Only or Peer Reviewed Citations Only.

Investigational Drugs Database (Iddb3)
Thomson Current Drugs
Web: http://www.iddb3.com/

A fee-for-service database with coverage on all aspects of investigational drug development, from first patent to eventual launch or discontinuation.

IPCS INTOX Databank
International Programme on Chemical Safety
Web: http://www.intox.org/databank/index.htm

An online databank that contains physical, chemical, and toxicological information on chemicals, pharmaceuticals, animals, plants, bacteria, fungi, as well as treatment guides, antidotes, and supplemental documents.

The Merck Veterinary Manual
Merck & Co., Inc.
Web: http://www.merckvetmanual.com/mvm/index.jsp

An open-access, online manual, which provides in-depth coverage of advances in veterinary science, the emergence of new pathogens and new diseases, advances in diagnosis and treatment, and expanded coverage of specialty fields such as cardiology, neurology, ophthalmology, toxicology, and emergency medicine.

National Drug Code Directory
U.S. Food and Drug Administration
Web: http://www.fda.gov/cder/ndc/database/default.htm

Drug products are identified and reported using a unique, three-segment number, called the National Drug Code (NDC), which is a universal product identifier for human drugs. The U.S. Food and Drug Administration (FDA) publishes information in the NDC Directory and allows users to search the information by proprietary name, active ingredient, application number, NDC number, and firm name.

Prescription Drug Information, Side Effects, Interaction-Drugs.com
Drugsite Trust
Web: http://www.drugs.com

A comprehensive and up-to-date drug information resource available online with fast, easy searching on over 24 000 prescription and over-the-counter medicines.

RxList – The Internet Drug Index for Prescription Drug Information, Interactions, and Side Effects
RxList, Inc.
Web: http://www.rxlist.com/script/main/hp.asp

An open-access database with coverage on thousands of prescription and over-the-counter medications, including information on uses, side effects, precautions, interactions, and overdose.

Veterinary Drug Residues in Food (MRLs/EMRLs)
FAO/WHO Food Standards, Codex alimentarius
Web: http://www.codexalimentarius.net/mrls/vetdrugs/jsp/vetd_q-e.jsp

An open-access database that allows users to conduct searches for the maximum residue limit of specific chemicals in a variety of animal species and food products.

WebMD Health – Drug Index
WebMD, Inc.
Web: http://www.webmd.com/drugs/index-drugs.aspx

An alphabetical compilation of prescription and over-the-counter medications that provides search options and information on the uses, side effects, precautions, interactions, and overdose for each entry.

CHAPTER

15

Chemicals: Dusts and Fibers

VICTORIA A. CASSANO AND TEE L. GUIDOTTI

INTRODUCTION

Dusts are finely divided particles in the solid phase which, when suspended in air, form aerosols. Aerosols may also form from particles in the liquid phase, or mists. Aerosols have a variety of properties and characteristic behavior depending on composition and air movement. Dusts within aerosols behave in air and adjacent surfaces according to their mass, density, size, dimensions, and electrostatic charge. Once inhaled, their fate in the upper respiratory tract and in the lung is determined by their mass, size, shape, and electrostatic charge. Once deposited in the lung, they may persist or be degraded according to their composition and water solubility. Only then does the dust exert any physiological effect it will have and aerosol science and particle deposition studies give way to toxicology.

These citations represent a selected list of references, including some important older sources, with a heavy emphasis on the major, controversial, and emerging issues of the last decade: asbestos, silica, wood dust, and nanoparticles. Some dust diseases of the lung may be associated with asthma and immunological responses, such as hypersensitivity pneumonitis, hard metal disease, and beryllium disease, but the majority are characterized by a fibrotic response to the deposition of dust in the alveolus, resulting in a pneumoconiosis. Three are particularly troublesome because of the intensity of the fibrosis and how common they are in the workplace: silicosis, asbestosis, and coal workers' pneumoconiosis.

Asbestos studies are highly contentious with on-going debate over the relative toxicity of chrysotile, notwithstanding that commercial chrysotile is known to be associated with lung cancer, mesothelioma, and non-malignant asbestos-related disease. Silica studies have been dominated in recent years by studies that sought to question or confirm the association of lung cancer with silica exposure but as this question is now largely settled, attention has turned to characterizing the rheumatological and kidney disorders associated with inhaled silica. Wood dust presented a surprise a decade ago when softwood dust was found to be associated with nasal and sinus carcinoma, as is hardwood dust; the relevant particle size for wood dust is greater than for mineral dusts. Nanoparticles and fine particulate air pollution have been intensively studied just in the last 10 years and their subtle but intense effects are still being characterized.

RESOURCES

Books

Castleman BI, Berger SL (2005)
Asbestos: Medical and Legal Aspects, 5th edition
New York: Aspen.

A comprehensive history of asbestos, asbestos exposure in the workplace, and asbestos litigation. Detailed description and evaluation of legal arguments put forth by plaintiff and defense counsel, with an emphasis on what companies knew about asbestos hazards at various times.

Cherry N, Ogden T (eds.) (1997)
Inhaled Particles VIII
Proceedings of an International Symposium on Inhaled Particles organized by the British Occupational Hygiene Society, 26–30 August 1996

Amsterdam, the Netherlands: Pergamon.

Inhaled Particles are a series of international symposia which have been organized by the British Occupational Hygiene Society since 1960. Inhaled Particles VIII was a landmark meeting held in Cambridge on 26–30 August 1996, entitled 'Occupational and Environmental Implications for Human Health'. This volume collects 123 concise papers on occupational and environmental exposure, inhalation, deposition, clearance, pathophysiology, experimental methodology, and modeling of dusts, including radioactive particles, fibers, coal, and silica. Inhaled Particles IX (2001) has been widely anticipated but has not yet appeared. It is reportedly still in production at Oxford University Press. Abstracts from the 2001 meeting are available on-line at http://www.abdn.ac.uk/~oem148/news0215.hti.

Dodson RF, Hammar SP (eds.) (2006)
Asbestos, Risk Assessment, Epidemiology and Health Effects
Boca Raton, FL: Taylor and Francis.

An overview of asbestos research, bringing many topics together in one place related to health risk.

Goldman L, Coussens C. (eds.) (2005) Roundtable on Environmental Health Sciences, Research and Medicine
Implications of Nanoparticles for Environmental Health Research
Washington DC: National Academies Press.

Institute of Medicine. Committee on Asbestos: Selected Health Effects (2006)
Asbestos: Selected Cancers
Washington DC: National Academies Press.

A highly authoritative reference on the association between asbestos and cancers other than lung cancer.

International Agency for Research on Cancer (IARC) (1997)
Evaluation of the Carcinogenic Risk to Humans. Silica, some Silicates, Coal Dust, and Para-aramid Fibrils, Volume 68
Lyon, France: IARC Scientific Publications.
The essential reference on silica-associated lung cancer risk.

National Institute for Occupational Safety and Health
Health Effects of Occupational Exposure to Respirable Crystalline Silica
NIOSH Hazard Review
Department of Health and Human Services, Centers for Disease Control and Prevention, DHHS (NIOSH) Publication No. 2002-129, Cincinnati OH, April 2002.

This document summarizes information on silica-related lung disease, cancer risk, and rheumatological disorders. A comprehensive overview of silica.

Peters GA, Peters BJ (1980–2000)
Sourcebook on Asbestos Diseases
Charlottesville, VA: Lexis Publications.

The Sourcebook has long been the essential reference for attorneys and professionals working in the field of asbestos. Each of the 21 volumes features many detailed chapters written by experts on all aspects of asbestos-related disease.

Roggli VL, Oury TD, Sporn TA (eds.) (2004)
Pathology of Asbestos Associated Disease, 2nd edition
New York: Springer.

Surveys research and advances in its discussion of asbestos-induced diseases, including the mineralogy of asbestos, environmental exposure, and the pathology of asbestosis and asbestos-associated cancer. A detailed discussion on mesothelioma includes a historical background, addresses etiology and epidemiology, pathology, differential diagnosis, treatment, and prognosis.

Journal

Particles and Fibre Toxicology
This online journal is an open-access journal from Biomed Central (http://www.biomedcentral.com/) that receives manuscripts on the toxicological effects of particles and fibres; it also advocates multidisciplinary studies. For additional information and access to the journal, refer to http://www.particleandfibretoxicology.com/home/.

Journal articles

The journal literature on dusts and fibers is vast and highly specific. Few review articles address more than one dust and comparative studies are scarce.

American Thoracic Committee, Ad Hoc Committee (2004) [on Update of 1986 Criteria for the Diagnosis of Nonmalignant Asbestos-Related Disease: Guidotti TL, Miller A, Christiani D, Wagner G, Balmes J, Harber P, Brodkin CA, Rom W, Hillerdal G, Harbut M, Green FHY]. Diagnosis and initial management of nonmalignant diseases related to asbestos. Am. J. Respir. Crit. Care Med. 170: 691–715. Review and clinical guidelines.

Bernstein DM, Hoskins JA (2006) The health effects of chrysotile: current perspective based upon recent

data. Regul. Toxicol. Pharmacol, 45(3): 252–264. Epub 2006 Jul 11. Review.

Bhattacharya K, Dopp E, Kakkar P, et al (2005) Biomarkers in risk assessment of asbestos exposure. Mutat. Res. 579(1–2): 6–21. Review.

Blot WJ, Chow WH, McLaughlin JK (1997) Wood dust and nasal cancer risk. A review of the evidence from North America. J. Occup. Environ. Med. 39(2): 148–156. Review.

Borm PJ (2002) Particle toxicology: from coal mining to nanotechnology. Inhal. Toxicol. 14(3): 311–324. Review.

Chapman SJ, Cookson WO, Musk AW, Lee YC (2003) Benign asbestos pleural diseases. Curr. Opin. Pulm. Med. 9(4): 266–271. Review.

Cook AG, Weinstein P, Centeno JA (2005) Health effects of natural dust: role of trace elements and compounds. Biol. Trace Elem. Res. 103(1): 1–15. Review.

Fubini B (1997) Surface reactivity in the pathogenic response to particulates. Environ. Health Perspect. 105(Suppl 5): 1013–1020. Review.

Ghio AJ, Churg A, Roggli VL (2004) Ferruginous bodies: implications in the mechanism of fiber and particle toxicity. Toxicol. Pathol. 32(6): 643–649. Review.

Godleski JJ (2004) Role of asbestos in etiology of malignant pleural mesothelioma. Thorac. Surg. Clin. 14(4): 479–487. Review.

Gulumian M (2005) An update on the detoxification processes for silica particles and asbestos fibers: successess and limitations. J. Toxicol. Environ. Health B Crit. Rev. 8(6): 453–483. Review.

Gulumian M (1999) The role of oxidative stress in diseases caused by mineral dusts and fibres: current status and future of prophylaxis and treatment. Mol. Cell Biochem. 196(1–2): 69–77. Review.

Guthrie GD, Jr (1997) Mineral properties and their contributions to particle toxicity. Environ. Health Perspect. 105(Suppl 5): 1003–1011. Review.

Gwinn MR, Vallyathan V (2006) Nanoparticles: health effects – pros and cons. Environ. Health Perspect. 114(2): 1818–1825. Review.

Hesterberg TW, Hart GA (2001) Synthetic vitreous fibers: a review of toxicology research and its impact on hazard classification. Crit. Rev. Toxicol. 31(1): 1–53. Review.

Hnizdo E, Sullivan P, Bang KM, Wagner GR (2002) Association between chronic obstructive pulmonary disease and employment by industry and occupational in the U.S. population: a study of data from the Third National Health and Nutrition Examination Survey. Am. J. Epidemiol. 156: 738–746.

Ishihara Y (2001) In vitro studies on biological effects of fibrous minerals. Ind. Health, 39(2): 94–105. Review.

Jaurand MC (1997) Mechanisms of fiber-induced genotoxicity. Environ. Health Perspect. 105(Suppl 5): 1073–1084. Review.

Kreyling WG, Semmler M, Moller W (2004) Dosimetry and toxicology of ultrafine particles. J. Aerosol Med. 17(2): 140–152. Review.

Kurihara N, Wada O (2004) Silicosis and smoking strongly increase lung cancer risk in silica-exposed workers. Ind. Health, 42(3): 303–314. Review.

Manning CB, Vallyathan V, Mossman BT (2002) Diseases caused by asbestos: mechanisms of injury and disease development. Int. Immunopharmacol. 2(2–3): 191–200.

Marchevsky AM, Wick MR (2003) Current controversies regarding the role of asbestos exposure in the causation of malignant mesothelioma: the need for an evidence-based approach to develop medicolegal guidelines. Ann. Diagn. Pathol. 7(5): 321–332. Review.

Maxim LD, McConnell EE (2005) A review of the toxicology and epidemiology of wollastonite. Inhal. Toxicol. 17(9): 451–466. Review.

Muhle H, Mangelsdorf I (2003) Inhalation toxicity of mineral particles: critical appraisal of endpoints and study design. Toxicol. Lett. 140–141: 223–228. Review.

Muhle H, Pott F (2000) Asbestos as reference material for fibre-induced cancer. Int. Arch. Occup. Environ. Health, 73(Suppl): S53–S59. Review.

Nelson HH, Kelsey KT (2002) The molecular epidemiology of asbestos and tobacco in lung cancer. Oncogene 21(48): 7284–7288. Review.

Nishimura SL, Broaddus VC (1998) Asbestos-induced pleural disease. Clin. Chest Med. 19(2): 311–329. Review.

Oberdorster G (2002) Toxicokinetics and effects of fibrous and nonfibrous particles. Inhal. Toxicol. 14(1): 29–56. Review.

Oberdorster G (2000) Determinants of the pathogenicity of man-made vitreous fibers (MMVF). Int. Arch. Occup. Environ. Health, 73(Suppl): S60–S68. Review.

Oberdorster G (1997) Pulmonary carcinogenicity of inhaled particles and the maximum tolerated dose. Environ. Health Perspect. 105(Suppl 5): 1347–1355. Review.

Oberdorster G, Oberdorster E, Oberdorster J (2005) Nanotoxicology: an emerging discipline evolving from studies of ultrafine particles. Environ. Health Perspect. 113(7): 823–839. Review.

Ohar J, Sterling DA, Bleecker E, Donohue J (2004) Changing patterns in asbestos-induced lung disease. Chest, 2004 125: 744–753.

Paustenbach DJ, Finley BL, Lu ET, Brorby GP, Sheehan PJ (2004) Environmental and occupational health hazards associated with the presence of asbestos in brake linings and pads (1900 to present): a "state-of-the-art" review. J. Toxicol. Environ. Health B Crit. Rev. 7(1): 25–80. Review.

Rosenthal GJ, Simeonova P, Corsini E (1999) Asbestos toxicity: an immunologic perspective. Rev. Environ. Health, 14(1): 11–20. Review.

Rosenthal GJ, Corsini E, Simeonova P (1998) Selected new developments in asbestos immunotoxicity. Environ. Health Perspect. 106(Suppl 1): 159–169. Review.

Ross RM (2003) The clinical diagnosis of asbestosis in this century requires more than a chest radiograph. Chest 124: 1120–1128. Commentary.

Saffiotti U (1998) Respiratory tract carcinogenesis by mineral fibres and dusts: models and mechanisms. Monaldi. Arch. Chest Dis. 53(2): 160–167. Review.

Schins RP (2002) Mechanisms of genotoxicity of particles and fibers. Inhal. Toxicol. 14(1): 57–78. Review.

Stayner L (2007) Silica and lung cancer: When is enough evidence enough? Epidemiol. 18(1): 23–24.

Steenland K, Mannetje A, Boffetta P, et al (2001) Pooled exposure-response and risk assessment for lung cancer in 10 cohorts of silica-exposed workers: an IARC multi-centric study. Cancer Caus. Cont. 12: 773–784.

Upadhyay D, Kamp DW (2003) Asbestos-induced pulmonary toxicity: role of DNA damage and apoptosis. Exp. Biol. Med. (Maywood), 228(6): 650–659. Review.

Wagner GR (1997) Asbestosis and silicosis. Lancet 349(9061): 1311–1315. Review and commentary.

Warheit DB, Hart GA, Hesterberg TW, et al (2001) Potential pulmonary effects of man-made organic fiber (MMOF) dusts. Crit. Rev. Toxicol. 31(6): 697–736. Review.

Warheit DB, Reed KL, Webb TR (2001) Man-made respirable-sized organic fibers: what do we know about their toxicological profiles? Ind. Health, 39(2): 119–125. Review.

Wild P (2006) Lung cancer risk and talc not containing asbestiform fibres: a review of the epidemiological evidence. Occup. Environ. Med. 63(1): 4–9. Review.

Yarborough CM (2006) Chrysotile as a cause of mesothelioma: an assessment based on epidemiology. Crit. Rev. Toxicol. 36(2): 165–187. Review.

Zhu S, Manuel M, Tanaka S, et al (1998) Contribution of reactive oxygen and nitrogen species to particulate-induced lung injury. Environ. Health Perspect. 106(Suppl 5): 1157–1163. Review.

Organizations

American Association for Aerosol Research
15000 Commerce Parkway, Suite C
Mt. Laurel, NJ 08054 USA
Phone: 877 777-6753
Fax: 856 439-0525
E-Mail: info@aaar.org
Web: www.aaar.org

British Occupational Hygiene Society
5/6 Melbourne Business Court, Millennium Way
Pride Park
Derby, DE24 8LZ United Kingdom
Phone: +44 01332 298101
Fax: +44 01332 298099
E-Mail: admin@bohs.org
Web: www.bohs.org

National Institute for Occupational Safety and Health
Phone: 1-800-35-NIOSH (1-800-356-4674)
Fax: 513 533-8573

Databases

The usual databases relevant to toxicology (such as IRIS) contain information on aerosols, dusts, and fibers.

CHAPTER

16

Chemicals: Metals

RUSSELL BARBARE AND SHAYNE GAD

INTRODUCTION

No general principles that govern the toxicity of all metals and their compounds exist; however, a few generalizations are possible. Oxidation state and solubility are critical factors in toxic reactions. Metals usually produce their effects by reaction with enzymes, cell membranes, or specific cell components. These reactions can inhibit or stimulate the actions of these substances and components.

For the general population, the primary route of exposure is ingestion with food or with drinking water inhalation. The secondary route is inhalation, which can include exposure from environmental contamination or from industrial work. The very young and the elderly are most susceptible to metal toxicity. Essential metals such as calcium and iron can cross the placental barrier and a few toxic metals such as lead and mercury can also.

A small number of metals and their compounds are carcinogenic to humans but the vast majority are not. Some metals are essential for good health (e.g., copper, chromium, selenium). Others are suspected to be inessential (e.g., beryllium, lead, tin). Still others are under investigation (e.g., arsenic).

Metals are generally circulated bound to some blood protein and can selectively bioaccumulate; thus, metals can affect either specific target organs or multiple anatomical sites. For example, lead can deposit in the bone, affect the central nervous system (CNS), and interfere with the metabolism of the heme in hemoglobin; cadmium appears to concentrate in the kidneys and the liver; and mercury is a CNS toxin. Acute toxicity from metals can also cause non-specific symptoms including nausea and vomiting.

The metabolic product of the metal can determine the action in the organ in which the metal is deposited. Mercury is converted to methyl mercury chloride, which is soluble in lipids and appears to be concentrated over time in organs with high lipid content. Often, metabolism of metals can lead to detoxification and excretion. Some metals, such as selenium metal and oxides, are converted to the volatile trimethyl derivative and are exhaled. Metals such as cadmium, zinc, copper, and mercury induce special protein complexes called metallothioneins, which may be part of a detoxification function. Iron forms a number of other protein complexes (ferritin, hemosiderin, and transferrin), which are a normal part of body chemistry and are mainly metabolized by the liver.

RESOURCES

Books

Bingham E, Cohrssen B, Powell CH (eds.) (2001)
Patty's Toxicology, 5th edition

Covers chemical and metal toxicology from an industrial standpoint. The majority of the works are evaluations grouped by substance similarity, but it also includes articles on categories on toxicology, e.g. carcinogenesis and ecogenetics. The chapters generally cover both acute and long-term exposure, both accidental and planned exposure, and both animal and human data. Consists of nine volumes with a comprehensive index.

Bowden GT, Fisher SM (eds.) (1997)
Comprehensive Toxicology Volume 12: Chemical Carcinogens and Anticarcinogens

Discusses the actions of various chemical carcinogens, including metals, as well as ultraviolet and ionizing radiation in the context of the multistage process of both experimental and human carcinogenesis.

Chang LW, Magos L, Suzuki T (eds.) (1996)
Toxicology of Metals

Comprehensively reviews metal toxicology, covering aspects from exposure to symptoms to endpoints. This work covers broad subjects such as the major aspects and issues of metal toxicology as well as focused subjects such as carcinogenicity, neurotoxicity, and renal toxicity. Consists of two volumes.

Dart RC (ed.) (2004)
Medical Toxicology, 3rd edition

Approaches substance toxicology through the points of view of diagnosis, forensics, and treatment. Includes diagnosis suggestions for multiple diseases, antidotes and supportive care for known toxicities, and the toxicology and treatments for common drugs, poisons, chemicals, and natural toxins.

Ford MD, Delaney KA, Ling LJ, Erickson T (eds.) (2001)
Clinical Toxicology

Contains toxicology and treatment reviews of a number of therapeutic agents, illegal drugs, industrial and cleaning chemicals, and pesticides. The first two sections are on general management principles and treatment of specific symptoms and are therefore of less interest to the toxicologist.

Fowler BA, Nordberg M, Friberg L, Nordberg G (eds.) (2007)
Handbook on the Toxicology of Metals

Covers metal toxicology in detail by having separate chapters dedicated to individual metals but also having chapters covering general topics such as risk assessment, diagnosis, exposure routes, biochemistry, and ecotoxicology. The volume also includes chapters for specific toxicology areas such as carcinogenicity, reproductive toxicology, and immunotoxicology.

Goyer RA, Klaassen CD, Waalkes MP (eds.) (1995)
Metal Toxicology

Reviews the toxicology of metals mostly by a target organ system but also investigates underlying mechanisms, influencing factors, and carcinogenicity.

Goyer RA, Mehlman MA (eds.) (1977)
Toxicology of Trace Elements

Reviews primarily metal toxicology in a detailed manner, covering environmental, analytic, mechanistic, epidemiologic, pharmacokinetic, and target organ aspects.

Hayes AW (ed.) (2007)
Principles and Methods of Toxicology, 5th edition

Primarily covers the main ideas and techniques of toxicology but also solvents, crop protection chemicals, and metals.

Lewis RJ Sr. (ed.) (2004)
Sax's Dangerous Properties of Industrial Materials, 11th edition

Presents regulatory limits and reported toxicity levels, i.e. MLDs, LD_{50}s, TDLOs, etc., in a compact format along with basic chemical properties and a short safety profile. Consists of three volumes with a comprehensive index, including a CAS index.

Pohanish RP (ed.) (2002)
Sittig's Handbook of Toxic and Hazardous Chemicals and Carcinogens, 4th edition

Includes short descriptions of toxicity, exposure routes, and first aid, but concentrates on material handling and exposure prevention. Sittig's also includes the appropriate regulatory authorities with the regulated limits and recommended cleanup procedures. The format is similar to that found on MSDS forms. Consists of two volumes with a comprehensive index.

Review Articles

Aschner M, Guilarte TR, Schneider JS, Zheng W (2007) Manganese: recent advances in understanding its transport and neurotoxicity. Toxicol. Appl. Pharmacol. 221(2): 131–147.

Anderson GJ (2007) Mechanisms of iron loading and toxicity. Am. J. Hematol. 82(12 Suppl): 1128–1131.

Clarkson TW, Magos L (2006) The toxicology of mercury and its chemical compounds. Crit. Rev. Toxicol. 36(8): 609–662.

Drake PL, Hazelwood KJ (2005) Exposure-related health effects of silver and silver compounds: a review. Ann. Occup. Hyg. 49(7): 575–585.

Huff J, Lunn RM, Waalkes MP, Tomatis L, Infante PF (2007) Cadmium-induced cancers in animals and in humans. Int. J. Occup. Environ. Health, 13(2): 202–212.

Kreiss K, Day GA, Schuler CR (2007) Beryllium: a modern industrial hazard. Annu. Rev. Public Health, 28: 259–277.

Krewski D, Yokel RA, Nieboer E, et al (2007) Human health risk assessment for aluminium, aluminium oxide, and aluminium hydroxide. J. Toxicol. Environ. Health B Crit. Rev. 10(Suppl 1): 1–269. Erratum in: J. Toxicol. Environ. Health B Crit. Rev. 2008; 11(2): 147.

Lu H, Shi X, Costa M, Huang C (2005) Carcinogenic effect of nickel compounds. Mol. Cell Biochem. 279(1–2): 45–67.

Magos L, Clarkson TW (2006) Overview of the clinical toxicity of mercury. Ann. Clin. Biochem. 43(Pt 4): 257–268.

Nuttall KL (2006) Evaluating selenium poisoning. Ann. Clin. Lab. Sci. 36(4): 409–420.

Roney N, Osier M, Paikoff SJ, et al (2006) ATSDR evaluation of the health effects of zinc and relevance to public health. Toxicol. Ind. Health 22(10): 423–493.

Sedman RM, Beaumont J, McDonald TA, et al (2006) Review of the evidence regarding the carcinogenicity of hexavalent chromium in drinking water. J. Environ. Sci. Health C Environ. Carcinog. Ecotoxicol. Rev. 24(1): 155–182.

Stern BR, Solioz M, Krewski D, et al (2007) Copper and human health: biochemistry, genetics, and strategies for modeling dose-response relationships. J. Toxicol. Environ. Health B Crit. Rev. 10(3): 157–222.

van der Voet GB, Todorov TI, et al (2007) Metals and health: a clinical toxicological perspective on tungsten and review of the literature. Mil. Med. 172(9): 1002–1005.

White LD, Cory-Slechta DA, Gilbert ME, et al (2007) New and evolving concepts in the neurotoxicology of lead. Toxicol. Appl. Pharmacol. 225(1): 1–27. Epub 2007 Aug 16.

Wright RO, Baccarelli A (2007) Metals and neurotoxicology. J. Nutr. 137(12): 2809–2813.

Journals

Drug and Chemical Toxicology

Food and Chemical Toxicology

Online Databases

Agency for Toxic Substances and Disease Registry (ATSDR)

Provides general information on toxic substances, including metals. The material is generally at the level of the educated layman and there are several tutorials with self-checks available. A subdivision of the U.S. Department of Health and Human Services.
Web: http://www.atsdr.cdc.gov/contents.html

Entrez Cross-Database Search

Searches several databases in the U.S. National Institutes of Health (NIH)/National Library of Medicine (NLM) family. The most notable difference from other databases is that it includes records from the U.S. National Center for Biotechnology Information, which has proteomic and genomic information such as the exact structure of known biological compounds with the metal in question and known karyotypes for metal-based neoplasms.
Web: http://www.ncbi.nlm.nih.gov/sites/gquery

Haz-Map

From the NIH, NLM's TOXNET system, it covers occupational exposure to metals and other hazardous agents by agent, by disease, or by job.
Web: http://hazmap.nlm.nih.gov/

Household Products Database

From the NIH, NLM, it allows searching for metals and other compounds that occur in household products. This database focuses on potential exposure from household products but also provides links to other toxicological sources such as TOXNET.
Web: http://householdproducts.nlm.nih.gov/

International Programme on Chemical Safety (IPCS)

Provides international information on chemical safety, with assessments of safety from both a human and environmental level. The primary format is specific monographs, so general information and data on less notable metals may not be available. IPCS is in partnership with the Canadian Centre for Occupational Health and Safety (CCOHS) and is part of a cooperative agreement among UNEP, ILO, FAO, WHO, UNIDO, UNITAR, and OECD.
Web: http://www.inchem.org/

TOXLINE

From the NIH, NLM, it allows searches of articles from a comprehensive set of toxicology literature. The primary advantages of this over NLM's PubMed are specificity (focused on toxicology) and its inclusion of U.S. and international working group publications.
Web: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?TOXLINE

TOXNET
Searches databases from the U.S. NIH, NLM family that are specifically focused on hazardous chemicals, toxic releases, and environmental health. The information type is specific to the individual databases but includes information for informed citizens, healthcare professionals, and toxicologists. Databases on this system with important specific foci are listed separately.
Web: http://sis.nlm.nih.gov/enviro.html

Organizations

Society for Risk Analysis
Society of Toxicology (www.toxicology.org/)

CHAPTER

17

Chemicals: Pesticides

ALLAN S. FELSOT

INTRODUCTION

The literature regarding basic mechanisms of pesticide toxicity, exposure assessment, and risk characterization has literally exploded over the last decade since publication of the 3rd edition of the IRT. The various information sources referenced in this listing were chosen primarily for their focus on human exposure and epidemiology. However, books and journals also covered references about environmental chemistry and ecotoxicological effects so that the interested reader could have some guidance for initiating a search on environmental aspects of pesticide technology.

Notable among the specific journal articles are series of publications by singular university or government entities that have been operating under large, multiyear Federal grants to focus on children and worker health in relation to pesticide exposure. For example, the Federally funded Agricultural Health Study (AHS) has a mandate to elucidate relationships between farmworker health and disease and associations with farm practices, especially pesticide use. The project is a collaborative effort between researchers from the National Institute of Environmental Health Sciences, the National Cancer Institute, and the Environmental Protection Agency. This project has turned out a disproportionate number of exposure and epidemiological investigations in two cohorts of farmworkers and their spouses and children. All of the papers produced under the aegis of the AHS are available online at the program website, URL: http://www.aghealth.org/. Thus, selected papers of particular importance are shown below because they have addressed important epidemiological issues, or alternatively the publication has generated media attention.

In addition to research focused on hazards of pesticides to humans, a few university research groups have been elaborating biochemical mechanisms of pesticide toxicity. Notable among these publications has been the intense focus on neurotoxicity of organophosphate insecticides. The included journal articles were chosen because they have reviewed and analyzed the literature over the last decade and/or they highlighted significant new findings regarding pesticide exposure and effects. The articles are cataloged under various focus areas of toxicology, especially including neurotoxicology and carcinogenicity. Each article is designated as either exposure assessment, basic mechanistic research on a particular physiological system (e.g., neurological, endocrine), or epidemiology.

Nearly all of the references listed were published after the last edition of the IRT. In some cases, especially for books, important continuing series were left out of the 3rd edition, yet represent a significant source of information about all aspects of pesticide technology, especially as studied with regard to exposure assessment. In compiling a useful and reasonably current list of bibliographic sources that are likely to stand the test of time, one has to be selective when the field is rapidly advancing owing to policy decisions reflecting societal concerns about the technology. Indeed, included under journal articles is a section on current pesticide-related policy issues. With this caveat in mind, the listed resources shown below represent the 'state-of-the-art' literature for pesticide toxicology related to human health effects.

RESOURCES

Books

American Chemical Society Symposium Series Books

The Division of Agrochemicals of the American Chemical Society has been holding biannual symposia on various topics of pesticide toxicology and environmental chemistry for over 30 years. The titles shown below are descriptive of the contents and have been published since the 3rd edition of the IRT. As indicated in the book title, themes have focused on exposure assessment for risk characterization.

Arthur EL, Barefoot AC, Clay VE (eds.) (2003) Terrestrial Field Dissipation Studies. Purpose, Design, and Interpretation. ACS Symposium Series 842, 343 pp. Washington, DC: American Chemical Society.

Ballantine LG, McFarland JE, Hackett DS (eds.) (1998) Triazine Herbicides: Risk Assessment. ACS Symposium Series 683, 480 pp. Washington, DC: American Chemical Society.

Clark JM (ed.) (1995) Molecular Action of Insecticides on Ion Channels. ACS Symposium Series 591, 356 pp. Washington, DC: American Chemical Society.

Clark JM, Kenna MP (eds.) (2000) Fate and Management of Turfgrass Chemicals. ACS Symposium Series No. 743, 480 pp. Washington, DC: American Chemical Society.

Clark JM, Ohkawa H (eds.) (2005) Environmental Fate and Safety Management of Agrochemicals. ACS Symposium Series 899, 357 pp. Washington, DC: American Chemical Society.

Clark JM, Yamaguchi I (eds.) (2002) Agrochemical Resistance. Extent, Mechanism, and Detection. ACS Symposium Series 808, 290 pp. Washington, DC: American Chemical Society.

Coats JR, Yamamoto H (eds.) (2003) Environmental Fate and Effects of Pesticides. ACS Symposium Series 853, 300 pp. Washington, DC: American Chemical Society.

Felsot AS, Racke DK (eds.) (2006) Certified Organic and Biologically Derived Pesticides: Environmental, Health, and Efficacy Assessment. ACS. Symposium Series 947, 326 pp. Washington, DC: American Chemical Society.

Franz JE, Mao MK, Sikorski JA (1996) Glyphosate: A Unique Global Herbicide. ACS Monograph Series No. 189, 653 pp. Washington, DC: American Chemical Society.

Gan JJ, Zhu PC, Aust SD, Lemley AT (eds.) (2003) Pesticide Decontamination and Detoxification. ACS Symposium Series No. 863, 280 pp. Washington, DC: American Chemical Society.

Garner WY, Royal P, Liem F (eds.) (1999) International Pesticide Product Registration Requirements: The Road to Harmonization. ACS Symposium Series No. 724, 336 pp. Washington, DC: American Chemical Society.

Green MB, Spilker DA (ed.) (1986) Fungicide Chemistry. Advances and Practical Applications. ACS Symposium Series 304, 173 pp. Washington, DC: American Chemical Society.

Hall JC, Hoagland RE, Zablotowics RM (eds.) (2001) Pesticide Biotransformation in Plants and Microorganisms. ACS Symposium Series 777, 432 pp. Washington, DC: American Chemical Society.

Johnston JJ (ed.) (2000) Pesticides and Wildlife. ACS Symposium Series No. 771, 384 pp. Washington, DC: American Chemical Society.

Marco GJ, Hollingworth RM, Durham W (eds.) (1987) Silent Spring Revisited, 214 pp. Washington, DC: American Chemical Society.

Plimmer JR (ed.) (1982) Pesticide Residues and Exposure. ACS Symposium Series 182, 213 pp. Washington, DC: American Chemical Society.

Phelps W, Winton K, Effland WR (eds.) (2002) Pesticide Environmental Fate: Bridging the Gap Between Laboratory and Field Studies. ACS Symposium Series No. 813, 248 pp. Washington, DC: American Chemical Society.

Racke KD, Leslie AR (ed.) (1993) Pesticides in Urban Environments. Fate and Significance. ACS Symposium Series 522, 378 pp. Washington, DC: American Chemical Society.

Ragsdale NN, Seiber J (eds.) (1999) Pesticides: Managing Risks and Optimizing Benefits. ACS Symposium Series No. 734, 304 pp. Washington, DC: American Chemical Society.

Seiber JN, Knuteson JA, Woodrow JE, et al (ed.) (1997) Fumigants. Environmental Fate, Exposure, and Analysis. ACS Symposium Series 652, 236 pp. Washington, DC: American Chemical Society.

Seiber JN, Krieger RI, Ragsdale NN (eds.) (2007) Assessing Exposures and Reducing Risks to People from the Use of Pesticides. ACS Symposium Series No. 951, 304 pp. Washington, DC: American Chemical Society.

Steinheimer TR, Ross LJ, Spittler TD (ed.) (2000) Agrochemical Fate and Movement: Perspectives and Scale of Study. ACS Symposium Series No. 751, 408 pp. Washington, DC: American Chemical Society.

Tweedy BG, Dishburger HJ, Ballantine LG, McCarthy J, Murphy J (ed.) (1991) Pesticide Residues and Food Safety. A Harvest of Viewpoints. ACS Symposium Series 446, 360 pp. Washington, DC: American Chemical Society.

Wang RGM, Franklin CA, Honeycutt RC, Reinert JC (eds.) (1989) Biological Monitoring for Pesticide Exposure. Measurement, Estimation, and Risk Reduction. ACS Symposium Series 382, 387 pp. Washington, DC: American Chemical Society.

Books Based on the IUPAC (International Union of Pure and Applied Chemistry) International Congresses of Pesticide Chemistry

Every 4 years since the 1960s, IUPAC has sponsored an International Congress devoted to all aspects of pesticide technology. Each book contains chapters based on keynote presentations that accompany various subject sessions. In these books one can find an evolution of pesticide chemistry and toxicology and thinking about risk assessment of the technology. The most recent publication emphasizes new product chemistries that would be considered 'reduced risk' by the Environmental Protection Agency.

Brooks GT, Roberts TR (ed.) (1999) Pesticide Chemistry and Bioscience. The Food-Environment Challenge, 438 pp. Cambridge, UK: Royal Society of Chemistry. (IUPAC 9th Pesticide Chem. Congr., London, UK)

Ohkawa H, Miyagawa H, Lee PW (eds.) (2007) Pesticide Chemistry: Crop Protection, Public Health, Environmental Safety, 497 pp. Weinheim, Germany: Wiley-VCH Verlag GmbH & Co. (IUPAC 11th International Congress of Pesticide Chemistry, Kobe, Japan)

Ragsdale NN, Kearney PC, Plimmer JR (eds.) (1995) Eighth International Congress of Pesticide Chemistry. Options 2000, 450 pp. Washington, DC: American Chemical Society.

Voss G, Ramos G (eds.) (2003) Chemistry of Crop Protection. Progress and Prospects in Science and Regulation, 395 pp. Weinheim, Germany: Wiley-VCH. (IUPAC 10th Pesticide Chem Congr, Basel, Switzerland)

Books Reviewing Herbicide or Fungicide Mode of Action

These books, which were not covered in the last edition of the IRT, provide thorough discussions of herbicide mode of action and therefore provide insights into possible vertebrate toxicology. Many of the herbicides discussed are still in modern use. Some cover environmental chemistry and impact on non-target plants.

Boger P, Sandmann G (1989) Target Sites of Herbicide Action. 295 pp. Boca Raton, FL: CRC Press.

Boger P, Sandman G (eds.) (1993) Target Assays for Modern Herbicides and Related Phytotoxic Compounds, 299 pp. Boca Raton, FL: Lewis Publishers.

Cobb A (1992) Herbicides and Plant Physiology. 176 pp. New York: Chapman & Hall.

Devine M, Duke SO, Fedtke C (1993) Physiology of Herbicide Action. 441 pp. Englewood Cliffs, NJ: PTR Prentice Hall.

Ferenc SA (ed.) (2001) Impacts of Low-Dose, High-Potency Herbicides on Nontarget and Unintended Plant Species, 198 pp. Pensacola, FL: Society of Environmental Toxicology and Chemistry (SETAC Press).

Grover R (ed.) (1988) Environmental Chemistry of Herbicides, Vol. 1, 207 pp. Boca Raton, FL: CRC Press, Inc.

Grover R, Cessna AJ (1991) Environmental Chemistry of Herbicides, Vol. II, 302 pp. Boca Raton, FL: CRC Press

Koller W (1992) Target Sites of Fungicide Action. 328 pp. Boca Raton, FL: CRC Press.

Lyr H (ed.) (1995) Modern Selective Fungicides. Properties, Applications, Mechanisms of Action, 595 pp. New York: Gustav Fischer Verlag.

Shaner DL, O'Connor SL (1991) The Imidazolinone Herbicides. 290 pp. Boca Raton, FL: CRC Press.

Reference Books for Pesticide Chemistry & Toxicology

These books cover all aspects of pesticide chemistry and toxicology, from basic mechanisms through risk assessment and regulation. In addition, some of the entries tackle more sociological issues of pesticide technology, exploring their future use as well as questions concerning their impact on health and the environment.

Bohmont BL (2007) The Standard Pesticide User's Guide, 7th edition, 622 pp. Weimar, Texas: Culinary and Hospitality Industry Publications Services.

Daniel P (2007) Toxic Drift: Pesticides and Health in the Post-World War II South. 209 pp. Baton Rouge, LA: Louisiana State University Press.

den Hond F, Groenewegen P, van Straalen NM (eds.) (2003) Pesticides: Problems, Improvements, Alternatives, 256 pp. Oxford, UK: Blackwell Science.

Krieger RI (ed.) (2001) Handbook of Pesticide Toxicology Second Edition; Volume 1, Principles; Volume 2, Agents, both volumes: 1908 pp. New York: Academic Press.

Matthews GA (2006) Pesticides: Health, Safety and the Environment. 235 pp. Oxford, UK: Blackwell Science.

Muller F (ed.) (1999) Agrochemicals: Composition, Production, Toxicology, Applications, 1031 pp. Weinheim, Germany: Wiley-VCH.

NRC (National Research Council) (1987) Regulating Pesticide in Food. The Delaney Paradox. 288 pp. Washington, DC: National Academy Press.

NRC (National Research Council) (2000) The Future Role of Pesticides in U.S. Agriculture. 301 pp. Washington, DC: National Academy Press.

Pimentel D, Lehman H (eds.) (1993) The Pesticide Question. Environment, Economics, and Ethics, 441 pp. New York: Chapman & Hall.

Plimmer JR, Gammon DW, Ragsdale NN (eds.) (2003) Encyclopedia of Agrochemicals, Vols. 1–3. Hoboken, NJ: Wiley-Interscience.

Tomlin CDS (ed.) (2006) The Pesticide Manual, 1344 pp. Hampshire, UK: British Crop Protection Enterprises. (Also available as a CD-ROM)

Ware GW, Whitacre DM (2004) The Pesticide Book, 6th edition, 496 pp. Willoughby, Ohio: Meister Media Worldwide (ISBN 1892829-11-8).

Wargo J (1996) Our Children's Toxic Legacy. How Science and Law Fail to Protect Us from Pesticides. 380 pp. New Haven, CT: Yale University Press.

Whitford F (ed.) (2002) The Complete Book of Pesticide Management: Science, Regulation, Stewardship, and Communication, 787 pp. New York: John Wiley & Sons Inc.

Whitford F, Acquavella J, Burns C (2003) Pesticides and Epidemiology. Unraveling Disease Patterns. Publication No. PPP43, Purdue Pesticide Programs, Purdue University Cooperative Extension Service. URL: http://www.btny.purdue.edu/Pubs/PPP/PPP-43.pdf

U.S. Environmental Protection Agency (2004) Overview of the ecological risk assessment process in the Office of Pesticide Programs, U. S. Environmental Protection Agency: Endangered and threatened species effects determinations. 106 pp. Washington, DC: U.S. EPA OPPTS. URL: http://www.epa.gov/oppfead1/endanger/consultation/ecoriskoverview.pdf.

Books Covering Exposure Assessment

Franklin CA, Worgan JP (eds.) (2005) Occupational and Residential Exposure Assessment for Pesticides, 409 pp. West Sussex, UK: John Wiley & Sons, Ltd.

Honeycutt RC, Day EW, Jr. (eds.) (2001) Worker Exposure to Agrochemicals. Methods for Monitoring and Assessment, 169 pp. Boca Raton, FL: CRC Press.

Journals

The following journals routinely publish articles dealing with all aspects of pesticide technology. Historically, a disproportionate number of pages had been devoted to pesticide topics. However, over the last decade, especially as new contaminants have emerged, fewer articles are about pesticides.

Aquatic Toxicology (1981–)
Amsterdam, the Netherlands: Elsevier.

Focuses on mechanisms of toxicity in aquatic environments and responses to toxic agents at community, species, tissue, cellular and subcellular level, including aspects of uptake, metabolism and excretion of toxicants.
Web: http://www.elsevier.com/wps/find/journal_browse.cws_home (note that this URL will allow access to all Elsevier journals listed in this section).

Archives of Environmental Contamination and Toxicology (1973–)
New York: Springer

Articles cover analytical chemistry, biochemistry, pharmacology, toxicology, and environmental chemistry of all environmental contaminants. Exposure focus includes non-target plants and animals, including humans.
Web: http://www.springerlink.com/content/0090-4341

Bulletin of Environmental Contamination and Toxicology (1967–)
New York: Springer.

Rapid publication of significant advances and discoveries in the fields of air, soil, water, and food contamination and pollution as well as articles on methodology and other disciplines concerned with the introduction, presence and effects of toxicants in the total environment.
Web: http://www.springerlink.com/content/101156/

Chemosphere (1972–)
Amsterdam, the Netherlands: Elsevier.

Multidisciplinary journal, offers maximum dissemination of investigations related to all aspects of environmental science. Divided into four sections: 'Persistent Organic Pollutants and Dioxins'; 'Environmental Chemistry'; 'Environmental Toxicology and Risk Assessment'; 'Science for Environmental Technology'.
Web: http://www.elsevier.com/wps/find/journal_browse.cws_home

Ecotoxicology (1992–)
Amsterdam, the Netherlands: Springer.

Fundamental research on the effects of toxic chemicals on populations, communities, and terrestrial, freshwater, and marine ecosystems. Papers focus on mechanisms and processes of effects on ecosystems with an

examination of the impact caused at the population or community level.
Web: http://www.springerlink.com/content/0963-9292

Ecotoxicology and Environmental Safety (1977–)
Amsterdam, the Netherlands: Elsevier.

Focused on the integrated mechanistic research on exposure pathways and interactions of substances and chemical mixtures in environmental media; on bioavailability; circulation and assimilation in target and non-target organisms, their biological response and damage mechanisms (endocrine disruption, genotoxicity), as well as on a further fate in the food chain, including humans.
Web: http://www.elsevier.com/wps/find/journal_browse.cws_home

Environmental Health Perspectives (1972–)
Research Triangle Park, NC: National Institute of Environmental Health Sciences.

Research and news on the impact of the environment on human health; includes many studies of exposure assessment and epidemiology.
Web: www.ehponline.org/

Environmental Pollution (1970–)
Amsterdam, the Netherlands: Elsevier.

Papers address issues relevant to the nature, distribution and ecological effects of all types and forms of chemical pollutants in air, soil, and water.
Web: http://www.elsevier.com/wps/find/journal_browse.cws_home

Environmental Science and Technology (1967–)
Washington, DC: American Chemical Society.

Currently focuses on all natural and anthropogenic contaminants, publishing articles on basic environmental chemodynamics, trends in residues, waste remediation, exposure assessment, and risk characterization.
Web: http://pubs.acs.org/journals/esthag/

Environmental Toxicology and Chemistry (1982–)
Pensacola, FL: Society of Environmental Toxicology and Chemistry.

Papers describe experimental or theoretical work that advances an understanding of contaminants from the perspective of environmental toxicology and environmental chemistry. Many papers are focused on hazard identification, but also includes a few on risk characterization.
Web: http://www.setacjournals.org/perlserv/?request=get-archive

Journal of Agricultural and Food Chemistry (1953–)
Washington, DC: American Chemical Society.

Focus on discovery and biological activity of potential crop protection products (natural and synthetic) and environmental chemistry of pesticides; now dominated by papers on prevalence and biological activity of plant antioxidants and various aspects of other food biochemicals in relation to food taste and quality.
Web: http://pubs.acs.org/journals/jafcau/index.html

Journal of Environmental Quality (1972–)
Madison, WI: American Society of Agronomy.

Articles focus on environmental chemistry of natural and anthropogenic chemicals, as well as environmental processes associated with agricultural operations and urban environments.
Web: http://jeq.scijournals.org/

Journal of Environmental Science and Health, Pt. B: Pesticides, Food Contaminants, and Agricultural Wastes (1966–)
London, UK: Taylor Francis.

Original research reports on analytical techniques or improvements on existing methods applicable to residues of pesticides, food contaminants (natural and additive), and other chemical contaminants, and their metabolites in the ecosphere. Subjects include persistence, binding, translocation, chemical and biodegradation, and metabolic fate of contaminant chemicals; methods of detoxification; and toxicological considerations and consequences. The journal also encompasses the development of integrated methods of pest control and various aspects of agricultural wastes.
Web: http://www.tandf.co.uk/journals/

Journal of Toxicology and Environmental Health, Parts A & B (1975–)
London, UK: Taylor Francis.

Focus is on basic toxicology of a wide variety of contaminants with numerous articles historically about pesticides (Part A). Includes numerous review articles (Part B) on specific pesticides and on affected physiological systems.
Web: http://www.tandf.co.uk/journals/

Pest Management Science (formerly Pesticide Science) (1970–)
Hoboken, NJ: Wiley Interscience.

Covers all aspects of research and development, application, use and impact on the environment of products designed for pest control and crop protection.

Web: http://www.interscience.wiley.com/cgi-bin/jhome/68504529?CRETRY=1&SRETRY=0

Pesticide Biochemistry and Toxicology (1971–)
Amsterdam, the Netherlands: Elsevier.

Focus is toxicodynamics of all pesticides, including natural products. Welcomes molecular, biochemical, and physiological approaches to advance comparative toxicology and understand selectivity and pest resistance.

Reviews of Environmental Contamination and Toxicology (formerly Residue Reviews) (1962–)
New York: Springer.

Monographs of comprehensive reviews of all contaminants (natural and synthetic) including analysis, environmental chemistry, toxicology, exposure assessment, risk characterization, and epidemiology.
Web: http://www.springer.com/west/home/new+&+forthcoming+titles+(default)?SGWID=4-40356-69-173621538-0

Journal Articles

Exposure Assessment

The following articles from the AHS studied the reliability of self-reported information from workers that has typically been the basis for cohort comparisons in epidemiological studies. In addition, AHS research began to focus on biomonitoring.

Bell EM, Sandler DP, Alavanja MC, et al (2006) High pesticide exposure events among farmers and spouses enrolled in the Agricultural Health Study. J. Agricultural Safety and Health 12(2): 101–116.

Blair AR, Tarone R, Sandler DP, et al (2002) Reliability of reporting on life-style and agricultural factors by a sample of participants in the Agricultural Health Study from Iowa. Epidemiology 13: 94–99.

Coble J, Arbuckle T, Lee WJ, et al (2005) The validation of a pesticide exposure algorithm using biological monitoring results. J. Occup. Environ. Hygiene 2: 194–201.

Curwin BD, Hein MJ, Sanderson WT, et al (2005) Urinary and hand wipe pesticide levels among farmers and nonfarmers in Iowa. J. Expo. Anal. Environmen. Epidemiol. 15(6): 500–508.

Curwin BD, Hein MJ, Sanderson WT, et al (2007) Urinary pesticide concentrations among children, others and fathers living in farm and no-farm households in Iowa. Ann. Occup. Hyg. 51(1): 53–65.

Dosemeci M, Alavanja MCR, Rowland AS, et al (2002) A quantitative approach for estimating exposure to pesticides in the Agricultural Health Study. Ann. Occup. Hyg. 46(2): 245–260.

Hoppin JA, Yucel F, Dosemeci M, et al (2002) Accuracy of self-reported pesticide use duration information from licensed pesticide applicators in the Agricultural Health Study. J. Expo. Anal. Environ. Epidemiol. 12: 313–318.

Hoppin JA (2005) Integrating exposure measurements into epidemiologic studies in agriculture. Scan. J. Work Environ. Health 31(suppl. 1): 115–117.

The following set of papers was published by researchers associated with PNASH, the Pacific Northwest Agricultural Safety and Health Center at the University of Washington (URL: http://depts.washington.edu/pnash/). The National Institute of Occupational Safety and Health over the last decade funded centers like PNASH throughout the U.S. to study all aspects of agricultural workers safety and health. Some of these centers have also been conducting assessments of children's exposure to pesticides, as well as potential health outcomes, under EPA funding mandates.

Curl CL, Fenske RA, Elgethun K, et al (2003) Organophosphorus pesticide exposure of urban and suburban pre-school children with organic and conventional diets. Environ. Health Perspect. 111: 377–382.

Elgethun K, Yost MG, Fitzpatrick CT (2007) Comparison of global positioning system (GPS) tracking and parent-report diaries to characterize children's time-location patterns. J. Expo. Sci. Environ. Epidemiol. 17: 196–206.

Elgethun K, Fenske RA, Yost MG, et al (2003) Time-location analysis for exposure assessment studies of children using a novel global positioning system instrument. Environ. Health Perspect. 111: 115–122.

Fenske RA, Birnbaum SG, Mathner MM, et al (2002) Fluorescent tracer evaluation of chemical protective clothing during pesticide applications in central Florida citrus groves. J. Agric. Saf. Health 8(3): 319–331.

Fenske RA, Bradman A, Whyatt RM, et al (2005) Lessons learned for the assessment of children's pesticide exposure: critical sampling and analytical issues for future studies. Environ. Health Perspect. 113: 1455–1462.

Fenske RA, Kissel JC, Kalman D, et al (2000) Biologically based pesticide dose estimates for children in an agricultural community. Environ. Health Perspect. 108(6): 515–520.

Fenske RA, Lu C, Curl CL, et al (2005) Biologic monitoring to characterize organophosphorus pesticide exposure among children and workers: an analysis

of recent studies in Washington State. Environ. Health Perspect. 113(11): 1651–1657.

Fenske RA, Lu C, Simcox NJ, et al (2000) Strategies for assessing children's organophosphorus pesticide exposures in agricultural communities. J. Exp. Anal. Environ. Epid. 10: 662–671.

Fenske RA (2005) State-of-the-art measurement of agricultural pesticide exposures. Scand. J. Work Environ. Health 31(Suppl 1): 67–73.

Kissel JC, Fenske RA (2000) Improved estimation of dermal pesticide dose to agricultural workers upon reentry. Appl. Occup. Environ. Hyg. 15(3): 1–7.

Koch DC, Lu C, Fisker-Anderson J, et al (2002) Temporal association of children's pesticide exposure an agricultural spraying: Report of a longitudinal biological monitoring study. Environ. Health Persp. 110(8): 829–833.

Lu C, Fenske RA (1998) Air and surface chlorpyrifos residues following residential broadcast and aerosol pesticide applications. Environ. Sci. Technol. 32: 1386–1390. (Correction noted in ES&T 32(16): 2480).

Lu C, Fenske RA (1999) Dermal transfer of chlorpyrifos residues from residential surfaces: comparison of hand press, hand drag, wipe, and polyurethane foam roller measurements after broadcast and aerosol pesticide applications. Environ. Health Perspec. 107(6): 463–467.

Lu C, Fenske RA, Simcox NJ, et al (2000) Pesticide exposure of children in an agricultural community: evidence of household proximity to farmland and take home exposure pathways. Environ. Res. 84: 290–302.

Lu C, Topel K, Irish R, et al (2006) Organic diets significantly lower children's dietary exposure to organophosphorus pesticides. Environ. Health Perspect. 114(2): 260–263.

Rodriguez T, Younglove L, Lu C, et al (2006) Biological monitoring of pesticide exposures among applicators and their children in Nicaragua. Int. J. Occup. Environ. Health 12: 312–320.

Thompson B, Coronado GD, Grossman JE, et al (2003) Pesticide take-home pathway among children of agricultural workers: study design, methods, and baseline findings. J. Occup. Environ. Med. 44(11): 42–53.

Other Children and Worker Exposure Assessment Articles

Particularly notable among this next subset of exposure assessment papers is a focus on biomonitoring urinary metabolites (especially of OP insecticides) or parent pesticides in children and farmworkers. The focus on children has been on exposures from use of pesticides in residential settings.

Arcury TA, Quandt SA, Barr DB, et al (2006) Farmworker exposure to pesticides: Methodologic issues for the collection of comparable data. Environ. Health Perspect. 114(6): 923–928.

Adgate JL, Barr DB, Clayton CA, et al (2001) Measurement of children's exposure to pesticides: analysis of urinary metabolite levels in a probability-based sample. Environ. Health Perspect. 109(6): 583–590.

Alexander BH, Mandel JS, Baskar BA, et al (2007) Biomonitoring of 2,4-dichlorophenoxyacetic acid exposure and dose in farm families. Environ. Health Perspect. 115: 370–376.

Barr DB, Thomas K, Curwin B, et al (2006) Biomonitoring of exposure in farmworker studies. Environ. Health Perspect. 114(6): 936–942.

Bradman A, Barr DB, Henn GGC, et al (2003) Measurement of pesticides and other toxicants in amniotic fluid as a potential biomarker of prenatal exposure: A validation study. Environ. Health Perspect. 111: 1779–1782.

Barton HA, Pastoor TP, Baetcke K, et al (2006) The acquisition and application of absorption, distribution, metabolism, and excretion (ADME) data in agricultural chemical safety assessments. Crit. Rev. Toxicol. 36(1): 9–35.

Berkowitz GS, Obel J, Deych E, et al (2003) Exposure to indoor pesticides during pregnancy in a multiethnic, urban cohort. Environ. Health Perspect. 111: 79–84.

Bouvier GN, Seta N, Vigouroux-Villard A, et al (2005) Insecticide urinary metabolites in nonoccupationally exposed populations. J. Toxicol. Environ. Heatlh Pt. B 8: 485–512.

Byrne SL, Shurdut BA, Saunders DG (1999) Potential chlorpyrifos exposure to residents following standard crack and crevice treatment. Environ. Health Perspect. 106(11): 725–731.

Castorina R, Bradman A, McKone TE, et al (2003) Cumulative organophosphate pesticide exposure and risk assessment among pregnant women living in an agricultural community: A case study from the CHAMACOS cohort. Environ. Health Perspect. 111: 1640–1648.

Colt JS, Cyr MJ, Zahm SM, et al (2007) Inferring past pesticide exposures: A matrix of individual active ingredients in home and garden pesticides used in past decades. Environ. Health Perspect. 115: 248–254.

Duggan A, Charnley G, Chen W, et al (2003) Di-alkyl phosphate biomonitoring data: assessing cumulative exposure to organophosphate pesticides. Reg. Toxiciol. Pharmacol. 37(3): 382–395.

Fenske RA, Lu C, Barr D, et al (2002) Children's exposure to chlorpyrifos and parathion in an agricultural community in central Washington state. Environ. Health Perspect. 110(5): 549–553.

Harnly M, Mchaughlin R, Bradman A, et al (2005) Correlating agricultural use of organophosphates with outdoor air concentrations: A particular concern for children. Environ. Health Perspect. 113: 1184–1189.

Hines C, Deddens A, Tucker SP, et al (2001) Distributions and determinants of pre-emergent herbicide exposures among custom applicators. Ann. Occup. Hygiene 45(3): 227–239.

Hoppin JA, Adgate JL, Eberhart M, et al (2006) Environmental exposure assessment of pesticides in farmworker homes. Environ. Health Perspect. 114(6): 929–935.

Hore P, Robson M, Freeman N, et al (2005) Chlorpyrifos accumulation patterns for child-accessible surfaces and objects and urinary metabolite excretion by children for 2 weeks after crack-and-crevice application. Environ. Health Perspect. 113: 211–219.

Landrigan PJ, Claudio L, Markowitz SB, et al (1999) Pesticides and inner-city children: exposures, risks, and prevention. Environ. Health Perspect. 107(Supplement 3): 431–437.

McKone TE, Castorina R, Harnly ME, et al (2007) Merging models and biomonitoring data to characterize sources and pathways of human exposure to organophosphorus pesticides in the Salinas Valley of California. Environ. Sci. Technol. 41(9): 3233–3240.

Nigg HN, Knaak JB (2000) Blood cholinesterases as human biomarkers of organophosphorus pesticide exposure. Rev. Environ. Contam. Toxicol. 163: 29–112.

Quandt SA, Hernandez-Valero MA, Gryzwacz JG, et al (2006) Workplace, household, and personal predictors of pesticide exposure for farmworkers. Environ. Health Perspect. 114(6): 943–952.

Rigas ML, Okino MS, Quackerboss JJ, et al (2001) Use of a pharmacokinetic model to assess chlorpyrifos exposure and dose in children, based on urinary biomarker measurements. Toxicol. Sci. 61: 374–381.

Ross JH, Dong MH, Krieger RI, et al (2000) Conservatism in pesticide exposure assessment. Reg. Toxicol. Pharmacol. 31: 53–58.

Ross JH, Driver JH, Cochran RC, et al (2001) Could pesticide toxicology studies be more relevant to occupational risk assessment?. Ann. Occup. Hyg. 45(Suppl 1): S5–S17.

Ross JH, Driver JH, Lunhick C, et al (2005) Dermal absorption of 2,4-D: A review of species differences. Reg. Toxicol. Pharmacol. 41: 82–91.

Ross JH, et al (2006) Pesticide exposure monitoring databases in applied risk analysis. Rev. Environ. Contam. Toxicol. 186: 107–132.

Rull RP, Ritz B (2003) Historical pesticide exposure in California using pesticide use reports and land-use surveys: An assessment of misclassification error and bias. Environ. Health Perspect. 111: 1582–1589.

Saieva C, Aprea A, Tamino R, et al (2004) Twenty-four-hour urinary excretion of ten pesticide metabolites in healthy adults in two different areas of Italy (Florence and Ragusa). Sci. Total Environ. 332: 71–80.

Sexton K, Adgate JL, Eberly LE, et al (2003) Predicting children's short-term exposure to pesticides: Results of a questionnaire screening approach. Environ. Health Perspect. 110: 123–128.

Shurdut BA, Barraj L, Francis M (1998) Aggregate exposures under the Food Quality Protection Act: An approach using chlorpyrifos. Regul. Toxicol. Pharmacol. 28: 165–177.

Stellman SD, Stellman JM (2004) Exposure opportunity models for Agent Orange, dioxin, and other military herbicides used in Vietnam, 1961–1971. J. Expo. Anal. Environ. Epidemiol. 14: 352–354.

Stewart PA, Prince JK, Colt JS, et al (2001) A method for assessing occupational pesticide exposures of farmworkers. Am. J. Ind. Med. 40: 561–570.

Whyatt RM, Barr DB, Camann DE, et al (2003) Contemporary-use pesticides in personal air samples during pregnancy and blood samples at delivery among urban minority mothers and newborns. Environ. Health Perspect. 111: 749–756.

Whyatt RM, Garfinkel R, Hoepner LA, et al (2007) Within- and between-home variability in indoor-air insecticide levels during pregnancy among an inner-city cohort from New York City. Environ. Health Perspect. 115: 383–389.

Wolf TM, Gallander KS, Downer RA, et al (1999) Contribution of aerosols generated during mixing and loading of pesticides to operator inhalation exposure. Toxicol. Lett. 105: 31–38.

Younes M, Galal-Gorchev H (2000) Pesticides in drinking water—A case study. Food Chem. Toxicol. 38(Supplement 1): S87–S90.

Neurodevelopmental and Neurotoxicological Effects

Epidemiological Correlations

Alarcon WA, Calvert GM, Blondell JM, et al (2005) Acute illnesses associated with pesticide exposure at schools. JAMA 294: 455–465.

Ascherio A, Chen H, Weisskopf MG, et al (2006) Pesticide exposure and risk for Parkinson's disease. Ann. Neurol. 60: 197–203.

Beseler C, Stallones L, Hoppin JA, et al (2006) Depression and pesticide exposures in female spouses of licensed pesticide applicators in the Agricultural Health Study cohort. J. Occup. Environ. Med. 48(10): 1005–1013.

Bilgin TE, Camdeviren H, Yapici D, et al (2005) The comparison of the efficacy of scoring systems in organophosphate poisoning. Toxicol. Ind. Health 21: 141–146.

Cochran RC (2002) Appraisal of risks from nonoccupational exposure to chlorpyrifos. Regul. Toxicol. Pharmacol. 35: 105–121.

Elbaz A, Clavel J, Richard F, et al (2004) CYP2D6 polymorphism, pesticide exposure, and Parkinson's disease. Ann. Neurol. 55(3): 430–434.

Engel LS, Keifer MC, Checkoway H, et al (1998) Neurophysiological function in farm workers exposed to organophosphate pesticides. Arch. Environ. Health 53(1): 7–13.

Eskenazi B, Bradman A, Castorina R (1999) Exposures of children to organophosphate pesticides and their potential adverse health effects. Environ. Health Perspect. 107(Supplement 3): 409–419.

Farahat TM, Abdelrasoul GM, Amr MM, et al (2003) Neurobehavioural effects among workers occupationally exposed to organophosphorus pesticides. Occup. Environ. Med. 60: 279–286.

Furlong CE, Holland N, Richter RJ, et al (2008) PON1 status of farmworker mothers and children as a predictor of organophosphate sensitivity. Pharmacogenet. Genom. 16: 183–190.

Kamel F, Engel LS, Gladen BC, et al (2005) Neurologic symptoms in licensed private pesticide applicators in the agricultural health study. Environ. Health Perspect. 113: 877–882.

Kamel F, Tanner CM, Umbach DM, et al (2007) Pesticide exposure and self-reported Parkinson's disease in the Agricultural Health Study. Am. J. Epidemiol. 165(4): 364–374.

Le Couteur DG, McLean AJ, Taylor MC, et al (1999) Pesticides and Parkinson's disease. Biomed. Pharmacother. 53: 122–130.

McCauley LA, Anger WK, Keifer MC, et al (2006) Studying health outcomes in farmworker populations exposed to pesticides. Environ. Health Perspect. 114(6): 953–960.

Miranda J, McConnell R, Delgado E, et al (2002) Tactile vibration thresholds after acute poisonings with organophosphate insecticides. Int. J. Occup. Environ. Health 8: 212–219.

Mishra GA (2006) The effect of tobacco consumption on blood cholinesterase levels among workers exposed to organophosphorus pesticides. Toxicol. Ind. Health 22: 399–403.

Needham LL, Barr DB, Candill SP, et al (2005) Concentrations of environmental chemicals associated with neurodevelopmental effects in U.S. population. Neurotoxicology 26: 531–545.

Priyadarshi A, Khuder SA, Schaub EA, et al (2000) A meta-analysis of Parkinson's disease and exposure to pesticides. Neurotoxicology 21(4): 435–440.

Rauh VA, Garfinkel R, Perera FP, et al (2006) Impact of prenatal chlorpyrifos exposure on neurodevelopment in the first 3 years of life among inner-city children. Pediatrics 118: 1845–1859.

Rosane Maria Salvi RM, Lara DR, Ghisolfi ES, et al (2003) Neuropsychiatric evaluation in subjects chronically exposed to organophosphate pesticides. Toxicol. Sci. 72: 267–271.

Rothlein J, Rohlman DS, Lasarev M, et al (2006) Organophosphate pesticide exposure and neurobehavioral performance in agricultural and nonagricultural Hispanic workers. Environ. Health Persp. 114: 691–696.

Rubin C, Esteban E, Kieszak S, et al (2002) Assessment of human exposure and human health effects after indoor application of methyl parathion in Lorain County, Ohio, 1995–1996. Environ. Health Perspect. 110(suppl 6): 1047–1051.

Spencer J, O'Malley M (2006) Pyrethroid illnesses in California, 1996–2002. Rev. Environ. Contam. Toxicol. 186: 57–72.

Stallones L, Beseler C (2002) Pesticide poisoning and depressive symptoms among farm residents. Ann. Epidemiol. 12: 389–394.

Torres-Sanchez L, Rothenberg SJ, Schnaas L, et al (2007) In utero p,p'-DDE exposure and infant neurodevelopment: A perinatal cohort in Mexico. Environ. Health Perspect. 115: 435–439.

Wesseling C, Keifer M, Ahlbom A, et al (2002) Long-term neurobehavioral effects of mild poisonings with organophosphate and N-methyl carbamate

pesticide among banana workers. Int. J. Occup. Environ. Health 8: 27–34.

Young JG, Eshkenazi B, Gladstone EA, et al (2005) Association between in utero organophosphate pesticide exposure and abnormal reflexes in neonates. Neuro. Toxicol. 26: 199–209.

Mechanistic Studies with Organophosphorus Insecticides and Pyrethroids

Abu-Qare AW, Abou-Donia MB (2003) Combined exposure to DEET (N,N-diethyl-m-toluamide) and permethrin: pharmacokinetics and toxicological effects. J. Toxicol. Environ. Health Pt. B 6: 41–53.

Albers JW Levin ED, Seidler FJ, et al (2007) Dose-effect analyses of occupational chlorpyrifos exposure and peripheral nerve electrophysiology. Toxicol. Sci. 97(1): 196–204.

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Web Resources

The evolution of internet access has greatly facilitated finding information about any toxicological subject. Even if entire journal articles cannot be downloaded, the abstracts are freely available along with links for communication with the senior author of an article. Thus, one can always request a reprint of the full article. In addition to facilitated access to the peer-reviewed research literature, a number of government and NGO websites have valuable information about pesticide toxicology and chemistry, and perhaps as importantly, scientific policy governing pesticide technology. Felsot (2002) comprehensively reviewed electronic resources of pesticide information. Below is an update of the more important websites that represent databases of information useful for conducting human health risk assessments.

Felsot AS (2002) WEB resources for pesticide toxicology, environmental chemistry, and policy: a utilitarian perspective. Toxicology 17: 153–166.

California EPA-Department of Pesticide Regulation (DPR) Risk Assessments

Web: http://www.cdpr.ca.gov/docs/risk/rcd.htm

CDPR conducts independent human health risk assessments for numerous active ingredients. Each is available form this site as a downloadable PDF file. From the home page of CDPR, one can also find useful information about all aspects of pesticide technology, including links to information about how CDPR regulates pesticides and conducts risk assessments.

EXTOXNET

Web: http://ace.orst.edu/info/extoxnet/

This site, which is hosted by Oregon State University, has an alphabetized linkable list of pesticides (under the link called 'Pesticide Information Profiles'). Although some of the information is becoming dated, and pesticides registered within the last several years are not included, the information provides a complete overview of pesticide mammalian toxicity, ecotoxicity, and environmental fate.

National Pesticide Information Center

Web: http://npic.orst.edu

Fact sheets downloadable as PDF files have been developed for some active ingredients (31 at this time) and are written in non-technical language. Some of them give detailed information about both hazards and dose-response relationships (for example, see the fact sheet for the insecticide synergist piperonyl butoxide). Fact sheets have also been developed on specific pesticide topics. Many of the pesticides with technical fact sheets are those commonly used in urban environments.

Non-Governmental Organizations

NCAP (Northwest Coalition for Alternatives to Pesticide)

Web: http://www.pesticide.org/

This NGO website provides information about pesticide hazards but also alternatives to pesticides that could provide effective pest control. The site also

includes information on inert ingredients and hosts various campaigns for increasing the public's right to know about pesticide ingredients. The site contains numerous fact sheets for registered pesticides that have appeared in the NGO's publication, *Journal of Pesticide Reform*.

PANNA (Pesticide Action Network of North America)
Web: http://www.panna.org/

NGO sites tend to be focused on hazard identification without consideration of exposure. Nevertheless NCAP and PANNA have extensive fact sheet information about many pesticides. PANNA has a searchable database that provides an acute toxicity endpoint (for example, oral and dermal LD_{50}) and narrative hazard information.

Program on Breast Cancer and Environmental Risk Factors
Web: http://envirocancer.cornell.edu/

Developed and hosted by Cornell University faculty, BCERF's mission is to address 'the relationship between environmental risk factors and breast cancer through a variety of research and education strategies'. The site has downloadable PDF files of critical analyses and HTML formats of fact sheets and extensive bibliographies. Most pesticides highlighted on the site are those where any association with breast cancer had been suspected from animal and human studies. The site has a search engine, and recent additions include a database of turf pesticides and cancer risk.

U.S. EPA Home Page to start searching for information
Web: http://www.epa.gov/pesticides

This site is EPA's portal for the plethora of information developed by the agency about all aspects of pesticide technology. Thus, from this portal one should be able to find information about specific active ingredients as well as regulations and science policy for conducting pesticide risk assessments. The site also includes a highlights section that links to news regarding recent agency decisions and science reviews.

U.S. EPA FIFRA Scientific Advisory Panel
Web: http://www.epa.gov/scipoly/sap/

This site posts numerous EPA position papers that have analyzed basic and applied pesticide toxicology issues that the agency desires its advisory panel to comment on. Many papers are oriented to science policy concerning modeling and testing that will aid in making pesticide registration decisions.

U.S. EPA Re-registration Eligibility Decision Database
Web: http://www.epa.gov/pesticides/reregistration/status.htm

This site has an alphabetical list of pesticides for which EPA has issued a re-registration eligibility decision. Documents are available for download as PDF files.

Organizations (professional scientific societies that include pesticides as a focal area)

American Chemical Society, Division of Agrochemicals
1155 Sixteenth Street, NW
Washington, DC 20036
Phone: (800) 227-5558
E-Mail: service@acs.org
Web: https://portal.acs.org/portal/acs/corg/memberapp (Home Page of Society)
Web: http://www.membership.acs.org/a/agro/ (Home Page for Division)

Society of Environmental Chemistry and Toxicology
1010 North 12th Avenue
Pensacola, FL 32501-3367
Phone: 850-469-1500
Fax: 850-469-9778
E-Mail: setac@setac.org
Web: http://www.setac.org/

Society of Toxicology
1821 Michael Faraday Drive, Suite 300
Reston VA 20190
Phone: (703) 438-3115
Fax : (703) 438-3113
E-Mail: sothq@toxicology.org
Web: http://www.toxicology.org/

CHAPTER

18

Chemicals: Solvents[1]

WILLIAM K. BOYES

INTRODUCTION

The organic solvents are among the most common substances in industry and commerce. They are used for a wide variety of applications where dissolving organic compounds is of interest. Among the principal applications are metal cleaning and degreasing, painting, printing, dry cleaning, adhesives, and fuels and fuel additives. Organic solvents are also common in consumer products such as glues, cleaning products, and inert ingredients in pesticide formulations. When measured by volume, three of the top five hazardous air pollutants released into the air are the common organic solvents toluene, benzene, and xylene. These three substances together comprise approximately 40% of all hazardous air pollutants released into the U.S. air each year. There are some chemicals that are not typically used as chemical solvents, but are usually considered among the solvents due to their similar chemical structure, propensity to release hydrocarbon vapors, and toxic properties. These include styrene monomer, a base substance for production of polystyrenes, and many components of fuels and gasoline. Gasoline contains many hundreds of organic compounds, but the common presence of benzene, toluene, ethylbenzene, and xylene (BTEX) has led to the use of BTEX as a marker of gasoline exposure. In a subset of the NHANNES III study, toluene and several organic solvents were detected in blood samples from greater than or equal to 75% of the U.S. population. Many hazardous waste sites contain substantial quantities of organic solvents, in particular chlorinated organics such as trichloroethylene and perchloroethylene. In proportion to their widespread use and large potential for human exposure, there is likewise a large and diverse scientific literature on the toxicity of organic solvents. One good source to begin an overview of the diverse toxicity of organic solvents is Bruckner et al (2008).

The toxicity of organic solvents is linked in large part to two key aspects of their physical nature, first they are lipophilic and second many are volatile. Lipophilic substances distribute readily across most biological membranes including the common portals of entry (lung, gut, skin) and across biological membranes that may serve as penetration barriers to other substances, including the blood–brain barrier and the placenta. Many of the common organic solvents are relatively small in molecular weight, such as toluene or trichloroethylene, and lack strong electrostatic intermolecular forces, causing them to have a low vapor pressure. Consequently, many organic compounds readily enter the vapor phase when they encounter air, and inhalation is typically the primary route of exposure. This can be true even when the more water-soluble of the organic solvents, such as TCE, are encountered as water contaminants (Scott & Cogliano 2000). Inhalation of vapors generated during showering may be the primary route of exposure for waterborne volatile organic contaminants. Recent efforts to reduce the hazards of organic solvents have included substitution of less volatile alternative constituents of fuels and other common products.

[1]This manuscript has been reviewed by the National Health and Environmental Effects Research Laboratory, Office of Research and Development, U.S. Environmental Protection Agency and approved for publication. Approval does not signify that the contents reflect the policies of the Agency nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

A common target organ for toxicity of organic solvents is the nervous system. Acute exposure to solvent vapors can lead to rapid behavioral, cognitive, and perceptual changes. Associated with these changes, neurophysiological measures of the function of the central nervous system are altered as well. Low levels of exposure may initially lead to increased excitation and activation, and a feeling of euphoria. With increasing exposure, these effects may be followed by sedation and general CNS depression. Recovery from acute solvent exposure is typically rapid and complete, and generally follows the time course of metabolism and clearance of the compound. Chronic or repeated episodes of acute high-level exposures can be followed by persistent or irreversible deficits in neurological function. These deficits have been observed primarily as impaired cognitive function, impaired performance on visual functions tests such as color discrimination or visual contrast sensitivity, and in some cases impaired balance and poor motor coordination associated with cerebellar dysfunction. The book by Arlien-Søborg (1992) is the most comprehensive source of information available on the neurotoxic properties of organic solvents. More recently Spencer et al (2000) provide chapters describing the neurotoxicity of several important organic solvents.

The vast literature on the toxicology of organic solvents and related substances makes it practically impossible to compile a comprehensive bibliography. The following is by no means a complete bibliography of the available primary literature. Instead this list of resources is intended to reflect some of the major sources of information available, including recent review articles, and should aid in the identification of the primary institutions involved in research and evaluation of potential health risks from exposure to organic solvents.

RESOURCES

Books

Arlien-Søborg P (1992)
Solvent Neurotoxicity
Boca Raton, FL: CRC Press.

Although somewhat dated now, this book remains the most comprehensive account of solvent neurotoxicity. Separate chapters are dedicated to toluene, xylene, styrene, n-hexane, methyl *n*-butyl ketone, methyl ethyl ketone, 2,5-hexanedione, methylene chloride, methyl chloride, trichloroethylene, 1,1,1-trichloroethane, white spirit, and solvent mixtures. Much of the literature on solvent neurotoxicology in occupationally exposed humans stems from the latter half of the 20th century, when occupational exposure levels were higher, for the most part, than they are in developed countries today. Therefore, this book contains important toxicological information that is less likely to be reported today.

Ash M, Ash I (2003)
Handbook of Solvents, 2nd edition
Synapse Information Resources, Inc.

Useful to solvent formulators and manufacturers, containing chemical and health and safety information for trade names and products that are used as solvents across industry sectors.

Bingham E, Corsen B, Powell CH (eds) (2001)
Patty's Toxicology, 5th edition
New York: John Wiley & Sons.

This multivolume set of books provides detailed reviews of the toxicological information relevant to major industrial compounds. The target audience is industrial hygiene professionals and allied fields in order to provide information adequate to manage a safe work environment. These volumes are also useful more broadly because of the depth of information provided.

Bruckner LV, Anand SS, Warren DA (2008)
Toxic effects of solvents and vapors. In: Klaassen CD (ed)
Casarett and Doull's Toxicology: the Basic Science of Poisons, 7th edition
New York: McGraw-Hill Medical Publishing Division.

This chapter provides an excellent overview of the general toxicity of solvents and vapors, especially regarding metabolism and other toxicokinetic factors. Solvents are detailed according to the following classes: chlorinated hydrocarbons, aromatic hydrocarbons, alcohols, ethers, fuels and fuel additives, and carbon disulfide.

Bushnell PJ, Crofton KM (1999)
Organic solvents. In: Niesink RJM, Jaspers RMA, Kornet LMW, van Ree JM, Tilson HA (eds)
Introduction to Neurobehavioral Toxicology Food and Environment, pp. 395–428
Boca Raton, FL: CRC Press.

This book chapter provides an overview of the neurotoxic properties of organic solvents including tables of the concentrations at which individual substances have olfactory and irritant properties, and tables listing solvents having ototoxic, sensory, motor and cognitive effects in laboratory animals and humans.

Reddy MB, Yang RS, Clewell H J III, Andersen ME (2005)
Physiologically Based Pharmacokinetic Modeling, Science and Applications

Hoboken, NJ: Wiley-Interscience, John Wiley & Sons, Inc.

This book contains detailed sections regarding pharmacokinetic modeling of organic solvents including alkenes, halogenated alkanes and alkenes, and aromatic compounds.

Reichardt C (2003)
Solvents and Solvent Effects in Organic Chemistry 3rd edition
Hoboken, NJ: Wiley-Interscience, John Wiley & Sons, Inc.

Solvent chemistry for the organic chemist. Provides insight into the properties of different organic solvents that are important for product formulations, and may serve as a reference in trying to select less toxic materials with specific chemical properties.

Spencer PS, Schaumburg HH, Ludolph AC (2000)
Experimental and Clinical Neurotoxicology, 2nd edition
New York: Oxford University Press.

This book contains chapters describing neurotoxic properties of many compounds including several organic solvents, or compounds that have solvent-like toxicity, including: carbon disulfide, n-hexane, methylene chloride, organic solvent mixtures, styrene, tetrachloroethylene, toluene, and trichloroethylene.

Journals

American Journal Industrial Medicine (1980)
Web:
http://www3.interscience.wiley.com/cgi-bin/jhome/34471

This journal publishes many articles regarding occupational health and exposure to organic solvents.

Environmental Health Perspectives (1972)
Web: http://www.ehponline.org/

This journal contains many articles on volatile organic compounds, especially considering those that many be contaminants of outdoor or indoor air.

Journal of Toxicology and Environmental Health (1975)
Web: http://www.tandf.co.uk/journals/titles/15287394.asp

Publishes numerous research articles on solvent toxicity.

NeuroToxicology (1979)
Elsevier (prior to 2001 this journal was published by Intox Press)
Web: http://www.neurotoxicology.com/journal.htm

This journal published papers on the toxic effects of a variety of substances on the nervous system, including many organic solvents. A special issue of this journal (vol. 7(4), 1986) presented proceedings of a workshop on neurobehavioral effects of solvents, including a diagnostic framework for clinical assessments.

Neurotoxicology and Teratology (1979)
Elsevier
Web: http://www.elsevier.com/wps/find/journaldescription. cws_home/525481/description#description

This journal frequently publishes experimental studies of solvent neurotoxicity in both humans and laboratory animals.

Scandinavian Journal of Work Environment & Health (1975)
Web: http://www.sjweh.fi/index.php

This journal publishes many papers on organic solvent toxicity in occupational settings, including the so-called 'Scandinavian painter's syndrome'.

The SIRC Review (1990)
The Styrene Information and Research Center, Washington DC
Web: www.styrene.org

This journal is sponsored by the styrene industry and presents articles relevant to the use of styrene and protection of public health and the environment. Many of the articles are commissioned by the Styrene Information and Research Center.

Toxicological Sciences (1981)
Web: http://toxsci.oxfordjournals.org/

This is the official journal of the Society of Toxicology and publishes many peer-reviewed research articles on solvent toxicity.

Journal Articles

Adgate JL, Church TR, Ryan AD, et al (2004) Outdoor, indoor, and personal exposure to VOCs in children. Environ. Health Perspect 112: 1386–1392.

This paper presents measured and time-average modeled levels of exposure to VOCs among a sample of American elementary school children.

Benignus VA, Bushnell PJ, Boyes WK (2005) Toward cost-benefit analysis of acute behavioral effects of toluene in humans. Risk Anal. 25: 447–456.

This article compares the effects of toluene to those of ethanol in a quantitative manner, with the goal of using the data on the economic consequences of ethanol exposure to help estimate benefit–cost relationships for control of exposure to toluene and other volatile organic compounds.

Benignus VA, Geller AM, Boyes WK, Bushnell PJ (2005) Human neurobehavioral effects of long-term exposure to styrene: a meta-analysis. Environ. Health Perspect. 113: 532–538.

This article presents a meta-analysis of the available literature from workplace exposures to styrene on the neurotoxic outcomes of simple and choice reaction times and color vision impairment.

Bowen SE, Batis JC, Paez-Martinez N, Cruz SL (2006) The last decade of solvent research in animal models of abuse: Mechanistic and behavioral studies. Neurotoxicol. Teratol. 28: 636–647.

This article presents a review of the literature of developmental exposure to toluene as related to potential drug abuse exposure scenarios.

Bukowski JA (2001) Review of the epidemiological evidence relating toluene to reproductive outcomes. Reg. Toxicol. Pharmacol. 33: 147–156.

A review of six published studies linking occupational toluene exposure to increased risks of spontaneous abortion, congenital malformation, or reduced fertility.

Bushnell PJ, Boyes WK, Shafer TJ, Bale AS, Benignus VA (2007) Approaches to extrapolating animal toxicity data on organic solvents to public health. Neurotoxicol 28: 221–226.

This review article describes a quantitative modeling framework to predict risks of exposure to organic solvents based on estimates of target tissue dose.

Caldwell DJ, Armstrong TW, Barone NJ, Suder JA, Evans MJ (2000) Hydrocarbon solvent exposure data: Compilation and analysis of the literature. Am. Ind. Hygiene Assoc. J. 61: 881–894.

A paper reporting creation of a database for estimating exposure to hydrocarbon for product end-users.

Churchill JE, Ashley DL, Kaye WE (2001) Recent chemical exposures and blood volatile organic compound levels in a large population-based sample. Arch. Environ. Health 56: 157–166.

A survey of blood levels of volatile organic compounds in the U.S. general population without occupational exposure based on data from the NHANES III study.

Dick FD (2006) Solvent neurotoxicity. Occup. Environ. Med. 63: 221–226.

A general overview of neurotoxic effects of solvent exposure targeted to occupational physicians.

Dreiem A, Myhre O, Fonnum F (2002) Relationship between lipophilicity of C6-10 hydrocarbon solvents and their ROS-inducing potency in rat cerebellar granule cells. Neurotoxicol 23: 701–709.

This paper presents data on the generation of reactive oxygen species in a primary tissue culture assay by aliphatic, alicyclic and aromatic hydrocarbons as a function of their log octanol/water partition coefficients.

Fustinoni S, Consonni D, Campo L, et al (2005) Monitoring low benzene exposure: comparative evaluation of urinary biomarkers, influence of cigarette smoking, and genetic polymorphisms. Cancer Epidemiol. Biomarkers Prev. 14: 2237–2244.

Developing biomarkers for evaluating low level occupational or environmental exposures to benzene.

Gagnaire F, Langlais C (2005) Relative ototoxicity of 21 aromatic solvents. Arch. Toxicol. 79: 346–354.

A comparison of 21 organic solvents given to orally to rats, allowing assessment of structure/activity relationships for causing a loss of hearing.

Hooiveld M, Haveman W, Roskes K, et al (2006) Adverse reproductive outcomes among male painters with occupational exposure to organic solvents. Occup. Environ. Med. 63: 538–544.

An epidemiological study of Dutch painters shows an increased relative risk of having offspring with congenital malformations associated with occupational solvent exposures.

Lamb JC, Hentz KL (2006) Toxicological review of male reproductive effects and trichloroethylene exposure: Assessing the relevance to human male reproductive health. Repro. Toxicol. 22: 557–563.

A critical review of the literature available regarding potential effects of exposure to trichloroethylene on male reproductive health.

McDermott C, Allshire A, van Pelt FNAM, Heffron JJA (2007) Sub-chronic toxicity of low concentrations of industrial volatile organic pollutants in vitro. Toxicol. App. Pharmacol. 219: 85–94.

A comparison of the toxicity of toluene, n-hexane and methyl ethyl ketone using two in vitro tissue culture systems, and exposure durations between 15 min and 5 days.

Morata TC (2003) Chemical exposure as a risk factor for hearing loss. J. Occup. Environ. Med. 45: 676–682.

Overview of a workshop dealing with hearing loss from combined exposures to organic solvents or other ototoxic compounds and noise.

Nielsen GD, Lund SP, Ladefoged O (2006) Neurological effects of white spirit: contribution of animal studies during a 30-year period. Basic Clin. Pharmacol. Toxicol. 98: 115–123.

A critical review of the literature on neurotoxic effects in experimental animals following exposures to mixtures of organic solvents including white spirit.

Ridgway P, Nixon TE, Leach J-P (2003) Occupational exposure to organic solvents and long-term nervous system damage detectable by brain imaging, neurophysiology or histopathology. Food Chem. Toxicol. 41: 153–187.

This is a critical review of 70 reports of neurotoxicity from occupational solvent exposure, including 40 of which reported objective measures of impairment other than neuropsychological testing.

Sallmen M, Baird DD, Hoppin JA, Blair A, Sandler DP (2006) Fertility and exposure to solvents among families in the Agricultural Health Study. Occup. Environ. Med. 63: 469–475.

A cross-sectional analysis of participants in an epidemiological study of pesticide exposure in which increased levels of solvent usage was associated with increased relative risks of low fertility.

Schreiber JS, Hudnell HK, Geller AM, et al (2002) Apartment residents' and day care workers' exposures to tetrachloroethylene and deficits in visual contrast sensitivity. Environ. Health Perspect. 110: 655–664.

A report linking residence in apartment buildings that contain co-located dry cleaning businesses with reduced sensitivity to perceive visual contrast. This is notable because the concentrations of perchloroethylene in the air of the apartments were substantially lower than those reported to cause changes in neurologic performance in previous studies of occupational or residential exposure.

Scott CS, Cogliano VJ (2000) Trichloroethylene health risks – state of the science. Environ. Health Perspect. 108(Suppl. 2).

This supplemental issue of the journal Environmental Health Perspectives was dedicated to reviewing the state of the science regarding trichloroethylene including assessments of exposure, health effects, pharmacokinetic models, metabolism, and cancer and non-cancer hazards.

Simmons JE, Evans MV, Boyes WK (2005) Moving from external exposure concentration to internal dose: duration extrapolation based on physiologically based pharmacokinetic derived estimates of internal dose. J. Toxicol. Environ. Health Part A 68: 927–950.

This paper provides a step-by-step approach to the development and use of physiologically based pharmacokinetic modes in a risk assessment context, using the example of the acute neurophysiological consequences of exposure to trichloroethylene as a case in point.

Spurgeon A (2006) Watching paint dry: Organic solvent syndrome in late-twentieth-century Britain. Med. Hist. 50: 167–188.

An historical account of the differences between Great Britain and other European countries in the recognition and diagnosis of occupational organic solvent encephalopathy.

Till C, Westall CA, Koren G, Nulman I, Rovet JF (2005) Vision abnormalities in young children exposed prenatally to organic solvents. Neurotoxicol 26: 599–613.

This paper shows that there are concerns for neurological development of the children of mothers who have occupational exposures to organic solvents. Previously this problem was considered primarily to be relevant only to the higher concentration exposures characteristic of inhalant abusers.

Triebig G, Hallermann J (2001) Survey of solvent related chronic encephalopathy as an occupational disease in European countries. Occup. Environ. Med. 58: 575–581.

A review across European countries of the rates and trends of diagnosis of occupational solvent-induced encephalopathy.

Watson RE, Jacobson CF, Williams A, Howard WB, DeSesso JM (2006) Trichloroethylene-contaminated drinking water and congenital heart defects: A critical analysis of the literature. Reprod. Toxicol. 21: 117–147.

The epidemiological and experimental literatures are reviewed with respect to reports of congenital heart defects attributed to exposure to trichloroethylene (TCE). The authors apply Hill's criteria for evidence of causation, and conclude that there is no evidence to link

gestational TCE exposure at environmental concentrations to the production of congenital heart defects.

Organizations

American Chemistry Council (ACC)
1300 Wilson Blvd.
Arlington, VA 22209
Phone: 703-741-5000
Fax: 703-741-6050
Web: http://www.americanchemistry.com/s_acc/index.asp

The American Chemistry Council (ACC) advocates for companies engaged in the business of chemistry. ACC has an extensive website related to chemicals, business, and health.

American Council of Governmental Industrial Hygienists (ACGIH)
1330 Kemper Meadow Drive
Cincinnati, Ohio 45240, USA
Phone: 513-742-6163
Fax: 513-742-3355
E-mail: mail@acgih.org
Web: http://www.acgih.org/home.htm

ACGIH is an organization of industrial hygienists working for the safety of workers. They produce well-respected guidelines of exposure to many solvents.

American Petroleum Institute (API)
1220 L Street, NW
Washington, DC 20005-4070
Phone: 202-682-8000
Web: http://www.api.org/

American Petroleum Institute is a national trade association that represents America's oil and natural gas industry. The API website has information about petroleum chemicals and products.

European Chemicals Bureau (ECB)
TP582
Institute for Health and Consumer Protection
Joint Reasearch Centre, Ispra Site
European Commission
Via fermi 1
I-21020 Ispra (VA), Italy
Phone: +39-0332-78-9037
Web: http://ecb.jrc.it/

The European Chemicals Bureau (ECB) is the focal point for data and the assessment procedure on dangerous chemicals, and provides scientific and technical support for the conception, development, implementation, and monitoring of EU policies related to dangerous chemicals.

Halogenated Solvents Industrial Alliance (HSIA)
1300 Wilson Boulevard
Arlington, Virginia 22209
Phone: 703-741-5780
Fax: 703-741-6077
E-mail: info@hsia.org
Web: http://www.hsia.org/

HSIA is an industry-supported group dedicated to serving the interests of the halogenated solvents industry.

International Agency for Research on Cancer (IARC)
150 Cours Albert Thomas
69372 Lyon CEDEX 08
France
Phone: +33 (0)4 72 73 84 85
Fax: +33 (0)4 72 73 85 75
E-mail: cie@iarc.fr
Web: http://monographs.iarc.fr/

Guided by interdisciplinary working groups of expert scientists IRAC produces monographs that identify environmental factors that can increase the risk of human cancer that can be used to prevent exposure to potential carcinogens.

Mickey Leland National Urban Air Toxics Research Center
P.O. Box 20286, Houston, Texas 77225-0286
Phone: (713) 500-3450
Fax: (713) 500-0345
E-mail: NUATRC@uth.tmc.edu
Web: http://www.sph.uth.tmc.edu/mleland/

The Mickey Leland National Urban Air Toxics Research Center (NUATRC), a non-profit organization located in the Texas Medical Center, is a research facility designed to sponsor and gather scientific information on the human health effects caused by exposure to air toxics including volatile organic compounds.

Styrene Information and Research Center (SIRC)
1300 Wilson Boulevard, Suite 1200
Arlington, Virginia 22209
Phone: 703-741-5010
Fax: 703-741-6010
E-mail: sirc@styrene.org
Web: http://www.styrene.org/

Styrene Information and Research Center (SIRC) is an industry-supported non-profit organization dedicated to being the principal focal point for public information and research on styrene.

Databases

American Cancer Society
Web: http://www.cancer.org/docroot/PED/content/PED_1_3X_Benzene.asp?sitearea=PED

Informational website on benzene written for laymen.

American Lung Association
Web: http://www.lungusa.org/site/apps/s/content.asp?c = dvLUK9O0E&b=34706&ct=66856

Information about effects of solvents on lung including respiratory irritation and other effects.

CDC/ATSDR
Web: http://www.atsdr.cdc.gov/HEC/CSEM/

Substance-specific continuing education courses for physicians or other health professionals available for several organic solvents including benzene, Stoddard solvent, toluene, and trichloroethylene.

CDC/NIOSH
Web: http://www.cdc.gov/niosh/topics/organsolv/

Safety and Health Topic: Organic Solvents. Includes links to Criteria Documents (critical reviews of scientific and technical information relevant to occupational hazards and control of risks from specific substances) and Current Intelligence Bulletins (emerging information about occupational hazards).

CDC/NIOSH
Web: http://www.cdc.gov/niosh/topics/noise/research/noiseandchem/noiseandchem.html

The proceedings of a workshop on the interaction between organic solvents or other ototoxic compounds and noise in the production of occupationally induced hearing loss.

CleanerSolutions
Web: http://www.cleanersolutions.org/

Web-based tools to help substitute greener product ingredients.

EPA. Integrated Risk Information System (IRIS)
Web: http://www.epa.gov/iris/index.html

Database of EPA risk assessments by chemical, including documentation of the rationale for each assessment.

EPA. National-Scale Air Toxics Assessment (NATA)
Web: http://www.epa.gov/ttn/atw/nata/index.html

National scale exposure modeling and risk estimates for compounds and compound classes listed under the 1990 Amendment to the Clean Air Act as Hazardous Air Pollutants, a list that includes numerous organic solvents.

EPA. Toxic Release Inventory (TRI)
Web: http://www.epa.gov/triexplorer/

Database of chemical emissions reported to EPA.

International Labor Organization
Web: http://www.ilo.org/public/english/protection/safework/cis/products/safetytm/solvents.htm

General information about safe use and handling of solvents in the workplace.

Occupational Safety and Health Organization (OSHA)
Web: http://www.ilo.org/public/english/protection/safework/cis/products/safetytm/solvents.htm

Informational website on the safety and health topics related to use of solvents in the workplace.

Oregon Health & Science University, Center for Research on Occupational and Environmental Toxicology
Web: http://www.croetweb.com/links.cfm?topicID=39

This website lists numerous databases and informational resources regarding common organic solvents.

Solvents Database (Chemicals & Chemical Engineering) by George Wypych (CD-ROM-Jan 15, 2001)
Noyes Publications

This is a searchable CD-ROM database with the chemical and physical properties of more than 1100 solvents. Among the sets of information provided are solvent performance, processing characteristics, and environment and health information.

Toxicology Excellence for Risk Assessment
Web: http://www.tera.org/

This organization facilitates the Voluntary Children's Chemical Evaluation Program (VCCEP). This program is an agreement between EPA and involved industries to assess the potential risks to children for several industrial chemicals, including a number of organic solvents such as benzene, toluene, ethylbenzene, and xylenes. The website links to documents developed by contractors to the participating industries that summarize the currently available information relevant to each substance, and also comments from an independent peer-review committee evaluating the documents.

Toxicology Profiles
Agency for Toxic Substances and Disease Registry
Web: http://www.atsdr.cdc.gov/toxpro2.html

Toxicology Profiles summarize relevant information for about 175 substances commonly found at National Priorities List hazardous waste sites. Many of the profiles are for organic solvents.

CHAPTER

19

Chemicals: Selected Chemicals

ANTOINETTE HAYES

INTRODUCTION

This chapter focuses on selected chemical reviews concerning alcohol (ethanol), arsenic, caffeine, dioxin, formaldehyde, fluoride, PCBs, rubber, tobacco, etc. The following references will give the researcher a broad overview of the chemical literature available in the areas listed above and also areas relating to the reactions of chemical mixtures and the effects of chemical interactions on the human body and environment. Also included is a reference on environmental forensics which is the science that deals with the forensic analysis of environmental contamination, and a reference on green chemistry, which institutes the use of environmentally safe chemicals in processes where chemicals are mass produced and the probability of release into the environment is increased.

These references are broad overviews meant to be used as a starting point for more extensive research in the selected areas. The latest editions are listed where applicable. Many references, though seemingly dated, continue to be highly regarded tools for research in their respective fields and for this reason, are included in this list.

RESOURCES

Books

Abel EL (ed.) (2004)
Fetal Alcohol Syndrome
New York: Springer.
Web: http://www.springer.com

This book provides straightforward facts regarding the impact of alcohol consumption as it affects the development of the embryo and fetus. Current research addressing the immediate and delayed effects is covered. A chapter is devoted to assessing the behavior of children who were exposed, in utero, to alcohol.

Barton J, Rogers R (1997)
Chemical Reaction Hazards
New York: Gulf Professional Publishing.
Web: http://www.elsevier.com

This book provides information regarding the hazards of chemical mixtures and the combination of incompatible substances. It describes safety measures that should be taken when working with chemicals and offers examples in the appendices which relate 100 incidents of hazardous mixtures.

Benowitz NL (ed.) (1998)
Nicotine Safety and Toxicity
New York: Oxford University Press.
Web: http://www.oub.co.uk

Looks at nicotine in relation to cardiovascular disease, cancer, reproduction, and behavioral toxicity.

Bhattacharya P (ed.) (2007)
Arsenic in Soil and Groundwater Environment, Volume 9: Biogeochemical Interactions, Health Effects and Remediation (Trace Metals and Other Contaminants in the Environment)
New York: Elsevier Science.
Web: http://www.elsevier.com

This volume contains information regarding the latest developments in arsenic contamination of groundwater

and soil and remediation efforts. It also reports the effects of arsenic on plants, animals, and humans.

Chang LW (1996)
Toxicology of Metals, Volume I (Toxicology of Metals)
Boca Raton, FL: CRC Press.
Web: http://www.crcpress.com

Comprehensive book on metal toxicology covering toxic endpoints such as cancer, neurodegenerative diseases, and renal toxicities.

Cheremisinoff NP (1994)
Hazardous Chemicals in the Polymer Industry
Boca Raton, FL: CRC Press.
Web: http://www.crcpress.com

Written as a practical reference for engineers, technicians, and compounders. The handbook gives information on toxic and hazardous properties, symptoms of overexposure, safe handling and shipping, fire hazards, and spill responses for both generic and specific polymer chemicals.

Chin SB, Pisoni DB (2006)
Alcohol and Speech
New York: Academic Press.
Web: http://www.academicpress.com

Serves as a reference source for those interested in speech motor effects evident in the acoustic record, reaction times, speech communication strategies, and perceptual judgments accompanying ingestion of ethanol. It is a comprehensive review of the effects of alcohol on speech and compares the various theoretical concerns which form this research. An interesting example from the Exxon Valdez oil spill is reviewed.

Chollat-Traquet C (1992)
Women and Tobacco
Geneva, Switzerland: World Health Organization.
Web: http://www.who.int

Intended to inform all those concerned with the effects of tobacco use and the health of women. The six chapters include the issues at stake, women and usage patterns, tobacco and health (organs and systems affected), factors influencing use of tobacco, prevention and cessation aids, and a strategy for long-term control. Each chapter includes selected references for detailed follow-up.

Toxicological and Performance Aspects of Oxygenated Motor Vehicle Fuels
Committee on Toxicological Aspects of Oxygenated Motor Vehicle Fuels (1996)
Washington, DC: National Academy Press.
Web: http://www.nap.edu

Assesses the effects of oxygenated gasoline on public health, air quality, fuel economy, engine performance, and water quality. The basic chemical discussed throughout is methyl *t*-butyl ether. In addition to evaluating the scientific basis of the government report covering this topic, research attempting to better understand the overall impact of oxygenated fuels is presented.

Comyns AE (2007)
Encyclopedic Dictionary of Named Processes in Chemical Technology
Boca Raton, FL: CRC Press.
Web: http://www.crcpress.com

This book defines over 3000 processes used in the chemical industry, covering a broad range of chemicals. Each entry is accompanied by the name of the process, the date of its introduction, patent information, and its usage internationally.

Davis DE (ed.) (1999)
Tobacco: Production, Chemistry, and Technology, Illustrated
Malden, MA: Blackwell Publishing.
Web: http://www.blackwellpublishing.com

A comprehensive, illustrated review of tobacco.

Deitrich RA, Erwin VG, (eds.) (1995)
Pharmacological Effects of Ethanol on the Nervous System
Boca Raton, FL: CRC Press.
Web: http://www.crcpress.com

Reviews current data on the action of ethanol in the central nervous system and the resulting behavioral effects. Old theories of effect are updated. Particularly helpful are chapters covering the fetal alcohol syndrome and the effects of long-term ethanol exposure. The mechanisms for effect at the neurotransmitter level are well presented.

Doble M, Kumar A (2007)
Green Chemistry and Engineering
New York: Academic Press.
Web: http://www.elsevier.com

This book describes processes, materials, and the theories behind conducting green chemistry or chemistry that is geared toward the use of environmentally friendly methods that reduce the release of harmful emissions and waste.

Erickson MD (1997)
Analytical Chemistry of PCBs, 2nd edition
Boca Raton, FL: CRC Press.
Web: http://www.crcpress.com

A comprehensive review of the analytical chemistry of PCBs. Includes gas chromatographic determination,

mass spectrometry, sampling approaches, separations, interlaboratory studies, and PCB toxicology.

Halliwell BB (ed.) (2006)
Cigarette Smoke and Oxidative Stress
New York: Springer.
Web: http://www.springer.com

Reviews the mechanisms of diseases caused by cigarette smoke including cancers, cardiovascular disease, and pulmonary diseases.

Kozlowski LT, Henningfield JE (2004)
Cigarettes, Nicotine, and Health: A Biobehavioral Approach (Behavioral Medicine and Health Psychology)
Thousand Oaks, CA: Sage Publications, Inc.
Web: http://www.sagepub.com

Addresses the psychology of tobacco use, epidemiology, and pharmacology. Also cover the health consequences of tobacco and nicotine use.

Robertson Larry W, Hansen Larry G (eds.) (2001)
Recent Advances in Environmental Toxicology and Health Effects (Hardcover)
Kentucky: University Press of Kentucky

Some Industrial Chemicals
Lyon, France: World Health Organization.
Web: http://www.who.it

Volume 27 of the *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans*. Reviews 14 industrial chemicals by an expert committee for their potential to be carcinogenic to humans. This book presents a relatively complete bibliography of the pertinent information along with the evaluation by the committee. The following chemicals were considered not classifiable regarding their carcinogenicity to man: ethylene, vinyl toluene, *N*-methylolacrylamide, methyl methac-rylate, and 2-ethylhexyl acrylate; the following were classified as possibly carcinogenic to humans: propylene oxide, isoprene, styrene, 4-vinylcyclohexene, and 4-vinylcyclohexene diepoxide; the following were classified as probably carcinogenic to humans: styrene-7,8-oxide and acrylamide; and the following was classified as carcinogenic to humans: ethylene oxide.

Marrs TC, Maynard RL, Sidell F (eds.) (2007)
Chemical Warfare Agents: Toxicity and Treatment 2nd edition
Hoboken, NJ: Wiley.
Web: http://www.wiley.com

Comprehensive review of chemical warfare agents, their mechanisms, disposition in the environment, and regulatory issues concerning their use and misuse.

Murphy BL, Morrison RD (2007)
Introduction to Environmental Forensics
New York: Academic Press.
Web: http://www.elsevier.com

This book is in textbook format and offers an excellent introduction to the field of environmental forensics. It outlines forensic techniques used to identify the source of chemical pollutants, the time the contamination occurred, and chemical 'fingerprinting' methods used when analyzing a spill.

Ojima I, McCarthy JR, Welch JT (eds.) (1996)
Biomedical Frontiers of Fluorine Chemistry
American Chemical Society, Washington, DC
Web: http://www.acs.org

Reviews recent research on fluorine-containing, biologically relevant molecules in biology and medicinal chemistry. The text covers applications of organofluorine compounds as enzyme inhibitors, antithrombotics, anticancer agents, central nervous system agents, and antifungal and antiviral agents.

Pilch RF, Zilinskas RA (eds.) (2005)
Encyclopedia of Bioterrorism Defense
Hoboken, NJ: Wiley.
Web: http://www.wiley.com

Covers biotechnology and bioterrorism and detection technologies. Also covers specific biowarfare agents and over 100 articles and case studies.

Ramamoorthy S, Ramamoorthy S (1997)
Chlorinated Organic Compounds in the Environment: Regulatory and Monitoring Assessment
Boca Raton, FL: CRC Press.
Web: http://www.crcpress.com

Toxicity profiles provided for each chemical allow for evaluation of the short- and long-term effects on the environment. Discussions of environmental residues and pertinent worldwide regulations help readers compare chloro-organic contamination in different areas and analyze the associated regulatory approaches.

Romano JA, Lukey BJ, Salem H (eds.) (2007)
Chemical Warfare Agents: Chemistry, Pharmacology, Toxicology, and Therapeutics 2nd edition
Boca Raton, FL: CRC Press.
Web: http://www.crcpress.com

Covers the effects of chemical warfare agents and includes effects of short-term and long-term exposures and antidotes.

Schecter A, Gasiewicz TA (eds.) (2003)
Dioxins and Health, 2nd edition
Hoboken, NJ: Wiley-Interscience.
Web: http://www.wiley.com

Presents the latest information relating to potential human health risks of dioxin. The main areas include cancer, immune system compromise, reproductive and developmental disorders, neurological damage, and endocrine system alterations. Most of the 20 chapters include specific new data relating to the particular end-point toxicity, and the difficulty of applying both the human and the animal data to an appropriate quantitative risk assessment is considered throughout.

Schnoor JL (ed.) (2001)
Fate of Pesticides and Chemicals in the Environment (Environmental Science and Technology: A Wiley-Interscience Series of Texts and Monographs)
Hoboken, NJ: Wiley-Interscience.
Web: http://www.wiley.com

Scientific collaboration between the U.S. and the Soviet Union regarding the fate of pesticides in the environment and public health issues surrounding contamination and exposure.

Sheftel VO (1995)
Handbook of Toxic Properties of Monomers and Additives
Boca Raton, FL: CRC Press.
Web: http://www.crcpress.com

Provides comprehensive information on the toxic effects of plastics ingredients that enter the body, mainly by the oral route. The chapters include sections covering background information and format, monomers, plasticizers, stabilizers, catalysts, initiators, and other agents, and rubber ingredients, solvents, and other additives.

Smolinske SC (1992)
CRC Handbook of Food, Drug, and Cosmetic Exipients
Boca Raton, FL: CRC Press.
Web: http://www.crcpress.com

Summary of inactive ingredients in pharmaceutical, food, and cosmetic products that may be of concern to hypersensitive individuals.

Spiller G (ed.) (1997)
Caffeine
Boca Raton, FL: CRC Press.
Web: http://www.crcpress.com

Botany, cultivation, processing, composition, and consumption patterns of natural products such as tea, coffee, mate, and cocoa and chocolate products are described. Consumption of caffeine is examined in detail. An overview of basic physiology and biochemistry of caffeine is provided. Ergogenic, cognitive, and emotional effects of caffeine are discussed, as are specific health effects – serum cholesterol, cancer and fibrocystic breast disease, calcium and bone health, and human reproduction.

Stenerson J (2004)
Chemical Pesticides: Mode of Action and Toxicology
Boca Raton, FL: CRC Press.
Web: http://www.crcpress.com

This volume covers a wide range of chemical pesticides organized based on their mode of action. Also gives a nice introduction on pesticides, toxicity, and issues such as pesticide resistance.

World Health Organization (WHO) (1997)
Flame Retardants: A General Introduction,
Environ-mental Health Criteria No. 192
Geneva, Switzerland: WHO.
Web: http://www.who.it

Provides a general overview of the properties, mechanisms of action, production, use, and performance of chemicals added to polymeric materials, both natural and synthetic, to enhance flame-retardant properties. Flame-retardant chemicals are most often used with low-to-moderate cost commodity polymers to either lower ignition susceptibility or lower flame spread once ignition has occurred. The volume also indicates some of the known health and environmental hazards for certain flame retardants.

Yang RSH (ed.) (1994)
Toxicology of Chemical Mixtures
San Diego, CA: Academic Press.
Web: http://www.academicpress.com

Chapters presented attempt to answer the question of whether exposure to mixtures of chemicals results in interactions that alter the potential toxicologic response to the individual chemicals involved. Major sections include introduction and principles, real-life case studies or special problem-related situations, target organ toxicity or special toxicologic responses related to chemical mixture exposures, and contemporary issues.

Journal articles

General

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Busker RW, van Helden HP (1998) Toxicologic evaluation of pepper spray as a possible weapon for the Dutch police force: Risk assessment and efficacy. Am. J. Forensic Med. Pathol. 19(4): 309–316.

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Alcohols

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Kaneko M, et al (1996) The effect of work-related stress with change of working conditions for workers with alcohol drinking habit and liver disorder. Jpn. J. Alcohol Stud. Drug Depend. 31: 81–94.

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Ragland DR, et al (1995) Occupational and nonoccupational correlates of alcohol consumption in urban transit operators. Prevent. Med. 24: 634–645.

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Szabo G, et al (2007) TLR4, ethanol, and lipid rafts: a new mechanism of ethanol action with implications for other receptor-mediated effects. J. Immunol. 178: 1243–1249.

Victorin K, et al (1998) Methods for health risk assessment of chemicals: Are they relevant for alcohol. Alcohol Clin. Exp. Res. 22(Suppl. 7): 270S–276S.

Wood MD, et al (1996) Alcohol outcome expectancies and alcohol use and problems. J. Stud. Alcohol, 57: 283–288.

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Hering JG (1996) Risk assessment for arsenic in drinking water: Limits to achievable risk levels. J. Hazardous Mat. 45: 175–184.

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Kumagai Y, Sumi D (2007) Arsenic: signal transduction, transcription factor, and biotransformation involved in cellular response and toxicity. Annu. Rev. Pharmacol. Toxicol. 47: 243–262.

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Barron MG, et al (1995) Comparative reproductive and developmental toxicology of PCBs in birds. Comp. Biochem. Physiol. C Pharmacol. Toxicol. Endocrinol. 112: 1–14.

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Sauer PJ, et al (1994) Effects of polychlorinated biphenyl (PCBs) and dioxins on growth and development. Hum. Exp. Toxicol. 13: 900–906.

Seegal RF (1996) Epidemiological and laboratory evidence of PCB-induced neurotoxicity. Crit. Rev. Toxicol. 26: 709–737.

Silberhorn EM, et al (1990) Carcinogenicity of polyhalogenated biphenyls: PCBs and PBBs. Crit. Rev. Toxicol. 20: 439–496.

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Akopyan G, Bonavida B (2006) Understanding tobacco smoke carcinogen NNK and lung tumorigenesis. Int. J. Oncol. 29: 745–752.

Cooper RG (2006) Effect of tobacco smoking on renal function. Indian J. Med. Res. 124: 261–268.

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Terry AV, et al (2005) Cotinine, a neuroactive metabolite of nicotine: potential for treating disorders of impaired cognition. CNS Drug Rev. 11: 229–252.

Willems EW, et al (2006) Significance of ammonium compounds on nicotine exposure to cigarette smokers. Food Chem. Toxicol. 44: 678–688.

CHAPTER

20

Clinical Toxicology and Clinical Analytical Toxicology

PRIYA TAILOR AND SHAYNE GAD

INTRODUCTION

Clinical toxicology includes physicians and scientists involved with the understanding of the diagnosis and treatment of poisoning. Some clinical toxicologists work with poisoned patients through poison control (and poison information and treatment) centers (see Poison Centers chapter), while others are in a university, hospital, government agency, or in industry. A related discipline is veterinary toxicology, dealing with the diagnosis and treatment of poisoning in animals (see Veterinary Toxicology chapter).

The function of clinical analytic toxicology (also called clinical chemistry in toxicology) is to provide, via laboratory analysis of tissues and fluids, evaluations of the qualitative and quantitative characteristics of (1) specific endogenous and potentially adverse exogenous chemical components present in samples of blood, urine, feces, spinal fluid, and tissues, (2) changes in the formed elements of the blood and their function, and (3) histological changes in tissues and the components of the blood. The purpose is to help identify abnormal or pathological changes or their causes in organ system functions.

The most common biological specimens used in such analyses are blood, urine, and selected postmortem tissue samples. Many different tests exist to test for almost any type of chemical or cellular component in blood or urine; for example, blood glucose, electrolytes, enzymes, hormones, lipids (fats), other metabolic substances, proteins, red blood cells, white blood cells, and platelets. The tests used here were all initially developed for human clinical medicine, and may not possess the same utility when performed as part of either animal toxicity studies or the investigation of poisoning in a wide variety of other species. As such, one could consider clinical analytic toxicology to have at least three separate (but not independent) areas of investigation – clinical chemistry, tissue evaluations (histopathology, covered in another entry in this book), and forensic toxicology. To a degree, each of these is a part of a clinical analytic toxicology evaluation.

Clinical chemistry evaluations are commonly recommended in animal toxicology studies. Regulatory agencies such as the U.S. Food and Drug Administration and the U.S. Environmental Protection Agency have set guidelines for clinical pathology testing in nonclinical toxicity and safety studies. Measurement of chemical components of biological fluids allows the toxicologist to do serial sampling, detect metabolic injury or organ-specific effects, and perhaps gain additional information helpful in establishing the no-effect level and determining the mechanism of toxicity. When using serum enzymes as markers of tissue or organ damage, the enzyme of interest must reasonably reflect pathological change in a specific tissue, organ, or group of organs and must be easily measured.

The tests that are routinely performed provide information concerning hepatocellular and biliary integrity and function, renal function, carbohydrate, protein and lipid metabolism, and mineral and electrolyte balance. Modern analytical techniques require only small sample volumes to make accurate determinations, allowing in-life evaluations of effects in mice and larger species at multiple times during the course of a study without compromising animal health.

Forensic toxicology evaluates exogenously sourced materials in the body, with the information generated

having potential legal uses from the determination of whether harm was done by the intentional or accidental exposure to toxic materials (see Forensic Toxicology chapter). The techniques employed are those of analytical toxicology (see Analytical Toxicology chapter).

Related chapters

Analytical toxicology
Forensic toxicology
Poison control centers
Veterinary toxicology

RESOURCES

Books

Barile FA (2004)
Clinical Toxicology: Principles and Mechanisms
Boca Raton, FL: CRC Press LLC.

This book focuses on the current and contemporary principles and mechanisms of clinical toxicology. It examines the complex interactions associated with clinical toxicological events and chemical exposure. It also addresses the signs and symptoms of diseases and pathology caused by toxins and drug administration. Topics such as biological and chemical toxins, changes in protocols for managing toxic ingestions, new antidotes, and changes in particular treatments are also covered.

Dart RC (2004)
Medical Toxicology, 3rd edition
Philadelphia, PA: Lippincott Williams & Wilkins.

Ford M (ed.) Delaney K, Ling L, Erickson T (2000)
Clinical Toxicology
Los Angeles, CA: W.B. Saunders.

This book provides a detailed outline needed to assess, diagnose, and manage poisoned and overdosed patients. Clinically oriented and practical, this complete, yet concise, resource is organized to give clinicians quick access to fundamental toxicological information.

Gossel TA, Bricker JD (1994)
Principles Of Clinical Toxicology 3rd edition
New York: Raven Press Ltd.

In this third edition, the editors have made numerous changes for managing poison ingestion and treatment selection. It focuses primarily on the classes of toxic agents, their common sources and usual methods of intoxication, incidence and frequency of poisoning, mechanisms of action, clinical signs and symptoms of poisoning and management guidance.

Haddad LM, Shannon MW, Winchester JF (1998)
Clinical Management of Poisoning and Drug Overdose, 3rd edition
Philadelphia, PA: WB Saunders Company.

Hoffman RS, Nelson LS, Howland MA, Lewin NA 2006
Goldfrank's Toxicologic Emergencies
New York: McGraw-Hill Professional

Katzung BG (2006)
Basic & Clinical Pharmacology (Basic and Clinical Pharmacology) 10th edition
New York: McGraw-Hill Medical.

The 10th edition of this book has up-to-date information on integration of basic with clinical science as well as in-depth coverage of key pharmacology topics. For example it covers basic principles to pharmacologic considerations for autonomic, cardiovascular–renal, smooth muscle, CNS, endocrine, antimicrobial, and chemotherapeutic and immunotherapeutic drugs. It is also updated with dozens of new, recently approved drugs, including monoclonal antibodies.

Ling L, Clark RF, Erickson T, Trestrail JH (2001)
Toxicology Secrets, 1st edition
Philadelphia, PA: Hanley & Belfus.

This text contains 64 chapters covering topics such as general toxicology principles, over-the-counter drugs, prescription medications, antibiotics, cardiac drugs, psychopharmacologic medications, drugs of abuse, metals, chemicals, pesticides, gases, food poisoning, botanicals, envenomations, and toxic terrorist threats.

Lyle DP (2004)
Forensics for Dummies
Hoboken, NJ: Wiley Publishing, Inc.

Wecht C, Saitz G, Curriden M (2003)
Mortal Evidence: The Forensics behind Nine Shocking Cases
Amherst, New York: Prometheus Books.

Review articles

Bateman D (2005) Clinical toxicology: Clinical science to public health. Clin. Exp. Pharmacol. Physiol. 32(11): 995–998.

Breckenridge A (1996) A clinical pharmacologist's view of drug toxicity. Br. J. Clin. Pharmacol. 42(1): 53–58.

Wiener SW, Hoffman RS (2005) Trends in clinical toxicology: Advances that may change your practice. Basic Clin. Pharmacol. Toxicol. 97(1): 1–7.

Journals

Basic & Clinical Pharmacology & Toxicology

British Journal of Clinical Pharmacology

Clinical and Experimental Pharmacology and Physiology

Clinical Toxicology (formerly the Journal of Toxicology: Clinical Toxicology)

Forensic Toxicology

Journal of Forensic Medicine and Toxicology

Journal of Medical Toxicology

General interest works

Howdunit Book of Poisons: A Guide for Writers
Stevens S, Bannon A (2007)
Writers Digest Books.

Poisons: From Hemlock to Botox to the Killer Bean of Calabar
Macinnis P (2005)
Arcade Publishing.

Databases

(U.S.) National Library of Medicine. Drug Information Portal.
http://druginfo.nlm.nih.gov

The Drug Information Portal provides a gateway to current and accurate drug information. Information for more than 15 000 drugs is available for searching.

Poisindex®, Thompson Healthcare
Web: www.micromedex.com/products/poisindex/

Organizations

American Academy of Clinical Toxicology
Web: www.clintox.org

American Association of Poison Control Centers
Web: www.aapcc.org

American Board of Forensic Toxicology
Web: www.abft.org

American College of Medical Toxicology
Web: www.acmt.net

European Association of Poisons Centres and Clinical Toxicologists
Web: http://www.eapcct.org

Society of Forensic Toxicology
Web: www.soft-tox.org

CHAPTER

21

Developmental and Reproductive Toxicology

STEVEN G. GILBERT AND KIMBERLY S. GRANT

INTRODUCTION

Reproduction and development are fundamental to the existence and evolution of all life. The complex biological processes that are required for normal fetal development must be executed in an organized and precisely timed manner. If developmental processes deviate from these preprogrammed stages and sequences, errors in development can occur. Genetic and environmental perturbations to the developing fetus can be expressed at birth in the form of structural malformations (birth defects) and functional deficits (losses in neurobehavioral competence). The first written documentation of fetal malformations was discovered on the Tablet of Nineveh about 4000 years ago along the Tigris River. In the 15th and 16th centuries, structural anomalies in newborns were thought to be associated with the devil and there are cases in which both the mother and child were killed. Insight into the cause of birth defects advanced along with medical and scientific understanding. Expertise and knowledge of reproduction and development has coalesced into the scientific discipline of teratology. Teratology, derived from the Greek term for monster, originally focused on the causes and prevention of physical or gross malformations in offspring at birth but has now expanded to include studies on deviations in behavioral and sensory development.

The recognition that environmental chemicals could dramatically affect fetal development was demonstrated in the 1950s when Japanese women exposed to methylmercury gave birth to severely affected infants (cerebral palsy, seizures, blindness, deafness, mental retardation). In 1961, the adverse effects of therapeutic medication drugs on development were recognized when women exposed to thalidomide during pregnancy gave birth to infants with missing and malformed limbs. James G. Wilson, a scientific pioneer, defined the Six Principles of Teratology in his book 'Environment and Birth Defects' in 1973. These core principles are still relevant and provide a foundation to better understand the causes of birth defects and developmental disabilities.

1. The final manifestations of abnormal development are death, malformation, growth retardation, and functional disorder.
2. Susceptibility of the conceptus to teratogenic agents varies with the developmental stage at the time of exposure.
3. Teratogenic agents act in specific ways (mechanisms) on developing cells and tissues in initiating abnormal embryogenesis (pathogenesis).
4. Manifestations of abnormal development increase in degree from no effect to the totally lethal level as dosage increases.
5. The access of adverse environmental influences to developing tissues depends on the nature of the agent.
6. Susceptibility to a teratogen depends on the genotype of the conceptus and on the manner in which the genotype interacts with environmental factors.

Over the last 50 years, a rich body of literature has developed regarding the effects of chemical and physical agents on reproduction and development. Below is a sampling of this literature that highlights a variety of resources and seminal publications in the field.

RESOURCES

Books

Anderson D, Brinkworth M (Eds.) (2007)
Male-mediated Developmental Toxicity
Royal Society of Chemistry, London

This book examines the causes and developmental effects of male germline mutations on future generations. The effects of both environmental and chemotherapeutic drug exposures are addressed.

Bennett PN (Ed.) (1996)
Drugs and Human Lactation
Elsevier, Amsterdam

Provides an overview of lactational drug exposure, including aspects of pharmacokinetics and drug effects on infant behavior and health.

Briggs GG, Yaffe S J, Freeman RK (2005)
Drugs in Pregnancy and Lactation: A Reference Guide to Fetal and Neonatal Risk, 7th Edition
Lippincott Williams & Wilkins, Baltimore

This edition features information on more than 1000 drugs. Most reviews are based on cases of human exposure. Animal experimental information is included only where human data are unavailable.

Briggs Update: Drugs in Pregnancy and Lactation, a quarterly update, is also available, as is a CD-ROM version of the book.

Committee on Developmental Toxicology, Board on Environmental Studies and Toxicology, National Research Council (2000)
Scientific Frontiers in Developmental Toxicology and Risk Assessment
The National Academies Press, Washington, DC

This book, developed by a committee of experts, explores recent advances in the fields of developmental biology, molecular biology, and genetics and integrates these findings within the conceptual framework of developmental toxicology.

Principles for Evaluating Health Risks in Children Associated with Exposure to Chemicals
Environmental Health Criteria 237 (2007)
World Health Organization, Geneva Switzerland
http://www.who.int/ipcs/publications/ehc/ehc237.pdf

This volume, published under the joint sponsorship of the United Nations Environment Programme, the International Labour Organization and the World Health Organization, and produced within the framework of the Inter-Organization Programme for the Sound Management of Chemicals is a comprehensive report addressing the unique vulnerability of children to social economic factors, nutrition, environmental chemicals and other hazards. In addition, risk assessment issues and preventive methods are considered.

Frazier L, Hage M (1998)
Reproductive Hazards of the Workplace
Van Nostrand-Reinhold, New York

The focus of this book is on the development of practical strategies for assessing and managing reproductive risk within an occupational setting. Using numerous case studies, the basics of reproductive and developmental biology, risk assessment, and workplace risk reduction are detailed and discussed. The roles that chemical, physical, ergonomic, biologic, and psychosocial factors play in reproductive health are also considered.

Friedman JH, Polifka JE (1998)
The Effects of Neurologic and Psychiatric Drugs on the Fetus and Nursing Infant: A Handbook for Health Care Professionals
Johns Hopkins Unviersity Press, Baltimore

A concise guide to the potential teratogenic risks of some 225 drugs that are prescribed for neurologic and psychiatric disorders in pregnant and nursing women. Rates the risk of teratogenic effects 'none, likely, minimal, small, moderate, high, or undetermined.'

Friedman JM, Polifka JE (2000)
Teratogenic Effects of Drugs: A Resource for Clinicians, (TERIS) 2nd edition
Johns Hopkins University Press, Baltimore

The 2nd edition of this comprehensive book is a hardcopy of TERIS, a computer database that covers the teratogenic risks associated with over 2000 drugs and environmental toxins. For each drug/chemical that is listed in TERIS, a comprehensive literature review through the National Library of Medicine bibliographic databases is conducted and a summary of the teratogenic risk is provided. This book is intended as a resource for professionals needing a quick but detailed look at the developmental risks associated with drug exposure in pregnant women.

Friedman JM, Polifka JE (1996)
The Effects of Drugs on the Fetus and Nursing Infant: A Handbook for Health Care Professionals
Johns Hopkins University Press, Baltimore

Provides an assessment of information available regarding fetal and neonatal risks associated with maternal use of common medications during pregnancy or lactation. The book is arranged alphabetically

by drug name and entries provide an assessment of potential for teratogenicity, an assessment of the quality and quantity of data available, effects reported in exposed infants, the risk from drug exposure during breast-feeding, and key references.

Forman R, Gilmour-White S, Forman N (1996)
Drug-Induced Infertility and Sexual Dysfunction
Cambridge University Press, New York

This book lays the groundwork for quick and informed clinical decision making on the role of drugs in infertility and sexual dysfunction. Following a review of sexual and reproductive function, chapters on antihypertensive therapy, CNS and psychotropic drugs, chemotherapeutic agents, hormonal therapy, antibiotics, drugs of abuse, and therapeutic medications are presented.

Hansen DK, Abbott BD (Eds) (2008)
Developmental Toxicology, third edition
Series: Target Organ Toxicology
Informa Healthcare, New York

This heavily revised new edition approaches issues related to developmental pharmacology and toxicology from a mechanistic perspective and brings in recent advances in genetics, biochemistry, cell biology, and molecular embryology.

Hood RD (2005)
Developmental and Reproductive Toxicology: A Practical Approach, 2nd edition
CRC Press, Boca Raton, FL

This is an updated edition and re-titled from *Handbook of Developmental Toxicology.* It provides a practical guide for developmental toxicologists by collecting and containing in a single place, information that is otherwise scattered throughout the literature. It contains both mechanistic studies of known developmental toxicants and the toxicological assessment of pharmaceutical agents, food additives, pesticides, industrial chemicals, and environmental pollutants to which pregnant women may be exposed.

Kacew S, Lambert GH (Eds.) (1997)
Environmental Toxicology and Pharmacology of Human Development
Taylor & Francis, London

Recent advances and extensive developments in the field are detailed. The book provides a review of the pharmacokinetic characteristics, metabolism, and renal handling of chemicals and drugs in the fetus, lactating infant, and developing newborn. It also discusses topics such as maternal–fetal exposure, heavy metals, pesticides, solvents, contaminants and breast milk, caffeine, genetic predisposition to toxicity, and retinoids.

Kalter H (2003)
Teratology in the Twentieth Century: Congenital Malformations in Humans and How Their Environmental Causes were Established
Elsevier Science, The Netherlands

An interesting historical perspective of issues related to congenital malformations associated with environmental factors.

Knobil E, Neill JD (Eds.) (1998)
Encyclopedia of Reproduction
Academic Press, New York

Covers in four volumes expanded information on all aspects of animal reproduction. The systems covered range from invertebrates to humans. Over 500 articles are included.

Korach KS (Ed.) (1998)
Reproductive and Developmental Toxicology
Dekker, New York

Offers extensive discussions on the pharmacological, environmental, endocrinological, and natural factors that alter reproduction or developmental processes. The text elucidates the effects on mechanisms of reproduction. Included in the book is an overview of the basic biology and physiology of organ systems affected by toxicants, detailed examples of altered developmental toxicity, analysis of germ cell toxicity and infertility, and discussion of how gonadal processes may be susceptible to toxicants.

Koren G (Ed.) (2001)
Maternal–Fetal Toxicology: A Clinician's Guide, 3rd ed.
Informa Healthcare, Dekker, New York

Presents accurate, up-to-date estimates of the teratogenic risks of exposure to drugs, chemicals, viruses, and radiation during pregnancy. It also covers the maternal–fetal toxicology of medicinal plants, developmental risk assessment, and biological markers of intrauterine exposure to drugs of abuse. It includes clinical cases in most chapters.

Little BB (2006)
Drugs and Pregnancy: A Handbook
A Hodder Arnold Publication

A practical reference guide directed toward physician and nurse practitioners to assist in understanding the toxic as well as expected side effects of drug exposure during pregnancy.

National Research Council (2001)
Evaluating Chemical and Other Agent Exposures For Reproductive and Developmental Toxicity
National Academy Press, Washington, DC

The National Research Council reviews and recommends approaches that can be used to evaluate chemicals and physical agents for their potential to cause reproductive and developmental toxicology.

Naz RK (2004)
Endocrine Disruptors: Effects on Male and Female Reproductive Systems, 2nd ed.
CRC Press, Boca Raton, FL

This new edition examines the epidemiology and etiology of environmental toxicants/hormone imposters, many of which act as reproductive toxicants that cause fertility problems and carcinogenic hazards.

Needleman HL, Bellinger D (Eds.) (1994)
Prenatal Exposure to Toxicants: Developmental Consequences
Johns Hopkins University Press, Baltimore

Summary of work in some of the key areas to provide the clinician, researcher, and public health specialist with insight into the current status of this area and a look at future needs. The four major sections are neurodevelopmental toxicology, toxicants well studied in humans, toxicants studied mainly in animals, and regulatory issues.

Neill JD (Ed.) (2005)
Knobil and Neill's The Physiology of Reproduction, Vols. 1 and 2, 3rd edition
Academic Press, New York

This new edition includes molecular level mechanism and presents a critical assessment of the state of the art in every aspect of research on the physiology of reproduction. Each section provides both an overview and details of topics, including gametes and fertilization, the reproductive system, endocrine control functions, reproductive behavior and its control, and the reproductive process and its control.

Nicolopoulou-Stamati P, Hens L, Howard CV (Eds) (2007)
Reproductive Health and the Environment
Springer, The Netherlands

An up-to-date documentation of the effects of toxic environmental contaminants, air pollution, and exposure to medical drugs on reproductive health and fertility on males and females.

O'Rahilly R, Muller F (2001)
Human Embryology and Teratology, 3rd Edition
Wiley-Liss, New York

The 3rd edition provides a reorganized and up-to-date, reasonably brief, reliable text specifically on the human embryo and fetus. Focused on the developmental stages during which various morphological features normally appear in the embryonic period proper. The book is divided into two major sections – the first deals with general embryology and teratology and the second with systemic embryology and teratology, addressing both normal and abnormal development.

Sadler TW (2006)
Langman's Medical Embryology, 10th Edition
Lippincott Williams & Wilkins, Baltimore

A concise, well-illustrated presentation of essential facts on human development, including summary tables and charts. This is directed at the medical student and researcher in the field of developmental biology. Includes a CD-ROM with extensive illustrations and animation of embryonic development.

Sastry BVR (Ed.) (1995)
Placental Toxicology
CRC Press, Boca Raton, FL

Examines placental transfer and toxicology of drugs and environmental agents to placenta as well as to the fetus. Placental and fetal consequences of exposure of pregnant women to drugs, environmental agents, and infections such as HIV are discussed. Featured chemical classes include drugs of addiction, pesticides, and hormonally active materials.

Schardein JL (2000)
Chemically Induced Birth Defects, 3rd Edition
Informa Healthcare Dekker, New York

Catalogs the available data on drugs and chemicals for their potential teratogenicity in animals and humans. The basic divisions are drugs and chemicals and they are sorted in a way which makes access to the desired specific information easy. The data are presented on a chemical-by-chemical basis and not by the various endpoints determined.

Schardein JL, Macina OT (2006)
Human Developmental Toxicants: Aspects of Toxicology and Chemistry
CRC Press, Boca Raton, FL

Contains information on chemical structures, properties, and biological activities for 50 known human and animal developmental toxicants. The book also includes a CD with an accessible database on chemicals and health effects.

Shepard TH, Lemire RJ (2007)
Catalog of Teratogenic Agents, 12th edition
Johns Hopkins University Press, Baltimore

Considered by many to be an important compilation of teratogenic agents. Helps link the information on experimental teratogenic agents with congenital defects in human beings. Agents listed include chemicals, drugs, physical factors, and viruses. A special effort was made to obtain agents to which pregnant women may be exposed, including pharmaceuticals, chemicals, environmental pollutants, food additives, household products, and viruses.

The Teratology Society (2005)
Teratology Primer (Paperback)
The Teratology Society

The Teratology Primer, written for beginning students and interested members of the public, provides the basics on the causes and consequences of birth defects.

Wilson JG (1973)
Environment and Birth Defects
Academic Press, New York

A classic text that remains a valuable reference to those working in the field of developmental toxicity. The aim is to provide the principles of information needed to evaluate environmental factors that may represent risks to unborn generations. Two areas of special concern handled by this book are mutagenesis and teratogenesis.

Journals

Birth Defects Research
Part A: Clinical and Molecular Teratology Journal
Part B: Developmental and Reproductive Toxicology Journal
Part C: Embryo Today: Reviews
John Wiley & Sons Press
www.teratology.org

These journals, sponsored by the Teratology Society, publish original research on basic and clinical studies on birth defects, developmental and reproductive effects of chemical and physical agents. Part A and B are continued publication of older journals (see below).

Development (1987–)
The Company of Biologists
Cambridge, UK
http://dev.biologists.org/

Focuses on the mechanisms of plant and animal development.

Neurotoxicology (1979–)
Elsevier Inc.

Neurotoxicology publishes papers dealing with the effects of toxic substances on the nervous system of humans and experimental animals of all ages.

Neurotoxicology and Teratology (1979–)
Elsevier Inc.

Focused on the neurobehavioral and neurochemical effects of developmental exposure to environmental chemicals, therapeutic drugs, and drugs of abuse.

Reproductive Toxicology (1987)
Elsevier Inc.

Publishes original research on the effects of chemical or physical agents on reproduction including in vitro, animal, or human research. This is the official journal of the European Teratology Society.

Teratogenesis, Carcinogenesis and Mutagenesis Teratology (1981–2002)
John Wiley & Sons Press

Focuses on original research on chemical and physical agents that elucidated the causes or mechanisms of teratology; now published as ***Part B: Developmental and Reproductive Toxicology***, as a journal of the Teratology Society.

Teratology (1968–1995)
John Wiley & Sons Press

An important historical account of research in teratology, now published as *Birth Defects Research Part A: Clinical and Molecular Teratology*, the official journal of the Teratology Society.

Journal articles

2005. NTP-CERHR monograph on the potential human reproductive and developmental effects of amphetamines. Ntp Cerhr Mon. vii–III1.

2006. NTP-CERHR monograph on the potential human reproductive and developmental effects of styrene. Ntp Cerhr Mon. vii–viii, 1–5, I1–2 passim.

2006. Principles for Evaluating Health Risks in Children Associated with Exposure to Chemicals, World Health Organization/International Programme on Chemical Safety. Environmental Health Criteria Series, No. 237. Available at: http://whqlibdoc.who.int/publications/2006/924157237X_eng.pdf.

Agency for Toxic Substance and Disease Registry (1998) Reproductive and developmental hazards. An overview for occupational and environmental health nurses. AAOHN J. 46(2): 57–65.

Buse E, Habermann G, Osterburg I, Korte I, Weinbauer GF (2003) Reproductive/developmental toxicity and immunotoxicity assessment in the nonhuman primate model. Toxicology 185: 221–227.

Collins TF (2006) History and evolution of reproductive and developmental toxicology guidelines. Curr. Pharm. Des. 12: 1449–1465.

Cummings A, Kavlock R (2005) A systems biology approach to developmental toxicology. Reprod. Toxicol. 19: 281–290.

Davidson P, Myers G, Weiss B (eds.) (2006) International Review of Research in Mental Retardation, Volume 30, Neurotoxicity and Developmental Disabilities. Elsevier Academic Press.

Frederiksen MC (2002) The drug development process and the pregnant woman. J. Midwifery Womens Health, 47: 422–425.

Gluck PA, Gluck JC (2005) A review of pregnancy outcomes after exposure to orally inhaled or intranasal budesonide. Curr. Med. Res. Opin. 21: 1075–1084.

Grant KS, Rice DC (2007) Environmental pollutants and child development: contributions from nonhuman primate research. In: Burbacher T, Grant K, Sackett G (eds.) Primate Models of Children's Health and Developmental Disabilities. Elsevier Academic Press, pp. 377–420.

Healy CE, Heydens WF, Nagler MW (2004) Mammalian toxicology overview and human risk assessment for sulfosulfuron. Regul. Toxicol. Pharmacol. 39: 310–324.

Hendrickx AG, Makori N, Peterson P (2002) The nonhuman primate as a model of developmental immunotoxicity. Hum. Exp. Toxicol. 21: 537–542.

Hoyer PB (2001) Reproductive toxicology: current and future directions. Biochem. Pharmacol. 62: 1557–1564.

Huggins J (2003) Alternatives to animal testing: research, trends, validation, regulatory acceptance. Altex. 20: 3–61.

Jahnke GD, Makori N, Peterson P (2004) Thyroid toxicants: assessing reproductive health effects. Environ. Health Perspect. 112: 363–368.

Jahnke GD, Iannucci AR, Scialli AR, Shelby MD (2005) Center for the evaluation of risks to human reproduction – the first five years. Birth Defects Res. B Dev. Reprod. Toxicol. 74: 1–8.

Kimmel CA, Makris SL (2001) Recent developments in regulatory requirements for developmental toxicology. Toxicol. Lett. 120: 73–82.

Ladics GS, Chapin RE, Hastings KL, et al (2005) Developmental toxicology evaluations – issues with including neurotoxicology and immunotoxicology assessments in reproductive toxicology studies. Toxicol. Sci. 88: 24–29.

Manson J, Brabec MJ, Buelke-Sam J, et al (2005) NTP-CERHR expert panel report on the reproductive and developmental toxicity of acrylamide. Birth Defects Res. B Dev. Reprod. Toxicol. 74: 17–113.

Matthews EJ, Kruhlak NL, Daniel Benz R, Contrera JF (2007) A comprehensive model for reproductive and developmental toxicity hazard identification: I. Development of a weight of evidence QSAR database. Regul. Toxicol. Pharmacol. 47: 115–135.

Peters PW (1998) Developmental toxicology: adequacy of current methods. Food Addit. Contam. 15(Suppl): 55–62.

Rice D, Barone S Jr (2000) Critical periods of vulnerability for the developing nervous system: evidence from humans and animal models. Environ. Health Perspect. 108(Suppl. 3): 511–533.

Rogers JM (2008) Tobacco and pregnancy: overview of exposures and effects. Birth Defects Res. C Embryo Today 84(1): 1–15.

Shelby M, Portier C, Goldman L, et al (2004) NTP-CERHR expert panel report on the reproductive and developmental toxicity of methanol. Reprod. Toxicol. 18: 303–390.

Valentine R, Himmelstein MW (2001) Overview of the acute, subchronic, reproductive, developmental and genetic toxicology of beta-chloroprene. Chem. Biol. Interact. 135–136: 81–100.

Wang C, Slikker W Jr (2008) Strategies and experimental models for evaluating anesthetics: effects on the developing nervous system. Anesth. Analg. 106(6): 1643–1658.

Winker R, Rudiger HW (2006) Reproductive toxicology in occupational settings: an update. Int. Arch. Occup. Environ. Health, 79: 1–10.

Organizations

European Teratology Society (ETS)
Phone: UK +44 (0)1483 689212
Fax: UK +44 (0)1483 686401
Email: L.Burton@surrey.ac.uk
Web: http://www.etsoc.com/

According to the website, the objectives of the Society are to stimulate interest in and promote the exchange of ideas and information about the etiology, prevention, and treatment of congenital malformations and is dedicated to the prevention of adverse effects on reproduction and development.

March of Dimes
1275 Mamaroneck Avenue
White Plains, NY 10605
Phone: (914) 997-4488
Web: http://www.marchofdimes.com/

The March of Dimes 'mission is to improve the health of babies by preventing birth defects, premature birth, and infant mortality.'

Middle Atlantic Reproduction and Teratology Association (MARTA)
For contact information visit the website
Web: http://www.e-marta.org/

Established in 1968, MARATA is an organization of academic and industry professionals and institutions committed to the study of reproduction and developmental anomalies.

National Center on Birth Defects and Developmental Disabilities (NCBDDD)
Centers for Disease Control and Prevention
1600 Clifton Rd, Atlanta
GA 30333, U.S.A.
Phone: (404) 639-3534/(800) 311-3435
Web: http://www.cdc.gov/ncbddd/default.htm

The NCBDDD works to identify the cause and prevent birth defects and developmental disabilities, and promotes the health of babies, children, and adults, toward ensuring that everyone has the opportunity to reach and maintain their full potential.

Neurobehavioral Teratology Society (NBTS)
For contact information visit the website
Web: http://www.nbts.org/

Founded in 1977, the mission of NBTS is to understand how the environment affects the health of infants and children. To this end, society members study how environmental chemicals, drugs, and genetic factors impact the developing nervous system.

Organization of Teratology Information Specialists (OTIS)
Phone: (866) 626-6847
Web: http://otispregnancy.org/

OTIS works to prevent birth defects through education and research in part by supporting a network of Teratogen Information Services across the U.S. and Canada. Their website has an extensive list of fact sheets.

Society for Developmental Biology (SDB)
9650 Rockville Pike
Bethesda, MD 20814-3998
Phone: (301) 634-7815
Fax: (301) 634-7825
E-mail: ichow@sdbonline.org
Web: http://www.sdbonline.org/

Founded in 1939, The Society for Developmental Biology (SDB) exists to 'promote the field of developmental biology and to advance our understanding of developmental biology at all levels.'

Teratology Society
1821 Michael Faraday Drive, Suite 300
Reston, Virginia 20190
Phone: (703) 438-3104
Fax: (703) 438-3113
E-mail: tshq@teratology.org
Web: http://teratology.org/

Founded in 1960, the Teratology Society promotes research into the causes and biological processes leading to abnormal development and birth defects including both basic and clinical research.

Databases

Canadian Congenital Anomalies Surveillance Network (CCASN)
http://www.phac-aspc.gc.ca/ccasn-rcsac/index.html

Established in 2002, CCASN, is designed to bringing together research, surveillance, and clinical and public health practices, with the goal to enhance the quality of surveillance data.

The Center for the Evaluation of Risks to Human Reproduction (CERHR)
Web: http://cerhr.niehs.nih.gov/

A resource for the latest information about potentially hazardous effects of chemicals on human reproduction and development.

International Federation of Teratology Societies
Atlas of Developmental Abnormalities in Common Laboratory Mammals
Web: http://www.ifts-atlas.org/ifts/

This atlas provides a set of images of both rare and common observations in fetuses and neonates from common laboratory mammals.

Reproductive Toxicology Center
Web: http://www.reprotox.org

Reproductive Hazard Information, Environmental Impact of Human Reproduction and Development. Impact of physical and chemical environment on human reproduction and development.

Teratogen Information System (TERIS)
Web: http://depts.washington.edu/terisweb/teris/

TERIS is a computerized, subscription-only, database that summarizes and rates the teratogenic potential of over 2000 chemicals and drugs. Aimed at clinicians, this on-line service also provides access to Shepard's Catalogue to Teratogenic agents.

CHAPTER

22

Disaster Preparedness and Management

C.C. BARTON

INTRODUCTION

A disaster is a serious disruption of the functioning of a community or a society causing widespread human, material, economic, or environmental losses which exceed the ability of the affected community or society to cope using its own resources. Over 96% of all deaths from natural disasters occur in developing countries. Natural disasters kill one million people around the world each decade and leave millions more homeless each year.

Disaster preparedness and management refers to measures taken to prepare for and reduce the effects of disasters. That is, to predict, prevent, and mitigate their impact on vulnerable populations, and respond to their consequences.

Disaster preparedness is a continuous and integrated process resulting from a wide range of activities and resources rather than from a distinct activity by itself. It requires the contributions of many different areas ranging from training and logistics, to health care to institutional development. Viewed from this broad perspective, disaster preparedness encompasses three main objectives:

1. Increasing the efficiency, effectiveness, and impact of disaster emergency response mechanisms at the community, state, and national levels. This includes: (a) the development and regular testing of warning systems (linked to forecasting systems) and plans for evacuation or other measures to be taken during a disaster alert period to minimize potential loss of life and physical damage; (b) the education and training of officials and the population at risk; (c) the training of first-aid and emergency response teams; and (d) the establishment of emergency response policies, standards, organizational arrangements, and operational plans to be followed after a disaster.
2. Strengthening community-based disaster preparedness. This could include educating, preparing, and supporting local populations and communities in their everyday efforts to reduce risks and prepare their own local response mechanisms to address disaster emergency situations.
3. Developing activities that are useful for both addressing everyday risks that communities face and for responding to disaster situations.

Disaster management can be defined as the effective organization, direction, and utilization of available counter-disaster resources. Another view is that there must be pre-disaster preparedness or mitigation measures to avoid or reduce the impact of disasters.

Emergency management (or disaster management) involves preparing, supporting, and rebuilding society when natural or human-made disasters occur. In general, any emergency management is the continuous process by which all individuals, groups, and communities manage hazards in an effort to avoid or ameliorate the impact of disasters resulting from the hazards. Actions taken depend in part on perceptions of risk of those exposed. Effective emergency management relies on integration of emergency plans at all levels of government and non-government involvement. Activities at each level (individual, group, community) affect the other levels. It is common to place the responsibility for governmental emergency management with the institutions for civil defense or within the conventional structure of the emergency services.

The nature of emergency management is highly dependent on economic and social conditions local to the emergency, or disaster. The process of emergency management involves four phases: mitigation, preparedness, response, and recovery.

Mitigation efforts attempt to prevent hazards from developing into disasters altogether, or to reduce the effects of disasters when they occur. The mitigation phase differs from the other phases because it focuses on long-term measures for reducing or eliminating risk. The implementation of mitigation strategies can be considered a part of the recovery process if applied after a disaster occurs. However, even if applied as part of recovery efforts, actions that reduce or eliminate risk over time are still considered mitigation efforts.

Mitigation measures can be structural or non-structural. Structural measures use technological solutions, like flood levees. Non-structural measures include legislation, land-use planning (e.g. the designation of non-essential land to be used as flood zones), and insurance. Mitigation is the most cost-efficient method for reducing the impact of hazards. However, mitigation is not always suitable and structural mitigation in particular may have adverse effects on the ecosystem.

Personal mitigation is mainly about knowing and avoiding unnecessary risks. This includes an assessment of possible risks to personal/family health and to personal property. An example of personal non-structural mitigation would be to avoid buying property that is exposed to hazards, e.g. in a flood plain, in areas of subsidence or landslides.

Personal structural mitigation in earthquake-prone areas includes installation of an Earthquake Valve to instantly shut off the natural gas supply to the property, seismic retrofits of property, and the securing of items inside the building to enhance household seismic safety such as the mounting of furniture, refrigerators, water heaters, and breakables to the walls, and the addition of cabinet latches. In areas prone to prolonged electricity black-outs a generator would be an example of an optimal structural mitigation measure. The construction of storm cellars and fallout shelters are further examples of personal mitigative actions.

In the preparedness phase, emergency managers develop plans of action for when the disaster strikes. Common preparedness measures include: (a) the communication plans with chain of command; (b) development and practice of multiagency coordination and incident command; (c) proper maintenance and training of emergency services; (d) development and exercise of emergency population warning methods combined with emergency shelters and evacuation plans; and (e) stockpiling and maintenance of supplies and equipment.

An efficient preparedness measure is an emergency operations center (EOC) combined with a practiced region-wide doctrine for managing emergencies. Another preparedness measure is to develop a volunteer response capability among civilian populations. Since volunteer response is not as predictable as professional response, volunteers are most effectively deployed on the periphery of an emergency.

On the contrary to mitigation activities which are aimed at preventing a disaster from occurring, personal preparedness is targeted on preparing activities to be taken when a disaster occurs, i.e. planning. Preparedness measures can take many forms. Examples include the construction of shelters, warning devices, back-up life-line services (e.g. power, water, sewage), and rehearsing an evacuation plan. For evacuation, a disaster supplies kit should be prepared and for sheltering purposes a stockpile of supplies.

The response phase includes the mobilization of the necessary emergency services and first responders in the disaster area. This is likely to include a first wave of core emergency services, such as firefighters, police, and ambulance crews. They may be supported by a number of secondary emergency services, such as specialist rescue teams.

In addition volunteers and non-governmental organizations such as the local Red Cross may provide immediate assistance. A well-rehearsed emergency plan developed as part of the preparedness phase enables efficient coordination of rescue efforts. Emergency plan rehearsal is essential to achieve optimal output with limited resources. In the response phase, medical assets will be used in accordance with the appropriate triage of the affected victims. Where required, search and rescue efforts commence at an early stage.

The response phase of an emergency may commence with a search and rescue phase. However in all cases the focus will be on fulfilling the basic needs of the affected population on a humanitarian basis. This assistance may be provided by local, state, or national agencies and organizations. Effective coordination of disaster assistance is often crucial, particularly when many organizations respond and local emergency management agency capacity may be over-stretched and diminished by the disaster itself.

On a personal level the response can take the shape either of a home confinement or an evacuation. In a home confinement scenario, a family should be prepared to stay inside their homes for days with minimum outside support. In an evacuation scenario, a family evacuates by an automobile (or other mode of transportation) with the maximum amount of supplies.

The aim of the recovery phase is to restore the affected area to its previous state. It differs from the

response phase in its focus; recovery efforts are concerned with issues and decisions that must be made after immediate needs are addressed. Recovery efforts are primarily concerned with actions that involve rebuilding destroyed property, re-employment, and the repair of other essential infrastructure.

In the United States, the National Response Plan dictates how the resources provided by the Homeland Security Act of 2002 will be used in recovery efforts. It is the Federal government that often provides the most technical and financial assistance for recovery efforts in the United States.

The recovery phase starts when the immediate threat to human life has subsided. In the reconstruction it is recommended to reconsider the location or construction material of the property.

Emerging tools and technologies such as Semantic Web application in public health preparedness and response has shown promise in effective information sharing, data integration, and timely decision making.

RESOURCES

Books

Alexander D (2002)
Principles of Emergency Planning and Management
New York: Oxford University Press.

As interest in planning for emergencies and disasters burgeons, and educational and training programs proliferate, this is the first book to meet the need for a concise yet comprehensive and systematic primer on how to prepare for a disaster. Providing readers with a comprehensive, systematic, yet concise introduction to effective preparation for disasters, it provides a unified starting point encompassing the scattered and parochial literature in this nascent field of academic enquiry and practical endeavor. The book provides a general introduction to the methods, procedures, protocols, and strategies of emergency planning, with emphasis on situations in industrialized countries and the local level of organization (i.e. cities, municipalities, metropolitan areas, and small regions), though with ample reference to national and international levels. Rather than concentrating on the practices of any one country or state, the author focuses on general principles. The book is designed to be a reference source and manual from which emergency managers can extract ideas, suggestions and pro-forma methodologies to help them design and implement emergency plans. A comprehensive all-hazards approach is adopted, with frequent reference to the most important individual hazards and the planning and management needs that they create. Twelve examples of actual emergency planning and management problems are analyzed in detail. The book is written especially for the new generation of emergency planners and managers that is emerging as a result of intensified governmental interest in disaster preparedness. Many of them will occupy positions in government or other organizations that require emergency plans. The book will also be of value to students of disasters and hazards who have a practical interest in how disasters are planned for and managed, and to professional workers and trainees who will eventually have to participate in disaster plans. The book is designed to be easily integrated with training courses in emergency preparedness.

Haddow G, Bullock J (2005)
Introduction to Emergency Management, 2nd edition (Butterworth-Heinemann Homeland Security)
Boston, MA: Butterworth-Heinemann.

Introduction to Emergency Management, Second Edition is a practical reference for students and professionals covering disaster response planning and mitigation. The book details the Federal Emergency Management Agency (FEMA) (U.S.), the Federal Response Plan (FRP), and the roles, responsibilities, and interrelationship between FEMA and state and local emergency management systems. It also covers the changes in emergency management since the events of September 11, 2001, the latest information on the Office of Homeland Security, and includes several detailed appendices. The book (1) includes continual connection of theory to real-world examples of disasters including the Tsunami disaster and instances of terrorism; (2) contains dozens of diagrams and statistics illustrating disaster management history and facts; and (3) provides links to Emergency Management websites and information sources, including homeland security sources.

Schneid TD, Collins LR (2000)
Disaster Management and Preparedness (Occupational Safety and Health Guide Series)
New York: Taylor & Francis.

This book addresses all the special considerations important in planning for disasters, from natural disasters to acts of terrorism to catastrophic events. It covers all aspects from assessing the risk prior to a disaster to the legal ramifications following a disaster. The text addresses the 'how-tos' of avoiding the common mistakes which turn natural and man-made catastrophes into economic disasters. It encompasses not only the tried and true tactics used for decades but also focuses on areas often overlooked during the reactive and post-disaster phases. Organizations

can be prepared and proactive by using this guide to make a disaster management plan before disaster strikes.

Waugh WL (1999)
Living With Hazards, Dealing With Disasters: An Introduction to Emergency Management
Armonk, NY: M.E. Sharpe, Inc.

This is the first concise introduction to emergency management, the emerging profession that deals with disasters from floods and earthquakes to terrorist attacks.

Coverage includes: (1) The history of emergency management and its evolution from volunteer effort to trained intervention; (2) Organization of emergency management systems – local, state, regional, national, international; governmental, for-profit, and non-profit; (3) Managing natural disasters – floods, earthquakes, hurricanes, wildfires, tornadoes, avalanches, etc.; (4) Managing manmade disasters – civil defense, terrorism, hazardous materials accidents, fires, structural failures, nuclear accidents, transportation disasters; (5) Policy issues in the management of risk, emergencies, and disasters; and (6) Disaster management in the twenty-first century – technological and political challenges.

Twenty case studies illustrate the handling of actual disasters including the Northridge Earthquake and the Oklahoma City Bombing. Discussion questions and guides to online information sources facilitate use of the book in the classroom and professional training programs.

Journals

Australasian Journal of Disaster and Trauma Studies
New Zealand: Massey University.
Web: http://www.massey.ac.nz/~trauma/welcome.shtml

The *Australasian Journal of Disaster and Trauma Studies* is a peer-reviewed electronic journal utilizing the Internet as a medium for the collation and distribution of original material on disaster and psychological trauma studies within Australia, New Zealand, and the Pacific Rim. Coverage includes disaster and trauma mitigation and prevention, response, support, recovery, treatment, policy formulation, and planning and their implications at the individual, group, organizational, and community level. The Journal is interested in events of natural, technological, and human-induced origin and their effects at individual, community, organizational, and national levels.

Disaster Prevention and Management
Emerald Group Publishing Limited, Bingley, UK
Web: http://www.emeraldinsight.com/info/journals/dpm/dpm.jsp

Disaster Prevention and Management, an international journal, sets out to advance the available knowledge in the fields of disaster prevention and management and to act as an integrative agent for extant methodologies and activities relating to disaster emergency and crisis management. Publishing high-quality, refereed papers, the journal supports the exchange of ideas, experience and practice between academics, practitioners, and policy-makers.

Journal of Natural Disaster Science
Kyoto, Japan: Gokasho, Uji.
Web: http://www.soc.nii.ac.jp/jsnds/contents/jsdn_back_number/jsdn_bn_list.html

The *JNDS*, published since 1979, has provided a unified forum for scientific research on various problems concerning natural hazards and the prevention or mitigation of natural disasters. From Volume 20 (1998) *JNDS* has been restructured as the journal of the Society for Natural Disaster Science, Japan. Publication is open to those who wish to contribute results of original research studies or investigations. All areas of Natural Disaster Science will be represented through regular papers, special reports, letters, and discussions. Original papers that provide new findings on natural hazard phenomena, and papers on interdisciplinary subjects dealing with the reduction of natural disasters are highly encouraged. Timely special reports are planned in the event of large-scale disasters.

Journal articles

Amaratunga CA, O'Sullivan TL (2006) In the path of disasters: psychosocial issues for preparedness, response, and recovery. Prehosp. Dis. Med. 21: 149–155.

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Bennett RL (2006) Chemical or biological terrorist attacks: an analysis of the preparedness of hospitals for managing victims affected by chemical or

biological weapons of mass destruction. Int. J. Environ. Res. Public Health 3: 67–75.

Brennan RJ, Waeckerle JF, Sharp TW, Lillibridge SR (1999) Chemical warfare agents: emergency medical and emergency public health issues. Ann. Emerg. Med. 34: 191–204.

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Keim M (2002) Using a community-based approach for prevention and mitigation of national health emergencies. Pac. Health Dialog. 9: 93–96.

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Lillibridge S (2003) New developments in health and medical preparedness related to the threat of terrorism. Prehosp. Emerg. Care 7: 56–58.

O'Neill PA (2005) The ABC's of disaster response. Scand. J. Surg. 94: 259–266.

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Schwenk M, Kluge S, Jaroni H (2005) Toxicological aspects of preparedness and aftercare for chemical-incidents. Toxicology 214: 232–248.

Tur-Kaspa I, Lev EI, Hendler I, et al (1999) Preparing hospitals for toxicological mass casualties events. Crit. Care Med. 27: 1004–1008.

Organizations

American Red Cross National Headquarters
2025 E Street, NW
Washington, DC 20006
Phone: 202-303-4498 or 800-REDCROSS (800-733-2767)
Web: http://www.redcross.org/

The American Red Cross (chartered as the American National Red Cross) is a humanitarian organization that provides emergency assistance, disaster relief, and education inside the United States, as part of the International Federation of Red Cross and Red Crescent Societies.

Today, in addition to domestic disaster relief, the American Red Cross offers compassionate services in five other areas: community services that help the needy; support and comfort for military members and their families; the collection, processing, and distribution of lifesaving blood and blood products; educational programs that promote health and safety; and international relief and development programs.

Department of Homeland Security
245 Murray Lane, SW
Washington, DC 20528-0300
Phone: 202-282-8000
Web: http://www.dhs.gov/index.shtm

The National Strategy for Homeland Security and the Homeland Security Act of 2002 served to mobilize and organize our nation to secure the homeland from terrorist attacks. This exceedingly complex mission requires a focused effort from our entire society if we are to be successful. To this end, one primary reason for the establishment of the Department of Homeland Security was to provide the unifying core for the vast national network of organizations and institutions involved in efforts to secure our nation. In order to better do this and to provide guidance to the 180 000 DHS men and women who work every day on this important task, the Department developed its own high-level strategic plan. The vision and mission statements, strategic goals, and objectives provide the framework guiding the actions that make up the daily operations of the department.

Disaster Preparedness and Emergency Response Association
P.O. Box 797
Longmont, CO 80502
Web: http://www.disasters.org/index.htm

DERA is a membership organization founded in 1962 as a non-profit association linking professionals, volunteers, and organizations active in all phases of disaster preparedness and emergency management. DERA remains an independent, non-governmental organization (NGO) with dual missions of professional support and disaster service.

DERA currently has active members around the world and invites you to obtain the benefits of membership

while sharing your knowledge, skills, and abilities to help those in need.

DERA provides professional support, resource sharing, leadership opportunities, and extensive networking for members and is actively involved in providing critical emergency assistance in response to several recent disasters.

Federal Emergency Management Agency
500 C Street S.W.
Washington, D.C. 20472
Phone: 800-621-FEMA (3362)
Web: http://www.fema.gov/

On March 1, 2003, the Federal Emergency Management Agency (FEMA) became part of the U.S. Department of Homeland Security (DHS). The primary mission of the Federal Emergency Management Agency is to reduce the loss of life and property and protect the Nation from all hazards, including natural disasters, acts of terrorism, and other man-made disasters, by leading and supporting the Nation in a risk-based, comprehensive emergency management system of preparedness, protection, response, recovery, and mitigation.

FEMA has more than 2600 full-time employees. They work at FEMA headquarters in Washington D.C., at regional and area offices across the country, the Mount Weather Emergency Operations Center, and the National Emergency Training Center in Emmitsburg, Maryland. FEMA also has nearly 4000 standby disaster assistance employees who are available for deployment after disasters. Often FEMA works in partnership with other organizations that are part of the nation's emergency management system. These partners include state and local emergency management agencies, 27 federal agencies and the American Red Cross.

International Association of Emergency Managers
201 Park Washington Court
Falls Church, VA, 22046-4527
Web: http://www.iaem.com/index.htm

The International Association of Emergency Managers (IAEM) is a non-profit educational organization dedicated to promoting the goals of saving lives and protecting property during emergencies and disasters.

National Emergency Management Association
PO Box 11910
Lexington, KY 40578
Phone: 859-244-8000
Fax: 859-244-8239
Web: http://www.nemaweb.org/index.cfm

NEMA is the professional association of and for state emergency management directors. NEMA's mission is to: (a) provide national leadership and expertise in comprehensive emergency management; (b) serve as a vital emergency management information and assistance resource; and (c) advance continuous improvement in emergency management through strategic partnerships, innovative programs, and collaborative policy positions.

Other websites of interest

Medline Plus: Disaster Preparation and Recovery
Web: http://www.nlm.nih.gov/medlineplus/disasterpreparationandrecovery.html

Resources for Members of the National Network of Libraries of Medicine (NN/LM) Southeastern/Atlantic Region (SE/A)
Web: http://nnlm.gov/sea/outreach/disasterrelief.html

Databases

HazLit
University of Colorado's Natural Hazards Center Library
Web: http://ibs.colorado.edu/hazards/Library/Hazlit/NatHazSearch.php

Provides access to books, journals, and reports about how societies prepare for and respond to natural hazards and catastrophic events. Can search by title, author, keyword, call #, or year published. Search results provide bibliographic information, but do not link directly to a resource.

Integrated Risk Information System (IRIS)
U.S. Environmental Protection Agency
Web: http://www.epa.gov/iris/index.html

The Integrated Risk Information System (IRIS), prepared and maintained by the U.S. Environmental Protection Agency (U.S. EPA), is an electronic database containing information on human health effects that may result from exposure to various chemicals in the environment. IRIS was initially developed for EPA staff in response to a growing demand for consistent information on chemical substances for use in risk assessments, decision-making, and regulatory activities. The information in IRIS is intended for those without extensive training in toxicology, but with some knowledge of health sciences.

The heart of the IRIS system is its collection of computer files covering individual chemicals. These chemical

files contain descriptive and quantitative information in the following categories:

- Oral reference doses and inhalation reference concentrations (RfDs and RfCs, respectively) for chronic non-carcinogenic health effects
- Hazard identification, oral slope factors, and oral and inhalation unit risks for carcinogenic effects
- International Toxicity Estimates for Risk Database (ITER)
- Toxicology Excellence for Risk Assessment
- http://www.tera.org/ITER/
- ITER is a free Internet database of human health risk values and cancer classifications for over 600 chemicals of environmental concern from multiple organizations worldwide. It presents risk data in a tabular format for easy comparison, along with a synopsis explaining differences in data and a link to each organization for more information.

QUAKELINE
University of Buffalo's Multidisciplinary Center for Earthquake Engineering Research
Web: http://mceer.buffalo.edu/utilities/quakeline.asp

QUAKELINE® is a bibliographic database developed and maintained by the Information Service. It covers earthquakes, earthquake engineering, natural hazard and disaster mitigation, and related topics. Varied publications are featured, including books, journal articles, conference papers, proceedings, technical reports, CDs, slides, and videos. The database is updated on a monthly basis and currently provides content for over 44 900 records.

Resource Guide for Public Health Preparedness
New York Academy of Medicine
Web: http://www.phpreparedness.info/

Provides access to various types of documents pertaining to public health preparedness, such as executive summaries, fact sheets, and glossaries. The 'Advanced option' allows you to search the database by document type, intended audience, or 'event category,' which includes biological or nuclear attacks. Every search result links directly to a resource.

Risk Assessment Information System
US Department of Energy
Web: http://rais.ornl.gov/

Database of toxicity values and information used to disseminate risk tools and supply information for risk assessment activities.

Toxicological Data Network (TOXNET)
US National Library of Medicine
Web: http://toxnet.nlm.nih.gov/

A central clearinghouse for 14 separate databases on toxicology, hazardous chemicals, environmental health, and toxic releases.

TOXNET
US National Library of Medicine
Web: http://toxnet.nlm.nih.gov/

Cluster of databases maintained by the National Library of Medicine's Division of Specialized Information Services. A total of 10 databases that provide information on various aspects of toxicology hazard identification. Can search databases individually or all at once.

CHAPTER

23

Environmental Toxicology: Aquatic

SAMANTHA J. JONES

INTRODUCTION

Aquatic toxicology generally involves the measurement of contaminant levels to characterize the hazards imposed on the aquatic environment; however, this field of study also includes information on how those contaminants can affect humans in and around these aquatic environments. Defined as the study of the effects due to anthropogenic materials and activities on aquatic organisms, aquatic toxicology is observed on multiple levels, from the subcellular to individual organisms to communities and ecosystems (Rand 1995).

The detrimental effects to both the aquatic environment and humans from anthropogenic chemical contaminants are illustrated in numerous historical incidents. One such incident occurred in Japan in the 1950s, in which an industrial release of mercury spilled into Minamata Bay. This resulted in mercury poisonings and severe neurotoxicological and developmental effects in the local villagers that consumed the tainted fish and shellfish from the bay (Hodgson & Levi 1997). Another well-known event, the *Exxon Valdez* oil spill in Prince William Sound, Alaska, occurred in 1989. This incident resulted in the release of more than 250 000 barrels (4.2×10^7 liters) of crude oil into the Sound (Harwell & Gentile 2006). The impact of the contamination on birds and marine mammals was significant. It has been estimated that approximately 375 000 seabirds died as a direct result of the oil spill (Ford et al 1996). The lasting effects of the incident on the Prince William Sound aquatic ecosystems and surrounding environment remain controversial.

Increased publicity of the deleterious effects of pesticides on wildlife and regulations such as the 1977 Clean Water Act helped propel environmental toxicology to the forefront of the public consciousness in the 1960s and 1970s. As part of this movement, aquatic toxicology expanded as interests were renewed in water quality and the quality of aquatic organisms (Mac 1998, Macek 1980).

Aquatic environments provide unique opportunities to study the impact of contaminants because toxicants frequently enter aquatic environments via multiple avenues, such as effluent discharge, terrestrial runoff, and atmospheric deposition (Kendall et al 2001, Pritchard 1993). Chemically induced toxic effects in freshwater and marine organisms, such as the *Daphnia magna* (commonly referred to as a water flea) and the *Pimephales promelas* (fathead minnow), serve as indicators of toxicological risk to humans and the environment (Kendall 2001). Established acute lethality toxicity tests commonly utilize aquatic organisms. While these acute tests represent a less likely scenario (when compared with a sublethal, longer-term approach), they remain ecologically significant tools that allow for comparisons across species and chemicals. Full life cycle fish tests have been developed to better represent the chemically induced changes in behavioral, physiological, and reproductive processes in affected aquatic organisms (Mac 1998).

Past research and information related to aquatic toxicology provided a foundation for the development of standard methods of analysis, while techniques for identifying biomarkers are constantly refined to increase sensitivity and specificity to detect chemical contaminants (Mac 1998). The expansion of chemical, biological, and toxicological databases has carried over into aquatic toxicology and allowed for improved characterization of the toxicity of aquatic chemical

contaminants. Furthermore, the incorporation of computational toxicology has supported the progression from mere detection of a pollutant to reliable, predictive outcomes that aid in preventing aquatic exposure to contaminants.

The multidisciplinary research that comprises the field of aquatic toxicology has provided a better understanding of the effects anthropogenic activities and chemical contaminants have on aquatic environments. Additionally, this increase in knowledge has improved the methods utilized and consequently, the confidence in measuring the potential hazards associated with humans exposed to contaminated aquatic environments and organisms (Pritchard 1993).

This chapter provides a plethora of resources used in the field of aquatic toxicology. The resources assembled are informative whether one is looking at the pollution generated by anthropogenic activities and the affected aquatic ecosystems or observing how contaminants in water and aquatic organisms affect water quality and the subsequent exposure to humans.

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Fairbrother A, Lewis MA, Menzer RE (2001) Methods in environmental toxicology. In: Wallace Hayes A (ed.) Principles and Methods of Toxicology, 4th edition. Philadelphia, PA: Taylor and Francis.

Ford RG, Bonnell ML, Varoujean DH, et al (1996) Total direct mortality of seabirds from the Exxon Valdez oil spill. In: Rice SD, Spies RB, Wolfe DA, Wright BA (eds.). Proceedings of the Exxon Valdez Oil Spill Symposium. American Fisheries Society Symposium 18: pp. 684–711, 1993 Feb 2–5; Anchorage, AK; Bethesda, MD: American Fisheries Society.

Harwell MA, Gentile JH (2006) Ecological significance of residual exposures and effects from the Exxon Valdez oil spill. Integrat. Environ. Assess. Manag. 2(3): 204–246.

Hodgson E, Levi PE (eds.) (1997) A Textbook of Modern Toxicology, 2nd edition. Stamford, CT: Appleton and Lange.

Kendall RJ, Anderson T, Baker R, et al (2001) Ecotoxicology. In: Curtis D (ed.) Klaassen Casarett and Doull's Toxicology: The Basic Science of Poisons, 6th edition. New York: McGraw-Hill.

Mac MJ, Opler PA, Puckett Haecker CE, et al (1998) Status and Trends of the Nation's Biological Resources, Volumes 1 and 2. Reston, VI: U.S. Department of the Interior, U.S. Geological Survey.

Macek KJ (1980) Aquatic toxicology: Fact or fiction? Environ. Health Perspect. 34: 159–163.

Pritchard JB (1993) Aquatic toxicology: Past, present, and prospects. Environ. Health Perspect. 100: 249–257.

Rand GM (ed.) (1995) Fundamentals of Aquatic Toxicology: Effects, Environmental Fate and Risk Assessment, 2nd edition. Washington, DC: Taylor & Francis.

RESOURCES

Books

Abel PD, Axiak V (eds.) (1990)
Ecotoxicology and the Marine Environment
New York: Horwood.

Provides an unusual blend of approaches to the application of toxicological data in the monitoring and control of marine pollution. Describes and discusses the most recent developments in the application of ecotoxicological principles and outlines ways in which toxicological techniques can be applied in practice.

Abel PD (1996)
Water Pollution Biology, 2nd edition
Washington, DC: Taylor & Francis.

Provides a thorough examination of the scale of water pollution problems and using case studies, explores the types of investigations biologists need to undertake in solving them. Focuses on the interaction between scientific and legislative approaches, including the use of monitoring and toxicological data in formulating pollution control strategies. The 3rd edition of this book was released in 2007.

Adams WJ, Chapman PM (eds.) (2007)
Assessing the Hazard of Metals and Inorganic Metal Substances in Aquatic and Terrestrial Systems
Pensacola, FL: SETAC Press.

Reviews the scientific underpinnings of the use of persistence as applied to metals, including bioavailability, and the use of bioaccumulation to evaluate aquatic species and aquatic-linked food chains. Examines toxicity procedures as used within Persistence, Bioaccumulation, and Toxicity (PBT) approaches and examines measures for metals in terrestrial ecosystems, seeking improvements or alternatives.

American Society for Testing and Materials (ASTM) (1993)
ASTM Standards on Aquatic Toxicology and Hazard Evaluation
Philadelphia, PA: ASTM Press.

Features 67 ASTM test methods, practices, and guides on field sampling (phytoplankton, zooplankton, benthic macroinvertebrates, and fishes), toxicity of water, toxicity testing of sediment, fate-related procedures, special procedures, uses of toxicological data, avian test procedures, and genotoxicity tests.

Baker LA (ed.) (1994)
Environmental Chemistry of Lakes and Reservoirs
Washington, DC: American Chemical Society (ACS).

Explores a broad range of research dealing with large bodies of water. The main topics include methodological advances, cycling and distribution of major aquatic elements, behavior of trace metals, and organic contaminants. Contains both background and research material.

Barbour MT, Norton SB, Preston HR, et al (eds.) (2004)
Ecological Assessment of Aquatic Resources: Linking Science to Decision-making
Pensacola, FL: SETAC Press.

Compiled following a SETAC Pellston workshop: Applications Workshop on Ecological Assessment of Aquatic Resources in which international representatives from government, academia, and industry addressed the relationship between ecological assessment and ecological risk assessment and their roles in aquatic resources. Guidelines for effectively conducting and communicating ecological assessments are included.

Bitton G, Dutka BJ (eds.) (1986)
Toxicity Testing Using Microorganisms, Volumes 1 and 2
CRC Press, Boca Raton, Florida

Surveys the literature on microbial and enzymatic tests which are used to screen for chemical toxicity in the research laboratory or in an aquatic system and describes the more commonly used microbial toxicity screening procedures.

Blaise C, Férard J (eds.) (2005)
Small-scale Freshwater Toxicity Investigations: Volume 1 – Toxicity Test Methods
The Netherlands: Springer.

Compiles detailed, comprehensive information on biological testing with background, theory, and practice associated with each bioassay.

Blaise C, Férard J (eds.) (2005)
Small-scale Freshwater Toxicity Investigations: Volume 2 – Hazard Assessment Schemes
The Netherlands: Springer.

Describes aquatic hazard assessment schemes in great detail using a homogeneous structure providing batteries of bioassays that are being used internationally to assess the toxic potential of complex environmental media (e.g., effluents, sediments) impacted by chemical contamination stemming from human activities. Contents include information on dealing with point and non-point source pollution using case studies and real world situations as a means of aquatic environment protection. Toxicity testing applications and glossaries of scientific/technical terms are included in each chapter.

Bortone SA (ed.) (2004)
Estuarine Indicators (Marine Science Series)
Boca Raton, FL: CRC Press.

Compiles the principles, concepts, practical use, and application of indicators in estuarine research and management practices that were discussed at a 2003 Estuarine Indicators workshop. Theory and presumed attributes associated with estuarine indicators as well as the methods and protocols of development and evaluation are included. Additional sections address effective and ineffective indicator examples and future directions of research and management practices.

Buffle J, Horvai G (eds.) (2000)
In Situ Monitoring of Aquatic Systems: Chemical Analysis and Speciation
New York: Wiley.

Reviews and evaluates the development, since 1980, of sensors and instrumentation for automatic on-site measurement of water quality. Emphasizes microanalytical monitoring techniques and microtechnology with critical discussions of the state of the art and performance of existing techniques and devices and outlines potential future improvements.

Crompton TR (1997)
Toxicants in the Aqueous Ecosystem
England: Wiley.

Provides coverage of all aspects of the occurrence, toxicity, and analysis of toxicants in the aqueous ecosystem, including natural waters and sedimentary matter present in these waters, aquatic organisms, and plants. Chapters deal with the toxicant effects on the natural waters and the organisms within this environment with topics covering toxicity measurement, control of pollution regulation, and toxicity data on metals and organometallic and organic compounds.

Crompton TR (2007)
Toxicants in the Aqueous Ecosystem: A Guide for the Analytical and Environmental Chemist
England: Springer.

Provides detailed methods for identifying types of inorganic, organic, and organometallic pollutants in

aquatic species (fish, crustaceans, weeds, plants, phytoplankton, and algae) and interpreting the analytical results.

Di Giulio RT, Hinton DE (eds.) (2008)
The Toxicology of Fishes
Boca Raton, FL: CRC Press.

An in-depth, state-of-the-science monograph concerning the interactions of chemical contaminants with freshwater and marine fishes. Includes discussions of critical general principles, such as bioaccumulation, toxicokinetics, biotransformations, mechanisms of toxic action, and adaptations to chemical stress and key target systems of fishes, such as liver, kidney, gills, nervous and immune systems, and reproduction. It also covers methodologies and applications for exposure, assessment, toxicity testing, and ecological studies and includes case studies that illustrate the toxicological impacts of important classes of chemical contaminants in real-world settings. This book was scheduled for release in February, 2008.

European Centre for Ecotoxicology and Toxicology of Chemicals (ECETOC) (1993)
Assessment of the Biodegradation of Chemicals in the Marine Environment, Technical Report No. 54
Brussels, Belgium: ECETOC.

Outlines a strategy for a tiered approach to assess the hazard of a chemical in the marine environment. Includes the differences between marine, estuarine, and limnic environments, assessment of existing test methods, and proposals for test guidelines.

European Centre for Ecotoxicology and Toxicology of Chemicals (ECETOC) (1993)
Environmental Hazard Assessment of Substances, Technical Report No. 51
Brussels, Belgium: ECETOC.

Describes the development of a process for aquatic environmental hazard assessment. Includes principles and practical approaches.

European Centre for Ecotoxicology and Toxicology of Chemicals (ECETOC) (1999)
Monitoring and Modeling of Industrial Organic Chemicals with Particular Reference to Aquatic Risk Assessment, Technical Report No. 76
Brussels, Belgium: ECETOC.

Details water pollution, organic compounds and other chemicals, organic water pollutants, and environmental risk assessment.

European Centre for Ecotoxicology and Toxicology of Chemicals (ECETOC) (2003)
Aquatic Hazard Assessment II, Technical Report No. 91
Brussels, Belgium: ECETOC.

Updates information previously presented in Technical Report No. 56: Aquatic Toxicity Data Evaluation, describing the compilation of referenced aquatic toxicity data points for approximately 350 chemicals.

Evans MS (ed.) (1988)
Toxic Contaminants and Ecosystem Health: Great Lakes Focus
New York: Wiley.

Based on the proceedings of a meeting of the Task Force on the Health of Aquatic Communities. The book is divided into three parts. Part 1 deals with Great Lakes biota and the effect of toxic substances on their well-being. Part 2 deals with approaches for investigating the effects of toxic substances and specific objectives of the discharge and concentration of various pollutants. Part 3 contains the deliberations of a workshop held after the meeting.

Garrigues P, Barth H, Walker CH, et al (eds.) (2001)
Biomarkers in Marine Organisms
The Netherlands: Elsevier.

Serves as an overview of biological markers in marine animals, detailing the results obtained during development and application of biological markers as indicators of marine environment exposure to toxic chemicals. Practical use of indicators and the evaluation of the health effects associated with environmental contamination in marine ecosystems are also covered. Sentinel species discussed include fish, bivalves, and crustaceans. Detailed experimental procedures developed for chemical and biochemical measurements are included.

Hamelink JL, Landrum PF, Bergman HL, et al (eds.) (1994)
Bioavailability, Physical, Chemical, and Biological Interactions
Boca Raton, FL: Lewis.

Discusses the relationship between the measured environmental concentrations of chemical contaminants and the true, biologically available exposure concentrations that have adverse effects on aquatic life in that environment. This is intended to provide a synopsis of the major factors which control the bioavailability of chemicals to different organisms in aquatic environments.

Harris R, Krabbenhoft DP, Mason R, et al (eds.) (2007)
Ecosystem Responses to Mercury Contamination: Indicators of Change
Pensacola, FL: SETAC Press.

Outlines the infrastructure and methods needed to measure, monitor, and regulate the concentration of mercury present in the environment. Proposes a set of indicators to use as a measure of changing mercury concentrations in air, water, soil, and aquatic biota. Offers a monitoring strategy and guidance for determining if concentration levels are changing systematically over time. Explains how additional monitoring strategies can relate observed changes in mercury concentrations to regulatory controls on mercury emissions. An integrated framework for establishing a national-scale program to monitor mercury concentrations in the environment is included.

Heath AG (1995)
Water Pollution and Fish Physiology, 2nd edition
Boca Raton, FL: Lewis.

Provides a reasonably concise synthesis of what is known about how pollutants affect physiological processes in fish. After an introductory chapter, experimental hypoxia, respiratory and cardiovascular responses, hematology, liver, ionic regulation, uptake and kinetics, energetic, enzyme changes, immune system, and behavioral, reproductive, and physiological effects are discussed in relation to chemical exposure.

Hill IR, Heiminback F, Leewangh P, et al (eds.) (1994)
Freshwater Field Tests for Hazard Assessment of Chemicals
Boca Raton, FL: Lewis.

Presents a series of papers critically assessing the theory and practice of freshwater field tests to move toward future development. Contains a set of recommendations for key issues involving the conduct of field tests, interpretation of results, and further research.

Hofer TN (ed.) (2008)
Marine Pollution: New Research
New York: Nova Science.

Discusses marine pollution characterized by the entry of chemicals or particles into the ocean. Presents problems associated with the many potentially toxic chemicals that can adhere to tiny particles which are then taken up and concentrated upward within ocean food chains and incorporated in terrestrial food chains. Topics include mining deep sea vents, pollution in bivalves, algal blooms, marine debris, oxidative stress, aquatic ecosystems and mitigation, fecal indicator bacteria in beach sand and water, petroleum pollution and penguins, and heavy metals. This book presents the latest research in the field from around the world. Release is scheduled for May, 2008.

Hoffman D, Rattner BA, Burton AG Jr, et al (eds.) (2002)
Handbook of Ecotoxicology, 2nd edition
Boca Raton, FL: Lewis.

Contains revised and updated information about the rapidly expanding field of ecotoxicology. Two chapters are devoted to aquatic toxicology: 'Aquatic Toxicology Test Methods' (Chapter 2) and 'Model Aquatic Ecosystems in Ecotoxicology Research: Considerations of Design, Implementation, and Analysis' (Chapter 3).

Howells G (ed.) (1994)
Water Quality for Freshwater Fish
Pennsylvania, PA: Gordon & Breach.

Provides a source of critically evaluated water-quality data concerning the effects of various toxins on freshwater fish. The report covers all stages of life cycle and relative trophic levels, including aquatic invertebrates and plants with potential for bioaccumulation up the food chain.

Huang CP, O'Melia CR, Morgan JJ (eds.) (1995)
Aquatic Chemistry: Interfacial and Interspecies Processes
Washington, DC: American Chemical Society (ACS)

Presents principles of aquatic chemistry in 19 chapters from experienced investigators. Includes recent developments in the field to allow a better understanding of the mechanisms regulating the chemical composition of natural waters. The transformation and transport of species in aquatic systems through interphase and interspecies interactions are discussed. The principles covered herein can be applied to the design of air, soil, water, and wastewater treatment systems.

Johnson, W. W. and Finley, M. T. (eds.) (1980)
Handbook of Acute Toxicity of Chemicals to Fish and Aquatic Invertebrates. Resource Publication 137
Washington, DC: U.S. Department of the Interior, Fish and Wildlife Service.

Results of toxicity tests on fish and aquatic invertebrates conducted at the Columbia National Fisheries Research Laboratory are presented, including 1587 acute toxicity tests on 271 chemicals in approximately 30 species of both fish and invertebrates.

Kennish MJ (1997)
Pollution Impacts on Marine Biotic Communities
Boca Raton, FL: CRC Press.

Features a basic introduction to pollution-related issues in coastal regions, case histories of highly contaminated systems, specific coverage of marine pollutants (from organic and radioactive wastes to heavy

metals and polycyclic aromatic hydrocarbons), and use and management of coastal resources.

Kraybill HF, Dawe CJ, Harshbonger JC, et al (eds.) (1977)
Aquatic Pollutants and Biological Effects with Emphasis on Neoplasia
New York: New York Academy of Sciences.

Stresses neoplasms in aquatic animals, including mollusks, eels, salamanders, carp, hagfish, and trout. Other topics include implications for humans of biological effects on marine animals and public health aspects.

Laws EA (2000)
Aquatic Pollution: An Introductory Text, 3rd edition
New York: Wiley.

Details pollution in marine and freshwater systems to provide both ecological and toxicological information on the scientific aspects of environmental issues. Utilizes case studies and an extensive collection of literature to describe fundamental concepts. Updates include new chapters on acid rain, groundwater pollution, and plastics.

Malins DC, Ostrander GK (1994)
Aquatic Toxicology: Molecular, Biochemical, and Cellular Perspectives
Boca Raton, FL: Lewis.

Examines findings from recent research on the chronic effects of pollutants on aquatic species. Evaluates modern techniques in molecular biology and biochemistry.

Montgomery JH (2007)
Groundwater Chemicals: Desk Reference, 4th edition
Boca Raton, FL: Lewis.

Collection of comprehensive data on groundwater chemical contaminants has been updated and expanded to include bioconcentration factors, aquatic toxicity values, environmental degradation rates and corresponding half-lives, ionization potentials, aqueous solubility of miscellaneous compounds, and environmental endocrine disruptors with references that also cover environmental fate and transport in various media, organic priority pollutants, and chemicals commonly found in the environment and workplace. The data should be useful to the environmental-regulated community and consultants in conducting risk-based contamination assessments. The main body of the book deals with chemical-specific information.

Mothersill C, Austin B (2003)
In Vitro Methods in Aquatic Ecotoxicology
New York: Springer.

Focuses on in vitro methods to study the toxicology of polluting agents (including heavy metals, radionuclides, micro-organics, estrogenic compounds, and complex mixtures) in the aquatic environment. The development of standardized techniques and validation of controlled substance- and species-specific experiments are some of the advantages of in vitro methods that allow for the execution of mechanistic studies without the problems of individual variation.

Munawar M, den Bestens PJ (eds.) (2005)
Ecotoxicological Testing in Marine and Freshwater Ecosystems
Boca Raton, FL: CRC Press.

Explores aquatic ecosystem health assessment describing ecotoxicological techniques and methods and evaluating the latest bioassay techniques used in the field, including both water and sediment analyses. Detailed discussions of the integration of data, recommendations for the preservation, enhancement, and restoration of ecosystem functions, risk communication, and risk perception are included. The authors analyze how improvements in data processing and information technology have led to the assessment of spatial variability and cover emerging research fields such as biomarkers, genome expression, multispecies tests, and tiered approaches. The appendices highlight the strengths and limitations of the techniques and provide references to additional literature.

Murty AS (1986)
Toxicity of Pesticides to Fish
Boca Raton, FL: CRC Press.

A detailed treatment of the environmental fate of pesticides and their acute and chronic toxicological effects on fish.

Neilson AH (1994)
Organic Chemicals in the Aquatic Environment: Distribution, Persistence, and Toxicity
Boca Raton, FL: CRC Press.

Discusses basic issues of chemical analysis, distribution, persistence, and ecotoxicology, with an emphasis on microbial reactions.

Newman MC (1995)
Quantitative Methods in Aquatic Ecotoxicology (Advances in Trace Substances Research)
Boca Raton, FL: CRC Press.

A quantitative evaluation of the science of ecotoxicology. Focuses on aquatic systems although the methods can be applied to terrestrial systems. Chapters discuss fundamental concepts and definitions as well as the fate and effects of toxicants at various levels of ecological organizations.

Norberg-King T, Ausley LW, Burton DT, et al (eds.) (2005)
Toxicity Reduction and Toxicity Identification Evaluations for Effluents, Ambient Waters, and Other Aqueous Media
Pensacola, FL: SETAC Press.

A Pellston Workshop discussing updates and advances in understanding the toxicity reduction evaluations (TRE) process and the science of toxicity identification evaluations (TIE) in aqueous effluents, surface water, and sediments. Serves as a comprehensive guide, including over 30 case studies, to document various aspects of the TRE process with specific attention directed to TIE procedures as they relate to the control of aqueous discharges and aquatic life toxicity under the 1977 Clean Water Act.

Nriagu JO (ed.) (1983)
Aquatic Toxicology
New York: Wiley.

Volume 13 in the series *Advances in Environmental Science and Technology.* This volume deals with the toxicity of many inorganic and organic contaminants to aquatic biota. Assesses the response at community, species, tissue, cellular, and subcellular levels to particular toxicants and covers the mechanisms of uptake, metabolism, and excretion of many pollutants. Methodology used in aquatic toxicology is also discussed.

Nriagu JO, Lakshminarayana JSS (eds.) (1989)
Aquatic Toxicology and Water Quality Management
New York: Wiley.

Volume 22 in the series *Advances in Environmental Science and Technology.* A toxicological survey of important aquatic pollutants that evaluates new concepts, methods, and data, and provides an overview of key research results. Topics ranging from principles of aquatic toxicology and the development of water quality guidelines for the protection of aquatic resources to the environmental effects of monitoring and future trends in water quality management are included. Important linkages for practical and effective environmental effects assessment between aquatic and terrestrial ecosystems are noted.

Ostrander G (ed.) (2005)
Techniques in Aquatic Toxicology, Volume 2
Boca Raton, FL: CRC Press.

Designed to assist research scientists and technicians in testing for everything from DNA damage to bioaccumulation of common toxins to assays of fish embryos and tissues. This second volume includes an update of approximately five techniques from the first volume (1996) and the addition of about 24 new techniques. The blend of established and recently developed techniques is detailed in sections covering the assessment of toxicity in whole organisms and at the cellular and subcellular levels, as well as contaminant identification, impacts in aquatic ecosystems, and general techniques. Each chapter covers a particular method or procedure, including a brief introduction, a materials section, a procedures section, results, and discussion. The chapters are designed to allow flexibility in modifying or adapting a technique for particular needs.

Paquin PR (2003)
Metals in Aquatic Systems: A Review of Exposure, Bioaccumulation, and Toxicity Models
Pensacola, FL: SETAC Press.

Reviews the literature and existing models for aquatic risk assessments of metal with descriptions of the utility, applicability, strengths and weaknesses, and recommendations for improvement. Model categories include fate and transport, chemical equilibrium, and bioaccumulation and toxicity.

Ramamoorthy S, Baddaloo SR (1995)
Handbook of Chemical Toxicity Profiles of Biological Species, Volume 1 – Aquatic Species
Boca Raton, FL: CRC Press.

Offers toxicity profiles on aquatic species. Data are arranged in decreasing order of toxicity for aquatic species such as amphibians, algae, bacteria, crustaceans, fish, insects, mollusks, and protozoa.

Rand GM (ed.) (1995)
Fundamentals of Aquatic Toxicology: Effects, Environmental Fate and Risk Assessment, 2nd edition
Washington, DC: Taylor & Francis.

A comprehensive source of information in aquatic toxicology for graduate students and practitioners. Addresses current testing procedures, data evaluation and interpretation, chemical fate in aquatic environments, structure–activity relationships, environmental legislation, and risk assessment. The 3rd edition of this book was scheduled for release in 2008.

Rao SS (ed.) (1999)
Impact Assessment of Hazardous Aquatic Contaminants
Boca Raton, FL: Lewis.

Characterizes complex toxicants and the resulting harmful effects on the cellular and subcellular levels in aquatic biota. Current information on contamination from industrial activity and remediation of

marine life as well as strategies and solutions for aquatic life management are presented to address global environmental issues.

Suter GW, II (ed.) (2006)
Ecological Risk Assessment, 2nd edition
Boca Raton, FL: Lewis.

Examines the risks of chemicals and mixtures to aquatic systems and characterizes chemical contaminants and other stressors in the application of ecological risk assessment. It contains a description of advances in science and practice of ecological risk assessment since 1992 and emphasizes risk assessments that predict the effects of new chemicals and effluents relative to those that describe the extent, magnitude, and causation of effects that began in the past.

Svensson EP (ed.) (2008)
Aquatic Toxicology Research Focus
New York: Nova Science.

Aquatic toxicology is the study of the effects of manufactured chemicals and other anthropogenic and natural materials and activities on aquatic organisms at various levels of organization, from subcellular through individual organisms to communities and ecosystems. This book presents the latest research in this field from around the globe including topics such as oxidative stress, metal toxicity, microbial and chemical assays, pesticides, environmental variation, *Legionella* spp. and *Pseudomonas* spp., and aquatic environments. Release of this book was scheduled for May, 2008.

Taylor EW (ed.) (1996)
Toxicology of Aquatic Pollution: Physiological, Cellular and Molecular Approaches
New York: Cambridge University Press.

Discusses the mechanisms of toxicity of aluminum, other metals, and aromatic hydrocarbons at low to sublethal levels. New approaches to pollution monitoring are considered, including large-scale models for the exchange of xenobiotics between fish and their environment and the alternative use of sensitive cellular and molecular markers of pollution.

Tessier A, Turner D (eds.) (1995)
Metal Speciation and Bioavailability in Aquatic Systems
England: Wiley.

A comprehensive review of the fundamental concepts and models, speciation measurements and field applications in metal speciation and bioavailability in aquatic environments that includes current developments regarding the interactions between trace metals and aquatic organisms. Laboratory bioassays are reviewed to thoroughly examine their use and limitations as predictive tools and as the basis for management decisions. The interdisciplinary nature of this topic ensures that this volume is invaluable for chemists, biochemists, biologists, ecologists, and environmental engineers involved in the fields of metal ecotoxicology, metal speciation, environmental and analytical chemistry, and the management of trace metals in aquatic systems.

Vos JG, Bossart G, Fournier M, et al (eds.) (2003)
Toxicology of Marine Mammals (New Perspectives: Toxicology and the Environment)
New York: Taylor and Francis.

Provides an overview of the effects of natural and anthropogenic toxicants on marine mammal organs and systems and contains the health status and contamination of various species including whales, pinnipeds, dolphins, polar bears, manatees, and sea otters. Case studies and future perspectives add to the comprehensive collection.

Wangersky PJ (ed.) (2000)
Marine Chemistry (Handbook of Environmental Chemistry)
Germany: Springer.

Focuses on recent topics including carbon dioxide absorption and gas exchange at the sea surface, photochemistry of marine aerosols, biomarkers in marine ecosystems, and the oceanic carbon cycle to provide an understanding of the global ecosystem between animals and environmental stress.

Weber LJ (ed.) (1982 and 1984)
Aquatic Toxicology, Volumes 1 and 2
New York: Raven Press.

Presents a concise description of some of the core biology needed to begin to use fish as models for toxicity testing. Proceeding from general to specific, emphasis on routes of administration, and exposure to toxins of concern in the environment are the main themes. Major physiological systems (cardiovascular, hepatic, respiratory, and nervous) are described as well as procedures to monitor wellbeing following exposure to various agents. A particularly useful chapter describes the potential for identification of carcinogens in fish.

Wells PG, Lee K, Blaise C (eds.) (1997)
Microscale Testing in Aquatic Toxicology: Advances, Techniques, and Practice
Boca Raton, FL: CRC Press.
Contains over 40 chapters on bioassay techniques and applications useful for aquatic hazard assessment and environmental quality monitoring and testing.

Wood EM (1987)
The Toxicity of 3400 Chemicals to Fish
Washington, DC: EPA/Office of Toxic Substances (OTS).

Presents results of an investigation undertaken to locate chemicals which would cause acute toxicity to fish at extremely low concentrations. These findings are intended to allow prioritization of testing/research needs in the area.

U.S. EPA Office of Water

The EPA publishes numerous documents related to water, including *Drinking Water Criteria, Drinking Water Health Advisories, Ambient Water Quality Criteria*, and *Water Quality Standards.* These are generally available online (http://www.epa.gov/ow) or from the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161. The publications catalog of EPA's Office of Water is on the Web at http://yosemite.epa.gov/water/owrccatalog.nsf. A browsable version of EPA's *Drinking Water Regulations* and *Health Advisories* is also available at http://www.epa.gov/waterscience/.

See also

Barnes: ***Fundamentals of Aquatic Ecology, 2nd edition*** (Ecology – aquatic)

Bergman: ***Reassessment of Metals Criteria for Aquatic Life Protection*** (Chemicals – metals)

Coe: ***Marine Debris: Sources, Impacts, and Solutions*** (Environmental toxicology – hazardous waste)

Evans: ***The Physiology of Fishes, 3rd edition*** (Animals in research)

Giddings: ***Atrazine in North American Surface Waters: A Probabilistic Aquatic Ecological Risk Assessment*** (Chemicals – pesticides)

Grothe: ***Whole Effluent Toxicity Testing*** (Testing methods and toxicity assessment)

Hockachka: ***Analytical Techniques: Biochemistry and Molecular Biology of Fishes***
(Analytical toxicology)

Louglin: ***Marine Mammals and the Exxon Valdez*** (Environmental toxicology – wildlife)

Meyer: ***Herbicide Metabolites in Surface Water and Groundwater*** (Chemicals – pesticides)

Rolland: ***Chemically Induced Alterations in Functional Development and Reproduction of Fishes*** (Developmental and reproductive toxicology)

United States Environmental Protection Agency (U.S. EPA): ***Methods for Measuring the Acute Toxicity of Effluents and Receiving Waters to Freshwater and Marine Organisms.*** EPA/600/4-90/027F. Office of Research and Development, Washington, DC.

United States Geological Survey (USGS): ***Summary of Published Aquatic Toxicity Information and Water Quality Criteria for Selected Volatile Organic Compounds (Open File Report 97-563)***

Journals

Aquaculture (1972–)
Amsterdam, the Netherlands: Elsevier.
Web: http://www.sciencedirect.com/science/journal/00448486

A collection of international research evaluating aquatic food resources and the improvement and management of these resources. Environments include freshwater, brackish, and marine waters that are related directly or indirectly to human consumption.

Aquatic Conservation: Marine and Freshwater Ecosystems (1991–)
England: Wiley.

Articles focus on freshwater, brackish, or marine habitats and conserving aquatic biological resources. Emphasizes cooperation to efficiently solve problems with conservation of aquatic resources.

Aquatic Sciences (1920–)
Switzerland: Springer.

Articles include reviews of the boundaries and impact of human activities on aquatic systems utilizing a range of approaches from the molecular level to whole ecosystems. Topics include geological, microbial, biological, chemical, physical, hydrological, and societal processes and interactions as well as interactions between water and land, air, and sediment.

Aquatic Toxicology (1981–)
The Netherlands: Elsevier.

Consists of scientific articles on effects induced by toxic agents on multiple levels (communities, species, tissue, cellular, and subcellular levels) within aquatic environments. Mechanisms of toxicity and aspects of uptake, metabolism, and excretion of toxicants are explored in an attempt at understanding effects of toxic substances on aquatic ecosystems as exhibited in biochemical and physiological reactions resulting in organisms exposed to toxicants. The development of procedures and techniques that significantly advance the understanding of processes and events that produce toxic effects and the human health aspects of aquatic toxicology are also covered.

Hydrobiologia (1958–)
Netherlands: Springer.
Web: http://springerlink.metapress.com/content/1573-5117/

Publishes articles of research, and reviews and opinions concerning the biology of all aquatic environments. Hypothesis-driven studies in aquatic ecology, limnology, oceanography, and systematics that provide information at the molecular, organism, community, and ecosystem level are includes as well as descriptive, theoretical papers are accepted.

Journal of Aquatic Animal Health (1989–)
Maryland: American Fisheries Society (AFS).
Web: http://afs.allenpress.com

Contains articles concerned with the health of aquatic organisms serving scientists and culturists on an international level. Topics include the causes, effects, treatments, and prevention of diseases of marine and freshwater organisms, particularly fish and shellfish. Additionally, biochemical and physiological aspects of fish health are described and environmental and pathogenic impacts are assessed.

Journal of Aquatic Ecosystem Health and Management Society (AEHMS) (1998–)
Philadelphia, PA: Taylor and Francis.
Web: http://www.aehms.org/journal.html

Includes articles that focus on the health of freshwater, marine, and estuarine ecosystems promoting comprehension of ecosystem functioning and impact of anthropogenic stress with an international and multidisciplinary approach to conservation of global aquatic ecosystems.

Marine Environmental Research (1978–)
Amsterdam, the Netherlands: Elsevier.
Web: http://www.sciencedirect.com/science/journal/01411136

Serves as a forum for information on biology, chemistry, and toxicology of chemical contaminants in marine environments with emphasis on understanding of the environmental processes. Focuses on articles on chemical, physical, and biological interactions in oceans and coastal waters. Evaluation of the roles of anthropogenic and natural causes of change in marine ecosystems as well as theoretical or conceptual developments in marine science are topics of interest.

Water, Air, and Soil Pollution (1971–)
The Netherlands: Springer.
Web: http://springerlink.metapress.com/content/1573-2932/

Includes articles that cover an interdisciplinary approach to all aspects of pollution and solutions to pollution in the biosphere. Aquatic topics include marine pollution and groundwater, waste water, pesticides, and sediment pollution. The effects of pollutants on humans, vegetation, fish, and aquatic species and the ecological implications are explored.

Water Environment Research (1928–)
Virginia Water Environment Federation.
Web: http://www.ingentaconnect.com/content/wef/wer

Includes articles on water quality assessment and point and non-point source pollution monitoring, water conservation and reuse, aquatic sediments and sediment/water interactions, modeling and simulation of environmental multimedia processes and systems. Additionally, drinking water and wastewater treatment with topics covering residuals and biosolids management, odors, and gaseous emissions are included.

Water Research (1967–)
Amsterdam, the Netherlands: Elsevier.

Concerned with science and technology of water quality and water quality management throughout the world. Topics include water quality standards and analyses, chemical, physical, and biological methods of monitoring water quality, and studies on inland, tidal or coastal waters, urban waters, including surface and ground waters and point and non-point sources of pollution. Analysis of sediments and water and the interactions between water and the atmosphere along with mathematical and modeling techniques are included. The journal also addressed public health and risk assessment.

Journal Articles

Adams SM (2003) Establishing causality between environmental stressors and effects on aquatic ecosystems. Hum. Eco. Risk Assess. 9(1): 17–35.

Altenburger R (1995) Drinking water: for human consumption only? The amendment of directive 80/778/EEC parameter 55 in the light of aquatic toxicology. Chemosphere 30(2): 307–312.

Andacht TM, Winn RN (2006) Incorporating proteomics into aquatic toxicology. Marine Environ. Res. 62(Suppl.): 156.

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aquatic organisms. Rev. Environ. Contam. Toxicol. 173: 1–37.

Beaty BJ, Mackie RS, Mattingly KS, et al (2002) The midgut epithelium of aquatic arthropods: a critical target organ in environmental toxicology. Environ. Health Perspect. 110(Suppl. 6): 911–914.

Blaise C (1998) Microbiotesting: an expanding field in aquatic toxicology. Ecotoxicol. Environ. Saf. 40(1–2): 115–119.

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Organizations

American Water Works Association (AWWA)
6666 West Quincy Avenue
Denver, Colorado 80235
Phone: 303-794-7711 or 800-926-7337
Fax: 303-347-0804
E-mail: see web site for contact page
Web: http://www.awwa.org

An educational and scientific society that is dedicated to improving water quality and supply. The association has become an international authoritative source on water quality and is concerned with improving the supply and quality of water as it relates to public health.

Aquatic Ecosystem Health and Management Society (AEHMS)
P.O. Box 85388
Brant Plaza, Postal Outlet
Burlington, Ontario
Canada
L7R 4K5
Fax: 905-634-3516
E-mail: munawarm@dfo-mpo.gc.ca
Web: http://www.aehms.org

The society focuses on international cooperation and communication of aquatic ecosystem health and promotes the protection, conservation, and sustainable management of global aquatic resources. Encourages understanding and management of aquatic ecosystems from an integrative, multidisciplinary, multitrophic perspective.

Society of Environmental Toxicology and Chemistry (SETAC)
1010 North 12th Avenue
Pensacola, Florida 32501-3367
USA
Phone: 850-469-1500
Fax: 850-469-9778
E-mail: setac@setac.org
Web: http://www.setac.org

Provides a forum for the study of environmental issues, management and conservation of natural resources, education, and research in the environmental field. Fields of study include anatomy and physiology, biology, environmental chemistry, soil sciences and engineering, atmospheric sciences and engineering, ecology, economics, classical toxicology, and genetics.

Databases

ASFA (Aquatic Sciences and Fisheries Abstracts)
Aquatic Sciences and Fisheries Information System (ASFIS), Food and Agriculture
Organization of the United Nations (FAO)
Web: http://www.fao.org/figis/servlet/static?dom=org&xml=asfa_prog.xml

The result of cooperative efforts in monitoring over 5000 serial publications, books, reports, conference proceedings, translations and limited distribution literature. As of June, 2006, the database contained over 1 million bibliographic references (or records) to the world's aquatic science literature accessioned since 1971; with monthly updates adding approximately 3700 new records. The database encompasses topics such as aquaculture, aquatic organisms, aquatic pollution, environmental quality, freshwater and marine environments, conservation, marine biotechnology, policy and legislation, meteorology, and oceanography. Access to the ASFA Bibliographic Database is available through subscription from CSA or from one of the CSA licensed providers (NISC, DIALOG, STN International (online)).

EAT (ECETOC Aquatic Toxicity)
European Centre for Ecotoxicology and Toxicology of Chemicals (ECETOC)
Web: http://www.eat-database.com

Information on the toxicity of substances to fresh and marine water species is maintained in the database which contains over 5450 entries that comprehensively covers ecotoxicity data for approximately 600 chemicals. The data included are comprised of highly reliable scientific information published from 1970 to 2000.

ECOSAR (Ecological Structure Activity Relationships)
U.S. Environmental Protection Agency (EPA)
Web: http://www.epa.gov/opptintr/newchems/tools/21ecosar.htm

A software program that predicts the toxicity of industrial chemicals that are discharged into water. This personal computer program uses structure activity relationships (SARs) to estimate the toxicity of these chemicals to aquatic organisms such as fish, invertebrates, and algae.

ECOTOX (Ecotoxicology)
U.S. Environmental Protection Agency (EPA)
Web: http://cfpub.epa.gov/ecotox/

Unique integration of three databases to provide single chemical toxicity information. The three, previously independent, databases: AQUIRE (Aquatic Information Retrieval), PHYTOTOX (Plant Toxicity), and TERRETOX (Terrestrial Toxicity Database), contain toxicity data from peer-reviewed literature for aquatic life, terrestrial plants, and terrestrial wildlife, respectively.

Other Resources

American Society for Testing and Materials (ASTM) (1989)
Aquatic Toxicology and Hazard Assessment, 12th edition (Special Technical Publication 1027)
Philadelphia, PA: ASTM Press.

A serial publication that is published annually and contains papers from the Symposium on Aquatic Toxicology and Hazard Assessment, sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate and its Subcommittee E47.01 on Aquatic Toxicology. This edition contains 34 papers that debate the merits of test development, animal and plant culture, nutrition and testing, and the lack of interagency harmony. The various topics include: field techniques, interpretation of microcosm data, quality assurance in ecotoxicity testing, sediment toxicity testing, culturing and testing of new organisms, nutrition and testing, target toxicant analysis, review of common modes of toxic action, and benefits of interagency harmonization of methodology.

American Society for Testing and Materials (ASTM) (1990)
Aquatic Toxicology and Risk Assessment, Volume 14 (Special Technical Publication 1124)
Philadelphia, PA: ASTM Press.

A serial publication that is published annually and contains papers from the Symposium on Aquatic Toxicology and Risk Assessment, sponsored by ASTM Committee E-47 on Biological Effects and Environmental Fate and its Subcommittee E47.01 on Aquatic Toxicology. This volume encompasses evolving concepts and perspectives in aquatic toxicology and hazard assessment with topics such as organ system toxicology and biomarkers, risk assessment and complex mixtures, sediment toxicity assessment, toxicant reduction strategies, bioconcentration, toxicity evaluation, carcinogenesis, and the Animal Welfare Act.

Aquatic Sciences and Fisheries Abstracts (ASFA) Series, Food and Agriculture Organization of the United Nations (FAO)
Aquatic Pollution and Environmental Quality *(ASFA 3)*
CSA (Supplier)
7200 Wisconsin Avenue
Bethesda, Maryland 20814
USA
Phone: 800-843-7751 (US); 301-961-6700 (outside US)
Fax: 301-961-6720
E-mail: sales@csa.com

A biweekly abstracts journal that focuses on the increasing global concern over the consequences of marine and aquatic pollution and is devoted exclusively to research and policy on the contamination of oceans, seas, lakes, rivers, and estuaries. ASFA 3 contains information collected since 1990 on aquatic pollution, prevention and control, effects on organisms, characteristics, behavior, and fate, and environmental quality that will benefit those who are interested in aquatic environments and marine pollution problems. As of May, 2006, over 139 000 references have been recorded and monthly updates are comprised on approximately 588 new records.

Aquatic Toxicity Workshop (ATW) (1974–)
Web: http://www.atw.ca

An annual workshop organized and supported by volunteer scientists across Canada to discuss current and emerging issue with open dialogue between the researchers and the regulating agencies. The workshops have focused on fish and invertebrate toxicity tests as well as chemical, physical and biological effects on aquatic ecosystems. Additionally, protective, proactive measures are proposed and discussed. The 34th annual Workshop will be held in 2007, covering topics such as development of bioassays, endocrine disruption, aquaculture, persistent contaminants, amphibian decline, effects of agriculture/pesticides, and mining of metals and diamonds as well as newer topics covering the genomics, proteomics, and metabolomics and climate change in aquatic toxicology.

U.S. Environmental Protection Agency (EPA) (2005)
Fish Physiology, Toxicology, and Water Quality: Proceedings of the Eighth International Symposium
Web: http://www.epa.gov/athens/publications/reports/EPA600R06062_8thFishSymposiumFinal.pdf

The meeting focused on hypoxia and vertebrates and comparing terrestrial to aquatic vertebrates. Includes 13 papers that discuss the fish, reptilian, and mammalian responses to hypoxia at the behavioral, physiological, and molecular levels.

CHAPTER

24

Environmental Toxicology: Air[1]

ASISH MOHAPATRA, DIETER SCHWALA, AND PERTTI J. HAKKINEN

INTRODUCTION

The study of air toxicology on human health and ecosystems is an integrated approach. It involves analysis of the complex dynamics of indoor and outdoor air quality, emission of pollutants and their dispersion and chemical transformation, exposure of populations in indoor and outdoor environments, health and environmental impacts as a consequence of exposure, source control measures, policy decisions (e.g., on acceptable magnitudes of emissions of chemicals of interest from various materials and products) related to indoor and outdoor air quality standards, economic incentives for consumers and polluters, and multistakeholder participation, collaboration, and sharing of information. Websites provide access to information on air toxicology, indoor and outdoor air quality, and the Internet provides opportunities for exchange and sharing of information. The information resources below are organized under 'Ambient air' and 'Indoor air' subsections covering the realm of air toxicology. Further, information resources under each subsection are listed under Books, Journals, Journal articles, Organizations and Web portals, and Databases. Additional information resources from government and non-governmental global agencies are also provided below.

[1]Disclaimer: Views expressed are those of the authors and do not represent official views of their respective organizations. The authors do not necessarily endorse any products or services mentioned in this chapter and the book and information provided via the web resources described. The authors have no editorial control over the ongoing changes in website contents. Readers should use caution and apply expert judgment when considering use of the information from websites.

RESOURCES

Books

Ambient Air

Jon Ayres, Robert L. Maynard, Roy Richards (2006)
Air Pollution and Health
Hardcover: 264 pages
Publisher: World Scientific Publishing Company
1st edition (September 15, 2006)
ISBN-10: 1860941915
ISBN-13: 978-1860941917

This comprehensive book covers a wide range of topics of interest to physicians, immunologists, toxicologists, public health advocates, and epidemiologists, including extensive references to the current literature on human response to air pollution.

Bell JNB, Treshow M (eds.) (2002)
Air Pollution and Plant Life (Hardcover)
Wiley, 2nd edition (June 15, 2002)

This book has a comprehensive overview of the impacts of air pollution on plant life. A group of international experts has written chapters that cover the main historical aspects and sources of pollutants, atmospheric transport and transformations of pollutants, and issues of global change and the use of science in air pollution policy formulation. Further, it covers the main phytotoxic pollutants, emphasizing their impacts ranging from the molecular to ecological levels of plant organization. Furthermore, the book also emphasizes the effects of air pollutants in altering plant response to both abiotic and biotic stressors.

Godish T (2004)
Air Quality, 4th edition
Hardcover: 480 pages
Publisher: CRC Press
ISBN-10: 156670586X
ISBN-13: 978-1566705868

The 4th edition of this book provides a comprehensive overview of air quality issues and atmospheric chemistry, the effects of pollution on public health and the environment, and the technology and regulatory practices used to achieve air quality goals. It includes new information related to toxicological principles and risk assessment, the health effects of particulate air pollutants, and a revised discussion on public policy concerns with a focus on air quality standards for ozone depletion and global warming.

Ness S (2007)
Air Monitoring for Toxic Exposures: An Integrated Approach. 2nd edition
John Wiley & Sons Inc.
Hardcover, 640 Pages

This book explores and evaluates potentially harmful exposures of people to hazardous chemicals such as radon, and biologicals such as bioaerosols. It provides practical information on how to perform air sampling, collect biological and bulk samples, evaluate dermal exposures, and determine the advantages and limitations of methodologies.

Omasa K, Isamu Nouchi, Luit J De Kok (eds.) (2006)
Plant Responses to Air Pollution and Global Change (Hardcover)
Springer: 1st edition

This book covers emerging topics on the plant metabolism of air pollutants and elevated carbon dioxide, responses of whole plants and plant ecosystems, genetics and molecular biology for the improvement of function, experimental ecosystems and climate change research, global carbon-cycle monitoring in plant ecosystems, and other important issues. The authors are researchers from Europe, the United States, Australia, and East Asia.

Seinfeld JH, Pandis SN (2006)
Atmospheric Chemistry and Physics from Air Pollution to Climate Change
Paperback: 1232 pages
Publisher: Wiley-Interscience: 2nd edition (August 11, 2006)
ISBN-10: 0471720186
ISBN-13: 978-0471720188

This book has been a premier text in the field of chemistry of the atmosphere covering important topics such as chemistry of the stratosphere and troposphere; formation, growth, dynamics, and properties of aerosols; meteorology of air pollution; transport, diffusion, and removal of species in the atmosphere; formation and chemistry of clouds; interaction of atmospheric chemistry and climate; radiative and climatic effects of gases and particles; and formulation of mathematical chemical/transport models of the atmosphere. The three new chapters in this edition are on atmospheric radiation and photochemistry; general circulation of the atmosphere; and global cycles. Several chapters such as stratospheric chemistry, tropospheric chemistry, and organic atmospheric aerosols have been updated based on the latest research findings.

USEPA (2007)
Air Toxic Program on Toxic Air Pollutants, Risk Assessments, Releases, Health Risks, Evaluating Exposures, Carcinogenic Risk (CD-ROM)
33 914 Pages
Progressive Management

This e-book provides a comprehensive guide to U.S. Environmental Protection Agency (EPA) regulation of toxic air contaminants. Toxic air contaminants, also known as hazardous air pollutants (HAPs), are those pollutants that are known or suspected to cause cancer or non-cancer health effects, such as reproductive effects or birth defects, or adverse environmental effects. EPA has been working with state, local, and tribal governments to reduce air toxics releases of 188 pollutants to the environment.

Indoor air

Baker SR, Driver J McCallum D (eds) (2001)
Residential Exposure Assessment: A Sourcebook (Hardcover)
New York: Kluwer Academic/Plenum Publishers.
Hardcover: 394 pages
ISBN: 0306465175

This book, initiated by the Society of Risk Analysis (SRA) and the International Society of Exposure Science (formerly the International Society of Exposure Analysis), is a compendium of information written by residential exposure experts about predictive methods and tools, monitoring methods, data sources, and key variables that characterize chemical, biological agent, and physical agent exposures in and around all types of residences (apartments, single-family homes, condominiums, farmhouses, mobile homes, row houses, retirement homes, and school dormitories). Residential exposure assessments are used to check indoor air quality, compliance with U.S. and other statutes, and as part of the evaluation of consumer product safety.

Bardana EJ (ed.) (1997)
Indoor Air Pollution and Health
(Clinical Allergy and Immunology Series Vol.9)
New York: Marcel Dekker.
Hardcover: 528 pages
Informa Healthcare: 1st edition

This book integrates health and building science, and presents a variety of viewpoints from diverse disciplines, including allergy, toxicology, oncology, environmental science, building engineering, and law. The book investigates various sources that affect air quality such as biologic agents, pesticides, tobacco smoke, solvents, combustion products, volatile organic compounds, indoor allergens, and radon.

Burge H (1995)
Bioaerosols
Boca Raton, FL: Lewis.

This book is a synthesis of the information available on air pollution research, and is a valuable resource that brings together important aspects of the relationship between humans and biological contaminants in indoor air. The 13 chapters provide essential information on the effects of air quality on the many organisms coexisting in our indoor and outdoor atmospheres.

Cox CS, Wather CM (1995)
Bioaerosols Handbook
Boca Raton, FL: Lewis.

This book provides up-to-date detailed descriptions, comparisons, and calibration methods for bioaerosol samplers, together with appropriate sampling methodologies and analytical procedures. Physical and biological properties are considered from both practical and theoretical viewpoints. The main parts deal with principles of sampling, calibration techniques, analysis, and examples from the experiences of current practitioners.

Gammage RB, Berven BA (eds.) (1996)
Indoor Air and Human Health, 2nd edition
Boca Raton, FL: Lewis.

This book covers areas such as chemical sensitivity, behavioral effects, upper airway irritants, allergic reactions and infections, bioaerosols, human and animal models, and risk assessment.

Penney David G (2007)
Carbon Monoxide Poisoning
Informa Health Care Publishers
Hardcover: 808 pages
Publisher: Informa Healthcare: 1st edition (November 1, 2007)

This book explores new information on CO toxicity, including rehabilitation, the dissemination of information to the public, litigation involving CO poisoning, economic loss assessment, and firefighting. Further, it emphasizes topics related to successful means to prevent, identify, and manage the effects of CO poisoning. Furthermore, detailed information on the risk of CO poisoning from kitchen ranges, recreational vehicles, and powerboats is provided. Other topics include diagnostic procedures and devices, and the pros and cons of hyperbaric oxygen therapy. It reviews the physiological effects of acute and long-term exposure to CO, as well as the neurocognitive and neurobehavioral sequelae.

Shih-Houng Young (2007)
Toxicology of 1-3-Beta-Glucans: Glucans as a Marker for Fungal Exposure (Digital-Kindle Edition)
File Size: 5963 KB
Print Length: 232 pages
Publisher: Taylor & Francis: 1st edition

This digital edition covers the basic chemistry and immunobiology of beta glucans. The book introduces current methods for detecting 1-3-beta-glucans in environmental samples and reviews risk evaluation in the environment. Further, it discusses evaluating occupational and environmental exposure, studies suggesting a strong link between environmental glucan concentrations and pulmonary inflammation, and signal transduction pathways and specific receptors.

Spengler JD, John F McCarthy, Jonathan M Samet (eds.) (2000)
Indoor Air Quality Handbook
McGraw-Hill Professional: 1st edition

This handbook has chapters from world experts on how to create and maintain safe and healthy indoor environments in schools, hospitals, sports facilities, office buildings, apartments, homes, and transportation vehicles. Further, the handbook answers a range of questions such as health and comfort effects, physiologic thresholds, ventilation measurement, and employee programs. Further, extensive information on indoor environmental instrumentation, contaminants, codes, and guidelines for assessment and the design of indoor environments have been provided. In addition, information on evaluation of indoor air quality complaints, assessment methods, and risk management and communication strategies are provided. Sick building investigations, indoor concentration data for biologicals (e.g., molds, pollens, and other allergens) chemical contaminants (e.g., VOCs), particles and fibers (e.g., asbestos) has been extensively researched in this book. Other critical information and issues such as health and productivity costs of poor IAQ filtration, air cleaning, and American

Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) standards are described.

(U.S.) Institute of Medicine (2000)
Clearing the Air: Asthma and Indoor Air Exposures
National Academy of Publishers

This publication includes 11 chapters correlating pathophysiology with the incidence of asthma in indoor environments, and recommendations are provided on how to manage asthma by improving indoor air quality.

(U.S.) National Research Council (2000–2007)
Subcommittee on Acute Exposure Guideline Levels, Committee on Toxicology
Acute Exposure Guideline Levels for Selected Airborne Chemicals
Volumes 1–5

These reports review documents on acute exposure guideline levels (AEGLs) for selected airborne chemicals developed by the National Advisory Committee on Acute Exposure Guideline Levels for Hazardous Chemicals (NAC).

(U.S.) Institute of Medicine (2004)
Committee on Damp Indoor Spaces and Health
Damp Indoor Spaces and Health
National Academy of Publishers

This book covers the health impact of exposures resulting from damp indoor environments, and offers recommendations for public health intervention. Further, it examines the relationship between damp or moldy indoor environments and adverse health outcomes, and discusses how and where buildings get wet, how dampness influences microbial growth and chemical emissions, and various ways to prevent and remediate dampness. The review of the literature finds sufficient evidence of an association between damp indoor environments and some upper respiratory tract symptoms, coughing, wheezing, and asthma symptoms in sensitized persons.

Sample chapters include:
Burge H
Biological Agents
Driver J, Connor J Jr, Guiseppi-Elie A, et al
General Framework for Assessing Potential Human Exposures to Chemical, Biological, and Physical Agents in the Residential Environment
Whitmyre G, Dang W, Driver J, et al
Consumer products and related sources
Eisenberg M (1998)
Risk Assessment and Indoor Air Quality
Boca Raton, FL: Lewis.

This book examines the problem of long-term exposure to low-level concentrations of toxins. In addition to commonly found toxins such as chemical fumes from furnishings and carpeting, and indoor use of pesticides, this book discusses risks associated with exposure to indoor allergens and infectious disease pathogens such as Legionnaires' disease.

See also
Chemicals – Cosmetics and Other Consumer Products
Chemicals – Dust and Fibers
Target Sites – Respiratory System
Everyday Exposure to Chemicals

Journals

Ambient Air

Air Quality, Atmosphere and Health
Print 1873-9318, Electronic 1873-9326
Contact: Joan Robinson
Phone: +49-6221-4878130 (Germany)
Publication: Since February 2008

This multidisciplinary journal focuses on the atmospheric consequences of human activity and its implications for human and ecological health. It primarily publishes original research articles and integrative reviews offering local, regional and global perspectives. The subject areas include climate change and air quality, greenhouse gases, acid precipitation, air quality management, risk assessment, atmospheric chemistry, air pollution climatology, clean air technology, and forest-fire emissions.

Atmospheric Environment
Editors-in-Chief: P. Brimblecombe, H.B. Singh
ISSN: 1352-2310
Publisher: Elsevier
Year of publication: since 1967

This journal covers air pollution research and its applications, with the main objective of providing a scientific understanding of the consequences of natural and human-induced disturbances of the earth's atmosphere. It publishes original results based on experiments, theory and modeling of the atmosphere, from the scale of buildings and streets to the global scale. Areas of importance include air pollution research and its applications, air quality and its effects, dispersion and transport, deposition, biospheric–atmospheric exchange, atmospheric chemistry, and induced changes in radiation and climate. It also includes review articles, special issues and supplements, and new directions on emerging issues columns.

Clean Air: International Journal for a Clean Environment
Editor-in-Chief: Maria da Graca Carvalho
ISSN: 15614417
Publisher: Begell House

This journal covers new and innovative technologies which maximize energy conversion while minimizing undesirable emissions. The main objectives are to promote integrated energy solutions for a better environment, contribute to a sustainable energy economy, provide a framework for the discussion of change in worldwide energy systems, and to promote the dissemination of new energy technologies appropriate to developing countries within the global market.

Global Change Biology
Editor: Steve Long
Print ISSN: 1354-1013
Online ISSN: 1365-2486
Frequency: Monthly
Current Volume: 14/2008

This journal promotes understanding of the relationships between current environmental change and biological systems. The topics include rising tropospheric ozone and carbon dioxide concentrations, climate change, loss of biodiversity, and eutrophication. Both biological responses and feedbacks to change are included, and may be considered at any level of organization from molecular to biome. It focuses on primary research articles, but also includes technical papers, mini-reviews, and opinion articles. Studies which integrate across levels of organization to provide a mechanistic understanding are particularly encouraged. Studies may be experimental, observational, or theoretical, and include aquatic or terrestrial and managed or natural environments.

Journal of the Air and Waste Management Association
Air & Waste Management Association
One Gateway Center, 3rd Floor
420 Fort Duquesne Blvd.
Pittsburgh, PA 15222-1435
Phone: +1-412-232-3444; +1-800-270-3444
Fax: +1-412-232-3450
E-mail: info@awma.org
Publications: Andy Knopes
Phone: +1-412-904-6009 (direct)
or +1-412-232-3444, ext. 6009
Email: aknopes@awma.org

This is one of the oldest published, peer-reviewed, technical journals in the world, first published in 1951 under the name *Air Repair*. The target audience includes those occupationally involved in air pollution control and waste management.

Water, Air, and Soil Pollution
Editor-in-Chief: Jack T. Trevors
ISSN: 0049-6979 (print version)
ISSN: 1573-2932 (electronic version)
Publisher: the Netherlands: Springer.

This journal covers all aspects of pollution and solutions to pollution in the biosphere. Topics include chemical, physical and biological processes affecting flora, fauna, water, air and soil. In addition to aquatic pollution and waste, sewage and sediment pollution, it covers sources, transport, deposition, accumulation, acid precipitation, atmospheric pollution, effects of pollutants on humans, vegetation, fish, aquatic species, micro-organisms, animals, ecological implications of pollution and pollution models. The journal has a special section on 'Meteorology & atmospheric sciences.'

Indoor Air
Publisher: Blackwell Munksgaard.
Homepage: http://www.blackwell-synergy.com/rd.asp?goto=journal&code=INA
First published year: 1991

This journal publishes original research results in the broad area defined by the indoor environment of non-industrial buildings. The multidisciplinary content includes indoor air-related fields such as health effects, thermal comfort, monitoring and modeling, source characterization, ventilation, and other environmental control techniques. The research results from those papers can be used by designers, building owners, and operators for a healthy and comfortable environment for building occupants, as well as giving medical practitioners information on how to deal with illnesses related to the indoor environment.

Indoor and Built Environment
Publisher: SAGE Publications Ltd
Homepage: http://ibe.sagepub.com/
First published year: 1992

This journal publishes reports related to the quality of the indoor and built environment, and their effect on the health, performance, efficiency and comfort of persons living or working there. Topics range from urban infrastructure, design of buildings, and materials used to laboratory studies including animal simulations and in vitro effects. The journal is available electronically on SAGE Journals Online at http://ibe.sagepub.com.

Journal articles

Ambient air

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Indoor air

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Organizations

Numerous governmental and non-governmental organizations offer access to air (indoor and outdoor) toxicology information resources. Particularly noteworthy are sites from the United Nations (UN) technical agencies such as the World Health Organization (WHO), the United Nations Environment Programme (UNEP), the World Bank and other development banks such as the Asian Development Bank (ADB), Clean Air Initiatives, European Union (EU), the European Environmental Agency (EEA), the United States Environmental Protection Agency (U.S. EPA) and the (U.S.) National Library of Medicine, and Stockholm Environment Institute (SEI). The World Health Organization (WHO), U.S. EPA and SEI websites offer information on emission inventories and emission factors; the U.S. EPA addresses dispersion modelling, and WHO offers extensive web sites on the

health impacts of indoor and outdoor air pollutants. Also noteworthy is the site from the German Association for Technical Co-operation (GTZ). Various organizations also provide opportunities for training, e.g. web sites offering training in air quality include UNEP, the U.S. EPA, the GTZ and SEI.

Air Pollution Training Institute (APTI), U.S. EPA

U.S. EPA's APTI primarily provides technical air pollution training to U.S. air pollution professionals and others. The curriculum is available in classroom, telecourse, self-instruction, and web-based formats. The training topics include all aspects of air quality management and toxicology. Recently introduced topics are training courses on the chain of custody, environmental statistics, and emission inventories. The course entitled 'Preparation of Fine Particulate Emission Inventories' provides a Student Manual and a Workbook on the web. The APTI home page is http://www.epa.gov/air/oaqps/eog/index.html.

Air Quality Guidelines

The first globally applicable guidelines for air quality of WHO were published in 2000, giving guideline values for about 80 non-carcinogenic air pollutants and 50 carcinogenic ones. This document looks at the guidelines and guideline values in the framework of urban atmospheric toxicology and impact of climate change. The publication can be downloaded from http://whqlibdoc.who.int/hq/2000/WHO_SDE_OEH_00.02_pp1-104.pdf and http://whqlibdoc.who.int/hq/2000/WHO_SDE_OEH_00.02_pp105-190.pdf. The most recent global guideline values for the common compounds – particulate matter, sulphur dioxide, nitrogen dioxide, and ozone – were published in 2005 and can be downloaded from the WHO European Regional Office website http://www.euro.who.int/air/activities/20050222_2.

Air Quality Management (AQM) Online Portal, USEPA

USEPA's AQM Online Portal at http://www.epa.gov/air/aqmportal/resources.htm seeks to identify useful training resources within the USEPA as well as other good sources of information. Available tools and training materials include control strategies, emissions inventories, dispersion modelling, and concentration monitoring.

Basic Environmental Health (1998) – Text Book

Web: http://whqlibdoc.who.int/hq/1998/WHO_EHG_98.19_(chapters1-3).pdf
Web: http://whqlibdoc.who.int/hq/1998/WHO_EHG_98.19_ (chapters4-7).pdf
Web: http://whqlibdoc.who.int/hq/1998/WHO_EHG_98.19_(chapters8-12).pdf

CAI-Asia

In 2001, Asian Development Bank together with the World Bank and the U.S. Agency for International Development/U.S.-Asia Environmental Partnership established the **Clean Air Initiative for Asian Cities (CAI-Asia)** as a multi-sector network promoting measures to improve air quality in the region. The Clean Air Initiative for Asian Cities (CAI-Asia) promotes and demonstrates innovative ways to improve the air quality of Asian cities through partnerships and sharing experiences. CAI-Asia addresses and provides reports and presentations on monitoring; modelling; emissions inventories; impacts; transboundary air pollution; policies and instruments; mobile and stationary sources; area sources; indoor air pollution; and education and awareness.

CAI-Asia organises the biannual Better Air Quality (BAQ) Workshops. Information on BAQ 2008 can also be found at the CAI-Asia website http://www.cleanairnet.org/caiasia/1412/channel.html.

CAI-Asia makes available country and city synthesis reports (CSR), which provide overviews of urban air quality management in cities in Asia. The CSRs cover the status and drivers of urban air pollution, impacts of air pollution on health, environment and economy, the air quality management framework on the national and local (city) levels, and the challenges that face the cities and the countries in implementing and improving their existing AQM frameworks. CSRs can be accessed at http://www.cleanairnet.org/caiasia/1412/article-70822.html.

CAI-LAC

The **Clean Air Initiative in Latin American Cities (CAI-LAC)** was also launched in 1998. On its website http://www.cleanairnet.org/lac/1471/propertyname-1893.html CAI-LAC publishes information on emission inventories, air quality monitoring and modelling and health, environmental and economic impacts of air pollution on the urban, regional and global scales. CAI-LAC developed a strategy for clean air to be implemented between 2007 and 2012. The strategy can be found at http://www.cleanairnet.org/lac_en/1415/channel.html.

CAI-SSA

The **Clean Air Initiative in Sub-Saharan Africa (CAI-SSA)** was launched in 1998 as a response to an increase in **air quality problems** in the region. The first workshops organized by CAI-SSA served to initiate the phase-out of lead in gasoline in Africa. In 2006,

the Better Air Quality Workshop (BAQ SSA) was organized which aimed to discuss air quality management issues by bringing them to the forefront of decision makers to come up with practical solutions. In 2007, CAI-SSA published a review on air quality management in 27 SSA countries (Schwela, 2007). Information can be accessed at http://www.cleanairnet.org/ssa/1414/article-70809.html.

Clean Air Initiative

The **Clean Air Initiative (CAI)** advances innovative ways to improve air quality in cities by sharing knowledge and experiences through partnerships in selected regions of the world.
The specific objectives of the CAI are to:
Raise awareness of the dangers of urban air pollution;
Measure baseline vehicle emissions, air quality, pollution exposure and effects;
Identify the most cost-effective control options;
Design, implement, and monitor the impacts of Air Quality Action Plans to reduce pollution; and
Strengthen local expertise on air quality management.
In the various regions of the world, the Clean Air Initiative organizes conferences and workshops and publishes on the Web reports, presentations and case studies. The initiative is currently active in Asia, Latin America and Sub-Saharan Africa. General information on the CAI can be found at http://www.cleanairnet.org/cai/1403/article-33678.html.

Deutsche Gesellschaft fur Technische Zusammenarbeit (GTZ)

For over thirty years, GTZ's key tasks have included developing its partners' potential and capacities in supporting countries with respect to Air Quality Management and moderating the concomitant processes of learning and change. "Capacity Development – empowering partners, promoting potentials" is the slogan for holistic competency development, which GTZ regards as the key to sustainable development. The spotlight of GTZ's work in 2007 was phrased "Capacity Development". The work of GTZ for the environment is performed in five areas: **Environmental policy and institution-building, sustainable management of natural resources, preparation and implementation of international agreements on the environment, urban-industrial environmental management, regional, transnational environmental cooperation.** The website of GTZ is http://www.gtz.de/en/17870.htm.
A Sourcebook on Sustainable Urban Transport was developed in 2002 and is continuously updated. The sourcebook contains six modules which address institutional and policy orientation; land use planning and demand management; mass transit options, walking and cycling; vehicles and fuels; environmental and health impacts; and resources for policy makers. It can be downloaded after free-of-charge registration at the Sustainable Urban Transport Project (SUTP) website http://www.sutp.org/content/view/426//lang,uk/.

Emission Factors

How to build up an emissions inventory and emission factors for stationary and mobile sources particularly suited for developing countries can be found in a WHO publication on the rapid assessment of sources of air, water, and soil pollution. The name of the file is WHO_PEP_GETNET_93.1-A.pdf and it can be downloaded from http://whqlibdoc.who.int/hq/1993/.

Environmental Epidemiology – a Textbook on Study and Public Health Applications

Web: http://whqlibdoc.who.int/hq/1999/WHO_SDE_OEH_99.7_(chapter1-4).pdf
Web: http://whqlibdoc.who.int/hq/1999/WHO_SDE_OEH_99.7_(chapter5-7).pdf
Web: http://whqlibdoc.who.int/hq/1999/WHO_SDE_OEH_99.7_(chapter8-12).pdf

Environmental Health

WHO's publications on environmental health (and others) can be found at two complementary webpages:

- http://whqlibdoc.who.int/hq/YEAR/ where YEAR = 1990, . . . , 2005; and
- http://www.who.int/phe/en/

Some other relevant publications are listed below:
"A methodology for understanding and estimating air pollution health effects"
http://whqlibdoc.who.int/hq/1996/WHO_EHG_96.5.pdf
Methods for health impact assessment in environmental and occupational health
http://whqlibdoc.who.int/hq/1998/WHO_EHG_98.4.pdf.

European Centre for Ectoxicology and Toxicology of Chemicals (ECETOC) (1994)

ECETOC addresses the safe manufacture, supply and use of chemicals, biomaterials and pharmaceuticals. Its mission is to use scientific evidence and expert judgment to ensure robust human and environmental risk assessment of these agents in the various media including air. The main output of ECETOC's work programme is published in a range of peer-reviewed technical reports and documents, criteria documents and monographs. The ECETOC website is http://www.ecetoc.org/Content/Default.asp.

European Environmental Agency (EEA)

The EEA aims to support sustainable development and to help achieve significant and measurable improvement in Europe's environment through the provision of timely, targeted, relevant and reliable information to policy-making agents and the public. Recent Web publications of the EEA referring to Atmospheric toxicology and impact of climate change include the 'EMEP/CORINAIR Emission Inventory Guidebook – 2007', the 'Greenhouse gas emission trends and projections in Europe 2007', the report on 'Air pollution in Europe 1990-2004', and the 'Greenhouse gas emission trends' assessment which all can be downloaded from http://www.eea.europa.eu/themes/air.
The EEA has also published a multilingual environmental glossary with terms relevant for air quality management and toxicology, which can be accessed at http://glossary.eea.eu.int/EEAGlossary/.

European Federation of Allergy and Airways

EFA, 2004. Towards Healthy Air in Dwellings in Europe. The THADE Report. European Federation of Allergy and Airways Diseases Patients Association. 97 pp. http://www.efanet.org/activities/documents/THADEReport.pdf

European Union (EU)

European Commission (EC) legislation provides the basis for urban air quality management in EU Member States. A number of Directives addresses issues of air quality management, environmental impact assessment (EIA) of planned projects and strategic environmental assessment (SEA) of programmes and policies. The Framework Directive (96/62/EC) outlines the information to be included in national, regional and local plans to improve ambient air quality. While in Daughter Directives (1999/30/EC; 2000/69/EC; 2002/3/EC; 2004/107/EC) the EU sets air quality limits, the Member States are able to decide what are most appropriate means of achieving these standards within their country (Haq et al., 2002). Framework and Daughter Directives can be found at the EUR-Lex website http://eur-lex.europa.eu/EurovocView.do?idRoot=1&refinecode=LEG*T1=V112;T2=V1;T3=V5&eurovocrep=52.
In the European Union, Environmental Impact Assessment (EIA) is regulated by the Directive on Environmental Impact Assessment of the **effects of projects** on the environment introduced in 1985 and amended in 1997. The aim of an Environmental Impact Assessment (EIA) is to provide environmental protection for a planned project (e.g. a planned industrial area, a planned airport) by foreseeing and preventing environmental, particularly air pollution, problems. The EIA process ensures that air quality consequences of projects are identified and assessed before authorisation is given. Stakeholder opinion is taken into account after public hearings before authorisation of the project. Stakeholders are informed of the decision afterwards. The strength of EIA is to enable the best environmental balance to be found between a project and its surroundings and in helping to determine whether the project is acceptable. The EIA Directive can be found at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri = CELEX:31985L0337:EN:NOT.
Additional information on various related projects on indoor and outdoor air quality and exposure assessment can be found in the following documents:
EU European Commission, JRC, 2004. The INDEX Project: Critical Appraisal of the Setting and Implementation of Indoor Exposure Limits in the EU. (331 pp).
http://web.jrc.ec.europa.eu/pce/pce-documentation.html (The report is listed among many other reports on the website)
The main objective of the INDEX project was to propose a list of priority compounds that should be considered for regulation in indoor environments based on the overall population risk caused by indoor sources, toxicological properties (in addition to hypersensitivity for allergy and asthma); known health effects and comfort considerations.
The AIRMEX study dealt with the measurements of indoor/outdoor air and personal chronic exposure to pollutants in various European cities. Its results can be found in a presentation entitled "Emerging Substances in indoor Air" http://www.norman-network.com/public_docs/slides_stresa/day_1_session_i/kotzias/sess1_kotziasi.pdf.

Global Burden of Disease

More recently, WHO estimated the global burden of disease (GBD) due to 22 risk factors including outdoor air pollution, indoor smoke from solid fuel use, lead and climate change. The report can be found at http://www.who.int/whr/2002/en/ and the basic information on burden of disease estimates at www.who.int/evidence. Documentation and GBD 2000 summary tables are available on the WHO websites:
http://www3.who.int/whosis/menu.cfm?path=evidence,burden,burden_manual
http://www3.who.int/whosis/menu.cfm?path=evidence,burden
A calculation template for disability adjusted life years (DALYs), and list of disability weights used for the yearly estimates of the GBD (WHO, 2002), are available at the WHO web site:

http://www3.who.int/whosis/menu.cfm?path = whosis,burden,burden_manual,burden_manual_other&language = english.
This template should be used in connection with the *National Burden of Disease Manual* at: http://www3.who.int/whosis/menu.cfm?path=whosis,burden&language = english.

Health Effects Institute (HEI), USA

Charlestown Navy Yard
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Publications ordering/information: pubs@healtheffects.org

HEI's mission is to provide credible science to support environmental regulations and other policy decisions. The results of each HEI-funded project undergo peer-review by outside scientists and the HEI Health Review Committee. Periodically HEI analyzes and interprets the scientific issues pertaining to a specific environmental problem. The results of these analyses are published in HEI Special Reports. Since 2000, HEI has been publishing all reports free of charge on its website before they appear in print. Research topics of HEI include accountability, toxic air pollutants, carbon monoxide, diesel exhaust, fuels and fuel additives, pollutant mixtures, nitrogen oxides, ozone and particulate matter. A special compendium called 'Public Health and Air Pollution in Asia – Science Access on the Net' (PAPASAN) compiles studies of the health effects of air pollution in Asia. The relevant website for this information is http://pubs.healtheffects.org/types.php?type=2.

Indoor Air Quality

Web: http://www.who.int/indoorair/en/
Web: http://www.who.int/indoorair/info/en/

To combat this substantial and growing burden of disease, WHO has developed a comprehensive programme to support developing countries. WHO's Programme on Indoor Air Pollution focuses on research and evaluation, capacity building, evidence for policy-makers (excerpted from http://www.who.int/indoorair/en/). Several relevant WHO indoor air quality resources are provided below.
Bruce N, Rehfuess E, Mehta S et al (2006) Indoor air pollution. In: Jamison D, Breman J G, Measham A R et al (eds.) Disease Control Priorities in Developing Countries, second edition. Oxford, UK: World Bank and Oxford University Press.
Web: http://www.who.int/indoorair/publications/indairpoll/

Indoor Air Quality

Dasgupta S, Huq M, Khaliquzzaman M, Pandey K, Wheeler D 2004 Who Suffers from Indoor Air Pollution? Evidence from Bangladesh. World Bank Policy Research Working Paper 3428. 24 pp.
Web: http://www.cleanairnet.org/baq2004/1527/articles-59204_dasgupta.pdf
Dasgupta Susmita, Huq, Mainul, Khaliquzzaman M, Pandey Kiran, Wheeler David
Indoor Air Quality for Poor Families: New Evidence from Bangladesh (September 2004)
World Bank Policy Research Working Paper No. 3393. 48 pp. Web: http://papers.ssrn.com/sol3/Delivery.cfm/38254.pdf?abstractid = 625270&mirid=3

Indoor Air Quality Information Resources, U.S. EPA

Web: http://www.epa.gov/iaq/
Web: http://www.epa.gov/iaq/resources.html

This information resources web portal from U.S. EPA has relevant resources in indoor air quality, asbestos, lead, mould, radon, and secondhand smoke. Further, various protocols for indoor air quality, health effects, indoor air risk mitigation procedures, and emerging protocols can be found. For examples, Information on an emerging tool called Environmental Relative Moldiness Index (ERMI) is available in the following publication:
Vesper SJ, Mckinstry C, Haugland RA (2007) Relative Moldiness Index© as predictor of childhood respiratory illness. J. Expo. Sci. Environ. Epidemiol. 17(1): 88–94.
Additional information can be accessed from: http://www.epa.gov/nerl/news/forum2006/vesper.pdf
Other relevant publication includes:
United States Environmental Protection Agency (U.S. EPA)

Indoor Air Quality (IAQ) Tools for Schools Kit

Web: http://www.epa.gov/iaq/schools/
US Environmental Protection Agency (2001)

Mold Remediation in Schools and Commercial Buildings

Web: http://www.epa.gov/mold/mold_remediation.html

Institute for Inspection, Cleaning and Restoration Certification *(IICRC) (http://www.iicrc.org)*

IICRC has two important peer reviewed guidance documents on water damage and mold remediation.
IICRC S500-Standard and Reference Guide for Professional Water Damage Restoration
IICRC S520-Standard and Reference Guide for Professional Mold Remediation

Indoor Environmental Standard Organization (IESO)
12339 Carroll Avenue
Rockville, MD 20852
Phone: (301) 230-9636
Toll Free: (800) 406-0256
Fax: (301) 230-9648
E-Mail: info@iestandards.org

The IESO was established in 2002 to assist IAQ businesses. It is a non-profit organization that provides a national forum for the development and publication of voluntary consensus standards for the assessment of indoor environments. The mission of IESO is to be the foremost developer and provider of voluntary consensus indoor environmental quality standards, related technical information, and services having recognized quality and applicability that promote public health and safety, and the overall quality of life (excerpted from http://www.iestandards.org)
The users of those documents are encouraged to critically evaluate the applications of those standards and guidelines in various indoor environments.

International Organization for Standardization (ISO)

The ISO is the world's **largest developer** and publisher of **International Standards**. ISO is a **network** of the national standards institutes of **157 countries.** ISO is a **non-governmental organization** that forms a bridge between the public and private sectors. For air quality, ISO has developed a number of standards addressing air quality terminology, exchange of data, particle size fraction definition, monitoring uncertainty, determination of specific air pollutants in the ambient air, and determination of emissions from stationary and mobile sources. The catalogue of ISO standards referring to air quality can be found at http://www.iso.org/iso/iso_catalogue/catalogue_ics/catalogue_ics_browse.htm?ICS1=13&ICS2=40.

International Programme on Chemical Safety (IPCS)

Web: www.who.int/pcs/index.htm and www.who.int/pcs/pcs_pubs.html

The International Programme on Chemical Safety (IPCS) is a joint program of UNEP, the International Labour Organisation (ILO), and the WHO. The purpose of IPCS is to establish the scientific basis for safe use of chemicals and to strengthen national capabilities and capacities for chemical safety. IPCS evaluates chemical risks to human health and the environment and develops methodologies for these evaluations. Many of the IPCS documents are available on-line, while ordering instructions are provided for the rest. Risk assessment documents for specific substances are produced by a number of IPCS and WHO programmes and activities include:

- Environmental Health Criteria Documents (EHC) http://www.inchem.org/pages/ehc.html,Health and Safety Guides (HSG), http://www.inchem.org/pages/hsg.html
- Concise International Chemical Assessment Documents (CICAD) http://www.inchem.org/pages/cicads.html

Important Environmental Health Criteria include:

- Nitrogen oxides (1997), No. 188
- Diesel Fuel and Exhaust Emissions (1997), No. 171
- Carbon Monoxide, 2nd edition. (1999), No 213
- Human Exposure Assessment (2006) No 214

International Society of Indoor Air Quality and Climate (ISIAQ)

c/o Finnish Society of Indoor Air Quality and Climate
Attn: Ms. Helka Backman, ISIAQ Administrator
P.O. Box 25, FIN-02131, Finland
Tel.: +358 9 4355 5612, Fax: +358 9 4355 5655
e-mail: info@isiaq.org

ISIAQ is an international and multidisciplinary, scientific, non-profit organization which supports the creation of healthy, comfortable and productive indoor environments. Additional information can be found at www.isiaq.org. The publications website has links to the peer reviewed "Indoor Air" journal, "newsletter" and "e-newsletter". Newsletter publications can be submitted to:
ISIAQ Newsletter, ISIAQ Secretariat
c/o Finnish Society of Indoor Air Quality and Climate
P.O. Box 25, FIN-02131 Espoo, Finland
Tel. +358 9 4355 560, Fax: +358 9 4355 565
E-Mail: info@isiaq.org
Indoor Air Quality Association (IAQA), Inc.
12339 Carroll Avenue
Rockville, MD 20852
Phone: (301) 231-8388
Fax: (301) 231-8321
E-Mail: iaqa@aol.com
Web: http://www.iaqa.org/

The IAQA was established in 1995 to promote consistent standards, procedures and protocols in the IAQ Air Quality industry. In 2005, it's membership was consolidated with two other IAQ organizations: The American Indoor Air Quality Council (AmIAQ) and the Indoor Environmental Standards Organization (IESO). As of January 1, 2006, IAQA emerged from the consolidation with 5566 members. It has a monthly newsletter (40+ pages) titled, "Indoor Environment

Connections" (http://www.ieconnections.com). The association also has a bi-monthly 24-page technical newsletter with abstracts on the latest scientific and medical findings in the areas of indoor air quality and health. IAQA also promotes and provides peer reviewed standards and protocols from other professional organizations such as **Institute for Inspection, Cleaning and Restoration Certification**-IICRC (http://www.iicrc.org) and **Indoor Environmental Standard Organization (IESO).**

The Mickey Leland National Urban Air Toxics Research Center (NUATRC)

P. O. Box 20286, Houston, Texas, 77225-0286
Phone: (713) 500-3450
Fax: (713) 500-0345
E-Mail: NUATRC@uth.tmc.edu
Web: http://www.sph.uth.tmc.edu/mleland/default.htm

The NUATRC is a non-profit organization authorized by the U.S. Congress in the Clean Air Act Amendments of 1990 and incorporated in 1991. It is named after the late Congressman Mickey Leland. Its mission is to develop and support research leading to an improved understanding of the potential human health risks from exposure to indoor and outdoor air toxics. NUATRC's research program is developed by a Board of Directors and a Scientific Advisory Panel of experts from academia, industry, and government agencies. Current objectives include the study of the health effects in human populations exposed to indoor and outdoor air toxics, development of new approaches and methods, and to provide sound, peer-reviewed scientific data for regulatory purposes. The webpage is http://www.sph.uth.tmc.edu/mleland/Webpages/publications.htm

Organisation for Economic Co-Operation and Development (OECD)

The OECD – http://www.oecd.org/home/- provides governments with the analytical basis to develop environmental policies and instruments that are effective and economically efficient, including climate change issues, environment and sustainable development, economic policy and the environment in developing countries, environmental country reviews, and the environmental-social interface.
Environmental country reviews exist for 35 countries and can be accessed at http://www.oecd.org/infobycountry/0,3380,en_2649_34307_1_1_1_1_1,00.html.
Information on OECD publications for environmental indicators and OECD environmental data can be found at: http://www.oecdbookshop.org/ and http://www.oecdbookshop.org/oecd/display.asp?CID = oecd&LANG = EN&SF1 = DI&ST1 = 5LH237G3XPVB, respectively.
OECD is also providing a glossary of statistical terms relating to air quality, which can be accessed at http://stats.oecd.org/glossary/index.htm.

Stockholm Environment Institute (SEI)

SEI co-ordinates the Regional Air Pollution in Developing Countries (RAPIDC) Programme funded by the Swedish International Development Cooperation Agency (SIDA). It is carried out in collaboration with universities and inter-governmental agencies and research organizations in Asia and Africa. The aim of RAPIDC is to facilitate the development of agreements/protocols to implement measures, which prevent and control air pollution. Work areas include capacity building in Africa and Asia for emission inventories and scenarios, dispersion modelling, human health impact assessment, and rapid urban integrated assessment. For several countries of the South African Development Community (SADC), an Air Pollution Information Network for Africa (APINA) has been formed in order to enhance supranational collaboration on air quality management. A similar network was created in Asia for countries that have signed the Malé Declaration. Information on RAPIDC can be accessed at http://www.sei.se/rapidc/about.htm.
SEI developed six training modules on air quality management as output of the Clean Air for Asia Training Programme which was funded by the European Union's Asia Urbs programme. These modules refer to legislation, governance, implementation and enforcement; emissions inventories, dispersion modelling, monitoring and health impact assessment. The modules can be found on the SEI website http://www.sei.se/cleanair/

(U.S.) National Library of Medicine (NLM)

Medline Health Information resources from National Library Medicine have specific information web pages on different health related topics. Authentic information resources in emerging issues in indoor and outdoor air quality are provided.
Indoor Air Pollution: http://www.nlm.nih.gov/medlineplus/indoorairpollution.html
Outdoor Air Pollution: http://www.nlm.nih.gov/medlineplus/airpollution.html
Other NLM information sources include ToxTown®, an interactive guide to commonly encountered toxic substances in everyday locations such as in a house or on a farm (http://toxtown.nlm.nih.gov), the Household Products Database of U.S. consumer product formulations and other information , the Haz-Map (occupational toxicology database of chemicals and

biologicals, and TOXMAP®, which uses U.S. maps to show the amounts and locations of the release of chemicals into the environment reported by industrial facilities in response to the EPA's Toxics Release Inventory. Information about these and other NLM resources is available from http://www.nlm.nih.gov/pubs/factsheets/tehipfs.html.

UN-Habitat/UNEP

The Sustainable Cities Programme (SCP) is a facility established in the early 1990s to enhance capacities in urban environmental planning and management. The programme targets urban local authorities and stakeholders in participatory approaches.

The SCP Urban Air Quality Handbook systematically underlines an effective process for urban air quality management, with an emphasis on (i) Information & Expertise, (ii) Strategy Formulation and Action Planning, and (iii) Implementation and Institutionalisation. The handbook discusses the formulation and implementation of participatory urban air quality management, following a step-by-step procedure based on the SCP process. To further assist in developing and implementing an air quality management plan within the context of the SCP process, a Toolkit has been prepared. Its main purpose is to provide cities with information and techniques to help with the further assessment of information, development of strategies and implementation of those strategies. Handbook and Toolkit, combined as a 'Toolbook', can be found at http://unep.org/urban_environment/PDFs/handbook.pdf.

United Nations Environment Programme (UNEP)

UNEP has produced resources on air quality to facilitate the transfer of knowledge for sustainable development. Links to UNEP resources on air quality include the following documents:

- Air Quality Handbook and Toolkit (see UN-Habitat below)
- Eliminating Lead from Gasoline: Report on Valve Seat Recession
- Greener Driving
- Opening the Door to Cleaner Vehicles in Developing and Transition Countries: The Role of Lower Sulphur Fuels

This information can be accessed at http://www.unep.org/tools/default.asp?ct=air. Other UNEP projects relevant to air quality management include the atmospheric brown cloud (ABC) in Asia, regional monitoring within the Male declaration, acid rain and collection of GHG emissions within the Asia Least Cost Greenhouse Gas Abatement Strategy (ALGAS). Information can be downloaded from http://www.rrcap.unep.org/ew/air/projects.cfm. UNEP's web page http://www.unep.org/tools/default.asp?ct=urban provides links to further urban issues including:

- Assessment of Policy Instruments for Reducing Greenhouse Gas Emissions from Buildings
- Cleaner Vehicles in Developing and Transition Countries

A technical manual on wet and dry deposition outlining agreed methodologies was developed and finalized in consultation with national implementing agencies and relevant experts. A manual for national training programmes on air pollution monitoring was also published. Both manuals are accessible at http://www.rrcap.unep.org/ew/air/male/CPdoc.cfm.

The UNEP/TNT Toolkit for clean Fleet Strategy Development is designed to help develop a strategy for reducing the environmental impacts of vehicle fleets. It can be accessed at http://www.unep.org/tnt-unep/toolkit/. It provides information on vehicular air pollutants; the relationship between vehicle characteristics, fuel quality, and emissions; health effects; effects on the built environment; and sources of greenhouse gases and effects of climate change. Further tools are devoted to potential actions such as maintenance; driver behaviour; fuel quality; emission control technologies, advanced and future vehicles and fuels; strategy development for reducing the fleet's environmental impacts and the control of its efficiency; and a tool to estimate the fleet's emissions.

United States Environmental Protection Agency (U.S. EPA)

The U.S. EPA offers a wealth of information on all topics of air quality. Topics include a glossary, emission factors, emission inventory, dispersion models, reference methods for air pollutant monitoring, health and environmental impacts. The entry point for this information is the air quality management web portal at http://www.epa.gov/air/aqmportal/index.htm. This site seeks to identify useful resources within the EPA web site as well as other good sources of information. The site allows navigate to the following air quality management activities.

- Air Quality Goal Setting
- Legislation, Regulation & Implementation
- Compliance & Enforcement
- Public Participation
- Emissions Inventory
- Monitoring
- Modeling
- Human & Environmental Assessment
- Control Strategies

The web page http://www.epa.gov/air/airpollutants.html provides specific information to many air pollutants including the common pollutants (sulphur dioxide, nitrogen oxides, ozone, carbon monoxide, particulate matter, and lead), chlorofluorocarbons, mercury, propellants, radiation, radon, toxic air pollutant, and volatile organic compounds.
The website http://www.epa.gov/oar/oaqps/emission.html of the Office of Air Quality Planning and Standards assesses the consequences of air pollution emissions and the results of efforts to curb these emissions.
Within U.S. EPA's Technology Transfer Network (TTN) the Clearing House for Inventories & Emissions Factors (CHIEF) information is available on emission inventories, emission factors, and emission modelling. The website is: http://www.epa.gov/ttn/chief/.
The Support Centre for Regulatory Air Models (SCRAM) site provides information about mathematical models used to predict the dispersion of air pollution. The site includes computer codes, meteorological input data, documentation and guidance on usage. Its address is http://www.epa.gov/oar/oaqps/emission.html#scram.
Preferred and recommended dispersion models, which are required for State Implementation Plans, can be found in the Support Centre for Regulatory Atmospheric Modelling of the TTN at http://www.epa.gov/scram001/dispersion_prefrec.htm. Models include a steady-state plume model (AERMOD), a non-steady-state puff dispersion model (CALPUFF) and other dispersion models. The codes for these models can be downloaded free of charge together with the corresponding documentations and model evaluation databases.

WHO 1995

Jonathan E Sinton, Kirk R Smith, Hansheng Hu, Junzhuo Liu
Indoor Air
Pollution Database for China, WHO/EHG/95.8, Human Exposure Assessment Series, Office of Global and Integrated Environmental Health, Geneva, 120 pp.
Web: http://whqlibdoc.who.int/hq/1995/WHO_EHG_95.8.pdf

WHO 2002

Health effects of indoor air pollution in developing countries. 41 pp.
Web: http://whqlibdoc.who.int/hq/2002/WHO_SDE_OEH_02.05.pdf

WHO 2004

Smith KR, Mehta S, Maeusezahl-Feuz M (2004) Indoor smoke from household solid Fuels. In: Ezzati M, Rodgers AD, Lopez AD, Murray CJL (eds.) Comparative Quantification of Health Risks: Global and Regional Burden of Disease due to Selected Major Risk Factors, Vol. 2, pp. 1435–1493. Geneva, Switzerland: World Health Organization Overview.
Web: http://www.who.int/publications/cra/en/; Chapter 18 on IAP from solid fuels, 60 pp.
Direct link http://www.who.int/publications/cra/chapters/volume2/1435-1494.pdf

WHO 2006

Air Quality Guidelines, Global Update: Chapter 9, Indoor air quality issues associated with domestic solid fuel use in developing countries. Draft 4, September 2006.
WHO 2006 Development of WHO Guidelines for Indoor Air Quality, Report on a Working Group Meeting Bonn, Germany 23-24 October 2006.

World Health Organization (WHO)

WHO's publications are distributed over numerous websites and reports on particular topics and are not easy to find due to the fact that many publications before 2005 are arranged on the Web according to the internal organization structure of WHO. Therefore in the following paragraphs individual web pages are quoted in order to facilitate the finding of relevant papers. Training materials relevant for air quality and toxicology which are available on the WHO website include exercises for environmental epidemiology. Epi Info Teaching Modules can be downloaded from http://whqlibdoc.who.int/hq/1996/WHO_EHG_96.15.pdf. Problem-based training exercises for environmental epidemiology for students are available at http://whqlibdoc.who.int/hq/1998/WHO_EHG_98.2.pdf. Although these materials based on older epidemiological studies they are still relevant for the purpose of training on health impact assessment.

World Bank

In July 1998, the World Bank Group approved the 'Pollution Prevention and Abatement Handbook 1998: Toward Cleaner Production' (PPAH), for use in World Bank Group operations. The PPAH was compiled by environmental staff from the World Bank and the International Finance Corporation (IFC). It addresses pollution management, environmental standards, waste, energy efficiency, economic analysis, monitoring of emissions and modelling of concentrations, and health impact assessment. The PPAH can be downloaded from the IFC website http://www.ifc.org/ifcext/enviro.nsf/Content/PPAH.
Information Resources in Indoor Air Quality from Different Countries

Canada

Canadian Construction Industry Association

CCIA 2004. Canadian Construction Industry Association Mould Guideline (CCA-82)
Web: http://www.cca-acc.com/mould/
To contact: http://www.cca-acc.com/mould/contact/contact.html

Canadian Mortgage Housing Corporation (CMHC)

About your house series: http://www.cmhc-schl.gc.ca/en/co/co_001.cfm

CMHC Technical series 02-103. Moldy houses: why they are and why we care & additional analysis of Wallaceburg data: the Wallaceburg health and housing studies. http://www.cmhc.ca/publications/en/ rh-pr/tech/02-103-e.html

Clean Air Strategic Alliance (http://www.casahome.org/)

CASA is a multi-stakeholder partnership, composed of representatives selected by industry, government and non-government organizations, which recommends strategies to assess and improve air quality in Alberta. There are various project teams working in ambient and indoor air quality. For additional information, readers can access information resources at: http://www.casahome.org/?page_id=13

Climate Change, Air Pollution and Health Research Network

Web: http://www.climateairhealth.ca/html/aboutus.htm

The New Brunswick Lung Association (www.nb.lung.ca) and the Lung Associations' International Centre for Air Quality and Health (http://www.can-us-airhealth.org/) and Climate Change and Health Office of Health Canada, coordinate the Climate Change, Air Pollution and Health Research Network. This research Network also participates in the Canadian Climate Change Impacts and Adaptation Research Network (C-CIARN) (http://www.c-ciarn.ca) through Health Canada's climate change and health office.
The New Brunswick Lung Association and the Lung Associations' International Centre host this network for Air Quality and Health. It is a not-for-profit community charity organization, located in Fredericton, New Brunswick, Canada affiliated with the national Canadian Lung Association (CLA). The primary concern of the network is respiratory health and it is involved in numerous programs that help reduce air pollution and /or climate change:

Environment Canada - Clean Air Online

Web: http://www.ec.gc.ca/cleanair-airpur/Indoor_Air_Pollution-WS1280FDA8-1_En.htm

Government of Canada, Indoor Air Quality information resources:

Web: http://chp-pcs.gc.ca/CHP/index_e.jsp/pageid/4005/odp/Top/ Health/Environmental_Health/Air_Quality/Indoor_Air_Quality

Government of Canada (2005) Public Works and Government Services, Office of Greening Government Operations, Fungal Contamination Guidelines, Interpreting the Analysis, http://www.pwgsc.gc.ca/greening/files/fungal-e.pdf (June 2000, revised April 2005)

Alternative: http://www.pwgsc.gc.ca/greening/text/publications/fungal-e.html

Health Canada

Health Canada, Indoor Air Quality
Web: http://www.hc-sc.gc.ca/ewh-semt/air/in/index_e.html
Publications on air quality: http: //www.hc-sc.gc.ca/ewh-semt/pubs/ air/index_e.html

Health Canada 1987 (revised 1989, 1995). Exposure guidelines for residential indoor air.

28 pp.
Web: http://www.hc-sc.gc.ca/ewhsemt/alt_formats/hecs-sesc/pdf/pubs/air/exposure-exposition/exposureexposition_e.pdf

Health Canada 1993. Indoor Air Quality in Office Buildings: A Technical Guide, Health Canada

Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/air/office_building-immeubles_bureaux/index_e.html

Health Canada 1995. Fungal Contamination in Public Buildings: A Guide to Recognition and Management, Health Canada.

Web: http://www.sporometrics.com/fpwgmaqpb001.pdf

Health Canada 2001. Construction Related Nosocomial Infections in Patients in Health Care Facilities, Public Health Agency of Canada

Web: http://www.phac-aspc.gc.ca/publicat/ccdr-rmtc/01vol27/27s2/index.html

Health Canada 2001. National Strategy for Mold Response (Environmental Health Officer Protocol Manual, 2001)

Health Canada 2003. Indoor Air Quality – Tools for Schools Action Kit For Canadian Schools-Health Canada.

Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/air/tools_school-outils_ecoles/index_e.html

Health Canada 2004. Fungal Contamination in Public Buildings: Health Effects and Investigation Methods

Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/air/fungal-fongique/index_e.html

Health Canada 2006. Residential Indoor Air Quality Guideline: Formaldehyde. 3 pp.

Web: http://www.hc-sc.gc.ca/ewhsemt/alt_formats/hecs-sesc/pdf/pubs/air/formaldehyde_e.pdf

Health Canada 2007. CEPA Annex – Residential Indoor Air Quality Guideline for Mould

Web: http://www.ec.gc.ca/CEPARegistry/notices/NoticeText.cfm?intNotice=400&intDocument=2692

Healthy Indoor Air Partnership, Canada

Web: http://www.healthyindoors.com/english/home/home.htm

Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRSST)

Quebec, Canada

Web: http://www.irsst.qc.ca/en/home.html
It is a private, non-profit scientific research organization known for the quality of its work and the expertise of its personnel. The board of directors consist of an equal number of trade union and employers' representatives, making it a joint body. The Commission de la santé et de la sécurité du travail (CSST) provides most of the Institute's funding from the contributions it collects from employers.
IRSST 1994. Guide for the Prevention of Microbial Growth in Ventilation Systems, IRSST Quebec
Web: http://www.irsst.qc.ca/files/documents/PubIRSST/RG-089.pdf

National Research Council (NRC), Canada

Indoor Environment Program
Web: http://irc.nrc-cnrc.gc.ca/ie/index_e.html
Program Director: Dr. Morad Atif
Indoor Environment Program
Institute for Research in Construction
National Research Council of Canada
Ottawa, Ontario K1A 0R6
Tel.: (613) 993-9580
Fax.: (613) 954-3733
E-mail: IE.EI@nrc-cnrc.gc.ca

Relevant indoor air publications and information resources:
A Comprehensive VOC emission database for commonly-used building materials.
D Won, Magee RJ, Lusztyk E, et al
Institute for Research in Construction, National Research Council, Ottawa, Ontario, Canada
Web: http://irc.nrc-cnrc.gc.ca/pubs/fulltext/nrcc46265/nrcc46265.pdf
(A version of this document is published in: Proceedings of the 7th International Conference of Healthy Buildings, 7-11 Dec. 2003, pp. 1-6)
Material emission database for 90 target VOCs (Report #: NRCC-48314)
Authors: Won D, Magee RJ, Yang W, et al
Date: December 1, 2005
(A version of the document was presented at: Indoor Air 2005, The 10th International Conference on Indoor Air Quality and Climate, Beijing, China, Sept. 4-9, 2005, pp. 1-6
Web: http://irc.nrc-cnrc.gc.ca/pubs/fulltext/nrcc48314/nrcc48314.pdf)

USA

ACOEM 2002. Adverse Human Health Effects Associated with Molds in the Indoor Environment - Evidence-based Statement from American College of Occupational and Environmental Medicine, USA http://www.acoem.org/guidelines.aspx?id=850

American Industrial Hygiene Association (AIHA)

Web: http://www.aiha.org

ASHRAE American Society For Heating, Refrigerating, and Air Conditioning Engineers

Web: http://www.ashrae.org

- ASHRAE 62-2004 - Ventilation for Acceptable Indoor Air Quality
- ASHRAE Standard 55-2004, Thermal Environmental Conditions for Human Occupancy

California Indoor Air Quality Program

Web: http://www.cal-iaq.org/

California Air Resources Board (ARB) Indoor Air Quality and Personal Exposure Assessment Program http://www.arb.ca.gov/research/indoor/indoor.htm

New York City Department of Health & Mental Hygiene. Guidelines on Assessment and Remediation of Fungi in Indoor Environments, 2002. Bureau of Environmental & Occupational Disease Epidemiology

Web: http://www.nyc.gov/html/doh/html/epi/moldrpt1.html

University of Connecticut, 2004. Guidance for Clinicians on the Recognition and Management of Health Effects Related to Mold Exposure and Moisture Indoors, 2004 (University of Connecticut Health Centre, USA)

PCIA Partnership for Clean Indoor Air (PCIA)

Contact Information:
Brenda Doroski
U.S. Environmental Protection Agency
Washington, D.C.
Tel: 202-343-9764
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E-Mail: doroski.brenda@epa.gov
John Mitchell
U.S. Environmental Protection Agency
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Tel: 202-343-9031
Fax: 202-343-2393
E-Mail: mitchell.john@epa.gov
Elisa Derby
Winrock International
Boston, MA
Tel: 617-524-0466
Fax: 612-233-2394
E-Mail: ederby@winrock.org

Household Energy, Indoor Air. In addition to other resources, country indoor air quality overviews (e.g., Guatemala, India, South Africa, China, and Nepal) reports are available at http://www.pciaonline.org/resources.cfm

Finland

Finnish Building Code section D2: Indoor Climate and Ventilation of Buildings Regulations and Guidelines 2003. 41 pp.
Web: http://ww.ymparisto.fi/download.asp?contentid = 33667&lan = en

Finnish Society of Indoor Air Quality and Climate (FiSIAQ), 2001. Classification of Indoor Climate 2000; Target Values, Design Guidance and Product Requirements 40 pp.

Web: http://www.tervetalo.net/lataa/siy5-eng-part-1.pdf#search = %22classification%20of% 20indoor%20climate%202000%22

Germany

Indoor air hygiene
Web: http://www.umweltbundesamt.de/uba-info-daten-e/daten-e/health/indoor.htm

Umwelt Bundes Amt, 2005. Options for legal regulations concerning indoor pollution – Do we need a "TA Innenraum"? (9 pp)
Web: http://www.umweltbundesamt.de/uba-info-daten-e/daten-e/health/TAInnenraum_en.pdf

Japan

Ministry of Health, Labour and Welfare, Office of Chemical Safety/Pharmaceutical and Food
Safety Bureau, Committee on Sick House Syndrome: Indoor Air Pollution: Progress Report No.1 - Summary on the discussions from the 1st to 3rd meetings - 26 June 2000. 9 pp.
Web: http://www.nihs.go.jp/mhlw/chemical/situnai/kentoukai/rep-eng1.pdf
Ministry of Health, Labour and Welfare, Office of Chemical Safety/Pharmaceutical and Food
Safety Bureau, Committee on Sick House Syndrome: Indoor Air Pollution: Progress Report No. 3 - Summary on the discussions at the 6th and 7th meetings - 5 July 2001. 6 pp.
Web: http://www.nihs.go.jp/mhlw/chemical/situnai/kentoukai/rep-eng3.pdf
Japan Electronics and Information Technologies Industries Association (JEITA), 2006: VOC
Guidelines for Personal Computers (Ver. 1). 13 pp.
Web: http://it.jeita.or.jp/infosys/committee/environ/0601VOCguideline_en/0601VOCGuideline_final.pdf
Legislation in Japan (Chemicals)
Web: http://www.nihs.go.jp/law/elaw.html

Singapore

Singapore, 1996. Guidelines for good indoor air quality in office premises. 47 pp.
Web: http://www.nea.gov.sg/cms/qed/indoor_air.pdf

United Kingdom

COMEAP, 2004. Guidance on the Effects on Health of Indoor Air Pollutants. Committee on the Medical Effects of Air Pollutants, Department of Health, UK. 55 pp.
Web: http://www.advisorybodies.doh.gov.uk/comeap/PDFS/guidanceindoorairqualitydec04.pdf

Databases

The following list provides relevant air quality databases from USA, Europe, Canada and other countries.

AIRBASE

Web: http://air-climate.eionet.europa.eu/databases/airbase/

AirBase is a public air quality database system of the European Environmental Agency (EEA). In order to maintain this database, air quality monitoring information is submitted by the participating countries throughout Europe. It consists of multi-annual time series of air

quality measurement data and their statistics for a representative selection of stations and for a number of pollutants. Furthermore, it contains meta-information on the monitoring networks involved, their stations and their measurements. Geographically, it covers all the countries from the European Union, the EEA member countries and some EEA candidate countries. Based on the Council decision, 97/101/EC (a reciprocal Exchange of Information (EoI)), the EU member countries must report on ambient air quality. On the other hand, the EEA member countries either committed themselves to report to the EEA or develop the appropriate measuring and reporting protocol following EEA's EuroAirnet programme critiria. All data reported within EuroAirnet are also included in the database.

AirBase replaced the two EU databases APIS (Air Pollution Information System; air quality data) and GIRAFE (meta information on air quality networks and stations).

AirView is the web-application that provides a user interface for free data retrieval from this database. An user can also download the data as files as XML based exports from AirBase and access and modify the contents in XML compatible applications, such as web browsers and MS Excel (XP).

European Topic Centres (ETC) are centers of thematic expertise contracted by the European Environment Agency (EEA) to carry out specific tasks identified in the EEA strategy. The ETC on Air and Climate Change (ACC) assists the EEA in its support to EU policy in the field of air pollution and climate change. The ETC/ACC is a consortium of European institutes with MNP as its lead organization. Furthermore, the ETC/ACC reports on the progress of EU environmental policy on air quality, air emission and climate change issues. Additionally, it participates in European Environmental Outlook reports of the EEA. It collects data concerning the current state of the environment and further harmonizes European monitoring networks and reporting obligations.

airdata

Web: http://www.epa.gov/air/data/

The AirData Web site provides access to air pollution data for the United States of America (USA). For example, highest level of ozone that was measured in a particular state last year can be found by conducting a specific search. Further, locations of air pollution monitoring sites and sources of air pollution for each town are also provided. AirData has the capability of producing reports and maps of air pollution data based on specific search criteria provided by the user of the database. Further, AirData presents annual summaries of air pollution data from two EPA databases described below.

(i)*Air Quality System (AQS) database*

AQS provides air monitoring data, ambient concentrations of criteria and hazardous air pollutants at monitoring sites in cities and towns.

(ii) *National Emission Inventory (NEI) database*

NEI provides estimates of annual emissions of criteria and hazardous air pollutants from various types of sources. In 2002, the NEI database in replaced two other U.S. EPA emission databases for criteria air pollutants (**National Emission Trends, or NET**) and hazardous air pollutants (**National Toxics Inventory, or NTI**).

Air Quality Statistics (AQS) Database

Web: http://www.aeat.co.uk/netcen/airqual/statbase/dbasehome.html

The UK AQS Database contains options for the user to enter queries and retrieve statistical data related to the Air Quality in the UK from the present back to 1970. The national statistical tables are related to measured concentrations from the monitoring networks operated on behalf of the DEFRA, and also for estimates of air emissions. High professional standards are set out in the National Statistics Code of Practice. These data sets undergo rigorous quality assurance reviews to ensure that they meet research needs of various users. According to the website, they are produced free from any political interference. Contact the agency at aqinfo@aeat.co.uk for additional information.

Database of childhood acute respiratory infections in developing countries

Web: http://www.who.int/indoorair/health_impacts/databases_ari/en/index.html

In 2002, WHO Department of Child and Adolescent Health and Development developed a literature review database of published studies on acute respiratory infections. It contains information abstracted from a total of 220 reviewed papers. No calculations or standardizations were carried out for these datasets. Users are cautioned to refer to the detailed description of the database, which contains information on structure, variables and limitations.

Health Effects Institute (HEI) Air Quality Database

Web: http://hei.aer.com/login.php

The HEI Air Quality Database has been prepared and maintained by Atmospheric and Environmental Research (AER) Inc. It focuses on PM2.5 components and gaseous pollutants at and near sites in the U.S. EPA's PM2.5 Chemical Speciation Trends Network

(STN) and State, Local and Tribal air monitoring stations (SLAMS). It was originally prepared and made available in association with HEI's Request for Applications 05-1 (Studies to Compare Components and Characteristics of Particulate Matter Associated with Health Effects), which was issued in the summer of 2005. The Database is now available to researchers and investigators interested in using the information for research studies on air quality and health. The Database contains information on speciated PM components and gaseous pollutants at these sites for the years 2000-2006. Generally, information is updated regularly within 2-3 years. Users can access the database by setting up a user account with Dr. Betty Pun at AER (bpun@aer.com). Contact Dr. Pun with Questions about information in the Database. Contact Dr. Geoffrey Sunshine at (gsunshine@healtheffects.org) on Questions about RFA 05-1.

Indoor air pollution database for China

Web: http://www.who.int/indoorair/health_impacts/databases_china/en/index.html

WHO compiled a database of indoor measurements in 1994 to help provide access to databases and information on levels of various air pollutants in both urban and rural residences in China. More than 110 publications (1980–1994), are cited in this database that is organized by Pollutant (i.e., particulates, sulphur dioxide, carbon monoxide, nitrogen oxides and benzo[a]pyrene); Fuel type (coal, gas, biomass) and Location (urban, rural). The full report has an introduction to the database tables and conclusions about the overall pattern of indoor air pollution in China. The full report can be accessed at: http://whqlibdoc.who.int/hq/1995/WHO_EHG_95.8.pdf Excel spreadsheets for the main database tables are available at the UC Berkeley web site: http://ehs.sph.berkeley.edu/hem/page.asp?id = 32.

USEPA Source Ranking Database (SRD)

Web: http://www.epa.gov/oppt/exposure/pubs/srd.htm

SRD performs a systematic screening review of over 12,000 potential indoor pollution sources and identifies high-priority product and material categories for further evaluation. This database can also identify the products that have contained a specific chemical. Users can download SRD from the website.

World Health Organization Indoor air databases

Global indoor air pollution database
Web: http://www.who.int/indoorair/health_impacts/databases_iap/en/index.html

This Access database on global indoor air pollution was developed by researchers at the University of California at Berkeley to provide measured household indoor air pollution levels in approximately 250 communities around the world. Users of the databases and researchers can review and analyze findings within and across studies, and can either query the database directly or export the files into a statistical programme for in-depth analysis.

CHAPTER

25

Environmental Toxicology: Hazardous Waste

C.C. BARTON, AND S.C. SCHMITZ

INTRODUCTION

Human exposure to hazardous wastes is due to exposure to ground and surface water; soil, sludges, and dust; and indoor and outdoor air that contain elevated levels of hazardous chemicals. Hazardous waste can be the by-products of manufacturing processes or discarded commercial products. Hazardous waste can be specifically defined and listed in U.S. Environmental Protection Agency regulations or can be wastes that exhibit at least one of four characteristics – ignitability, corrosivity, reactivity, or toxicity.

The following is a list of resources on toxicology and the exposure to hazardous waste in the environment. Included in the resources are books, journals, journal articles, organizations, and databases that discuss the following topics:

- Basic chemistry and biochemistry
- Toxicological effects of specific chemicals
- Fat and transport of hazardous materials in the environment
- Metabolism of hazardous chemicals
- Exposure assessment
- Controlling risks from exposure to hazardous wastes
- Case studies of exposure to hazardous wastes
- Regulation of hazardous wastes and environmental law
- Treatment, storage, and disposal of hazardous wastes
- Site clean-up of hazardous waste
- Pollution prevention and recycling of hazardous waste
- Health and safety and personal protection equipment.

RESOURCES

Books

Andrews LP (Ed.) (1990)
Hazardous Waste and Public Health: International Congress on the Health Effects of Hazardous Waste
Princeton Scientific, Princeton, NJ

Collection of over 100 papers and 90 poster presentations from an international congress. The material is divided into the following main sections: hazardous wastes and public health approaches, policy and ethics, international programs, the role of communities, environmental exposure assessment, biomarkers, hazard assessment and risk estimation, health effects, and information services.

Applegate JS, Laitos JG (2005)
Environmental Law – RCRA, CERCLA, and the Management of Hazardous Waste
Foundation Press, New York, NY

This book surveys, organizes, and explains the most important provisions of RCRA and CERCLA while providing relevant background. This publication goes beyond other publications by emphasizing the scientific, policy, and legal issues that make hazardous waste management a difficult and complex problem for Congress, EPA, and practicing lawyers.

Bilitewski B, Hardtle G, Marek K (1996)
Worker Protection during Hazardous Waste Remediation
Van Nostrand–Reinhold, New York

Addresses specific problems and provides solutions for the practices needed to maintain a safe work environment and maintain compliance with SARA and the applicable OSHA standards. Covers employee/employer responsibilities, hazard recognition, engineering and personal protective equipment recommendations, and safety plans.

Chalmers G (1997)
Hazardous Waste and Human Health
Oxford University Press, Oxford

Considers health issues related to hazardous waste as well as prevention and control.

Johnson BL, Andrews JS, Xintaras C, Mehlman MA (Eds.) (1997)
Standard Handbook of Hazardous Waste Treatment and Disposal, 2nd edition
McGraw-Hill, New York

Provides information and data relevant for hazardous waste management, site clean-up, and alternative treatment. Topics covered include laws and regulations, hazardous waste characteristics and issues, special categories of hazardous wastes, pollution prevention, and recycling.

King RB, Long GM, Sheldon JK (1997)
Practical Environmental Bioremediation: The Field Guide, Second Edition
CRC Press, Boca Raton, FL

The Field Guide presents updated material, case histories, and many instructive illustrations to reflect the evolving image of this fast-emerging industry. Bioremediation technology has witnessed great strides towards simplifying treatability formats, finding new approaches to field application, more potent nutrient formulations, monitoring protocols and the resulting general improvement in results. This new guide condenses all currently available knowledge and presents necessary technical aspects and concepts in language that can be readily comprehended by the technical student, experienced scientist or engineer, the aspiring newcomer, or anyone else interested in this exciting natural cleanup technique.

King RB, et al (1998)
Hazardous Waste: Toxicology and Health Effects
Stockton Press, New York

Volume 25 in the series, *Advances in Modern Environmental Toxicology*. Papers of significant ongoing research and policy development generated under the Superfund statute.

Lunn G, Sansone EB (1994)
Biological Treatment of Hazardous Wastes
Wiley, New York

Provides engineers, scientists, and technical personnel with a conceptual framework to develop effective treatments adaptable to any hazardous waste scenario they may encounter.

Manahan SH (1990)
Hazardous Waste Chemistry, Toxicology, and Treatment
Lewis Publishers, Chelsea, MI

Designed in a compact form, it is an easy-to-understand book on the chemistry and toxicology of hazardous substances and wastes. It begins with a basic coverage of chemistry and biochemistry, environmental chemical processes, and toxicology. Detailed chapters discuss the chemistry and toxicology of inorganic and organic hazardous substances and biohazards. The fully documented text explains procedures for eliminating, detoxifying, and disposing of hazardous wastes with continual reference to their basic chemistry and toxicology.

Maslansky SP, Maslansky CJ (1997)
Destruction of Hazardous Chemicals in the Laboratory, 2nd edition
Wiley, New York

Collection of detailed procedures that can be used to degrade and dispose of a wide variety of hazardous chemicals. The procedures are applicable to the amounts generally found in the chemical laboratory. This edition also expands the scope to bulk quantities and is aimed so that laboratory technicians can perform the procedures safely.

Maughan JT (1996)
Health and Safety at Hazardous Waste Sites: An Investigator's and Remediator's Guide to HAZWOPER
Van Nostrand–Reinhold, New York

Covers hazard recognition, toxicology, respiratory protection, air monitoring, personal protective equipment, site control, health and safety programs, contingency planning, and confined space entry. The appendices provide a generic emergency response plan, a generic health and safety plan, and excerpts from applicable federal laws on hazardous waste operations and emergency response, permitting required for confined space entry, and excavations.

Moore EB (2000)
An Introduction to the Management and Regulation of Hazardous Waste
Battelle Press, Columbus, OH

This text is a cursory overview of hazardous wastes and their management from both a technical and a regulatory perspective. The content of the text is based upon two major federal laws that regulate hazardous wastes: the Resource Conservation and Recovery Act (RCRA), which regulates newly generated hazardous wastes, and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), which regulates abandoned or uncontrolled hazardous waste sites.

National Research Council. Committee on the Health Effects of Waste Incineration (1999)
Ecological Assessment of Hazardous Waste Sites
Van Nostrand-Reinhold, New York

Examines the overall approach to risk assessments as well as techniques for evaluating prominent aspects of ecological assessments. The main areas include terrestrial pathways of contaminants, sediment quality and contamination, and toxicity testing. Case studies involving ecological problems are presented.

Payne SM (1998)
Waste Incineration and Public Health
National Academy Press, Washington, DC

Provides details on processes involved in incineration and how contaminants are released, environmental dynamics of contaminants and routes of human exposure, and tools and approaches for assessing human health effects.

Sellers K (1998)
Strategies for Accelerating Cleanup at Toxic Waste Sites
Lewis, Boca Raton, FL

Provides practical methods to accelerate cleanup and decision-making. Tables list remedial and investigative technologies.

Travis CC, Cook SC (1989)
Fundamentals of Hazardous Waste Site Remediation
Lewis, Boca Raton, FL

Discusses the basics of hazardous materials chemistry, hydrogeology, reaction engineering, and cleanup-level development.

Turnberg WL (1996)
Hazardous Waste Incineration and Human Health
CRC Press, Boca Raton, FL

Examines topics such as composition of hazardous waste, incineration technology, risk assessment methodology, health risk assessment for organics and metals, and food chain analysis.

Wagner TP (1998)
Biohazardous Waste: Risk Assessment, Policy, and Management
Wiley, New York

Covers all important areas of biohazardous waste management, including regulation, collection, and disposal, with a section on health hazard assessment.

Waxman MF (Ed.) (1996)
The Complete Guide to the Hazardous Waste Regulations, 3rd edition
Wiley, New York

A new edition of an essential reference containing up-to-date information on changes made to the hazardous waste and hazardous materials program since 1991. Clarifies all RCRA, TSCA, HMTA, OSHA, and Superfund rules. Includes a summary of state-specific hazardous waste requirements.

Woodside G (1999)
Hazardous Materials and Hazardous Waste Management, 2nd Edition
Wiley, New York

For the professional faced with making sense of the reams of governmental regulations surrounding waste handling and disposal from the EPA, OSHA, and the Nuclear Regulatory Commission, untangling the legal jargon can be as challenging as managing these materials and wastes. Explaining how these complex regulations interrelate and when they apply, the first edition of *Hazardous Materials and Hazardous Waste Management* became an instant reference staple – offering practical, comprehensive guidance on current definitions of hazardous wastes and materials as well as their use, management, treatment, storage, and disposal.

Woodside G (1999)
Hazardous Waste Site Operations: A Training Manual for Site Professionals
Wiley, New York

Brings together information from available resources to those individuals involved in hazardous waste remediation or the generation of hazardous waste. The manual can be used either as the prime reference in conducting mandated training or to supplement lectures and training. The book provides a broad overview of the possible hazards encountered with hazardous wastes and how workers can properly protect themselves and conduct their work.

Journals

Journal of Hazardous Materials (1976–)
Elsevier, Amsterdam, London, New York
Web: http://www.elsevier.com/wps/find/journaldescription.cws_home/502691/description# description

The *Journal of Hazardous Materials* publishes full-length research papers, reviews, project reports, case studies, and short communications which improve our understanding of the hazards and risks certain materials pose to people and the environment or deal with ways of controlling the hazards and associated risks.

Waste Age
Prism Business Media, Inc.
Web: http://wasteage.com

Waste Age serves private contracting firms, governmental entities, consulting engineers, industrial plants, retailing firms, and hospitals, as well as equipment dealers, distributors, manufacturers, and other allied to the field. Every issue is devoted to bringing industry professionals the most comprehensive and up-to-date news and information.

Environmental Health Perspectives
National Institute of Environmental Health Sciences
Web: http://www.ehponline.org/

Environmental Health Perspectives (EHP) is a monthly journal of peer-reviewed research and news on the impact of the environment on human health. EHP's mission is to serve as a forum for the discussion of the interrelationships between the environment and human health by publishing in a balanced and objective manner the best peer-reviewed research and most current and credible news of the field.

Practice Periodical of Hazardous, Toxic, and Radioactive Waste Management
American Society of Civil Engineers
Web: http://www.pubs.asce.org/journals/hz.html

The *Practice Periodical of Hazardous, Toxic, and Radioactive Waste Management* publishes articles relating to the allied engineering and scientific disciplines involved in the environmental aspects of the management of hazardous, toxic, and radioactive waste. These include the traditional areas of investigation, design, and construction and the related areas of planning, analysis, oversight, operations, regulations, and policy. This publication offers articles about practical approaches and solutions as well as application-oriented research to the problems and challenges faced by practicing engineers, scientists, and government policymakers.

Journal of the Institute of Environmental Sciences and Technology
Institute of Environmental Sciences and Technology
Web: http://www.iest.org/journal/journal.htm

The *Journal of the Institute of Environmental Sciences and Technology* is an official publication of the Institute of Environmental Sciences and Technology (IEST) and is of archival quality and non-commercial in nature, established to advance knowledge through technical articles selected by peer review, and published as a benefit to IEST members and the technical community at large and as a permanent record of progress in the science and technology of the environmental sciences.

Journal of the Air and Waste Management Association (1951–)
Air and Waste Management Association
Web: http://www.awma.org/journal/

The *Journal of the Air and Waste Management Association* is one of the oldest continuously published, peer-reviewed, technical environmental journals in the world. It is intended to serve those occupationally involved in air pollution control and waste management through the publication of timely and reliable information.

Environmental Progress
American Institute of Chemical Engineers
Web: http://www.aiche.org/Publications/EnvironmentalProgress/index.aspx

Environmental Progress, a quarterly publication of the American Institute of Chemical Engineers, reports technological advances vital to engineering professionals whose responsibility includes or is related to environmental issues. It also covers such critical issues as abatement, control, containment of effluents and emissions, and various environmental compliance standards.

Journal of Exposure Science and Environmental Epidemiology
Nature Publishing Group, London, New York
Web: http://www.nature.com/jes/index.html

Journal of Exposure Science and Environmental Epidemiology is a peer-reviewed publication that publishes research important to exposure assessment for toxic substances, environmental epidemiology that includes a strong exposure analysis component and related disciplines that advance the exposure assessment process.

Environmental Science and Technology
American Chemical Society, Washington, DC
Web: http://pubs.acs.org/journals/esthag/index.html

Published twice monthly, *Environmental Science and Technology* is a unique source of information for scientific

and technical professionals in a wide range of environmental disciplines. In its research section, contributed material may appear as current research papers, policy analyses, or critical reviews. Also included is a magazine section called the A-Pages that provide authoritative news and analysis of the major developments, events, and challenges shaping the field.

Journal Articles

Baird N, Cook E, Perry W (1996) Evaluating surface contamination at hazardous waste sites. Occup. Health Safety 65: 47–50.

Cha DK, Sarr D, Chiu PC, Kim DW (1998) Hazardous waste treatment technologies. Water Environ. Res. 70(4): 705–720.

Cole BL, Shatkin JP, Delp L, et al (1994) A cross-sectional survey of workers and their training needs at 29 hazardous waste sites. Appl. Occup. Environ. Hygiene 9: 605–611.

Cortinas de Nava C (1996) Worldwide overview of hazardous waste. Toxicol. Ind. Health 12(2): 127–138.

De Rosa CT, Johnson BL, Fay M, et al (1996) Public health implications of hazardous waste sites: Findings, assessment and research. Food Chem. Toxicol. 34(11/12): 1131–1138.

Faroon OM, Williams M, O'Connor R (1994) A review of the carcinogenicity of chemicals most frequently found at National Priorities List sites. Toxicol. Ind. Health 10(3): 203–230.

Fay RM, Mumtaz MM (1996) Development of a priority list of chemical mixtures occurring at 1188 hazardous waste sites, using the HazDat database. Food Chem. Toxicol. 34(11/12): 1163–1165.

Gochfeld M (1995) Incineration: Health and environmental consequences. Mount Sinai J. Med. 62: 365–374.

Hjelmar O (1996) Disposal strategies for municipal solid waste incineration residues. J. Hazard. Mat. 47: 345–368.

Indulski JA, Lutz W (1995) Biomarkers used for the assessment of health hazards in populations living in the vicinity of communal and industrial waste dump sites. Int. J. Occup. Med. Environ. Health 8: 11–16.

Itavaara M, Vikman M (1996) An overview of methods for biodegradability testing of biopolymers and packaging materials. J. Environmental Polymer Degradation 4: 29–36.

Johnson BL (1995) Nature, extent, and impact of Superfund hazardous waste sites. Chemosphere 31: 2415–2428.

Johnson BL, DeRosa CT (1995) Chemical mixtures released from hazardous waste sites: Implications for health risk assessment. Toxicology 105: 145–156.

Johnson BL, De Rose C (1997) The toxicologic hazard of superfund hazardous-waste sites. Rev. Environ. Health 12: 235–251.

Johnson BL, Xintaras C, Andrews JS, Jr (1997) Proceedings of the 2nd International Congress on Hazardous Waste: Impacts on Human and Ecological Health. Toxicol. Ind. Health 13: 105–404.

Klopman G, Zhang Z, Woodgate SD, et al (1995) The structure–toxicity relationship challenge at hazardous waste sites. Chemosphere 31: 2511–2519.

Pleus RC, Kelly KE (1996) Health effects from hazardous waste incineration facilities: Five case studies. Toxicol. Ind. Health 12(2): 277–287.

Millano EF (1998) Hazardous waste storage disposal remediation and closure. Water Environ. Res. 70(4): 721–745.

Wei M-S, Weber F (1996) An expert system for waste management. J. Environ. Management, 46: 345–358.

Monosson E (2005) Chemical mixtures: Considering the evolution of toxicology and chemical assessment. Environ. Health Perspect. 113: 383–390.

Organizations

Agency for Toxic Substances and Disease Registry
1825 Century Blvd.
Atlanta, GA 30345
Phone: 800-232-4636
Web: http://www.atsdr.cdc.gov

The mission of the Agency for Toxic Substances and Disease Registry (ATSDR), as an agency of the U.S Department of Health and Human Services, is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and disease related to toxic substances. ATSDR produces 'toxicological profiles' for hazardous substances found at National Priorities List (NPL) sites. These hazardous substances are ranked based on frequency of occurrence at NPL sites, toxicity, and potential for human exposure. Toxicological profiles are developed from a priority list of 275 substances. ATSDR also prepares toxicological profiles for the Department of Defense (DOD) and the Department of Energy (DOE) on substances related to federal sites. A website has been dedicated to Hazardous waste sites in the USA (http://www.atsdr.cdc.gov/2p-hazardous-waste-sites.html).

American Council on Science and Health
1995 Broadway
Second Floor
New York, NY 10023-5860
Phone: 212-362-7044
Fax: 212-362-4919
E-mail: acsh@acsh.org
Web: http://www.acsh.org

The American Council on Science and Health (ACSH) is a consumer education consortium concerned with issues related to food, nutrition, chemicals, pharmaceuticals, lifestyle, the environment and health. ACSH is an independent, nonprofit, tax-exempt organization. The nucleus of ACSH is a board of 350 physicians, scientists and policy advisors – experts in a wide variety of fields – who review the Council's reports and participate in ACSH seminars, press conferences, media communications, and other educational activities.

Occupational Safety and Health Administration (OSHA)
200 Constitution Avenue
Washington, D.C. 20210
Phone: 800-321-6742
Web: http://www.osha.gov/SLTC/hazardouswaste/index.html

OSHA's mission is to assure the safety and health of America's workers by setting and enforcing standards; providing training, outreach, and education; establishing partnerships; and encouraging continual improvement in workplace safety and health. OSHA and its state partners have approximately 2100 inspectors, plus complaint discrimination investigators, engineers, physicians, educators, standards writers, and other technical and support personnel spread over more than 200 offices throughout the country. This staff establishes protective standards, enforces those standards, and reaches out to employers and employees through technical assistance and consultation programs.

U.S. Environmental Protection Agency Office of Solid Waste and Emergency Response
1200 Pennsylvania Avenue, N.W.
Washington, DC 20460
Phone: 800-424-9346
Web: http://www.epa.gov/oswer/index.htm

The Office of Solid Waste and Emergency Response provides policy, guidance, and direction for EPA's solid waste and emergency response programs. They develop guidelines for the land disposal of hazardous waste and underground storage tanks. They provide technical assistance to all levels of government to establish safe practices in waste management. They administer the Brownfields program which supports state and local governments in redeveloping and reusing potentially contaminated sites. They also manage the Superfund program to respond to abandoned and active hazardous waste sites and accidental oil and chemical releases as well as encourage innovative technologies to address contaminated soil and groundwater.

Databases

Integrated Risk Information System (IRIS)
U.S. Environmental Protection Agency
Web: http://www.epa.gov/iris/index.html

The Integrated Risk Information System (IRIS), prepared and maintained by the U.S. Environmental Protection Agency (U.S. EPA), is an electronic database containing information on human health effects that may result from exposure to various chemicals in the environment. IRIS was initially developed for EPA staff in response to a growing demand for consistent information on chemical substances for use in risk assessments, decision-making, and regulatory activities. The information in IRIS is intended for those without extensive training in toxicology, but with some knowledge of health sciences.

The heart of the IRIS system is its collection of computer files covering individual chemicals. These chemical files contain descriptive and quantitative information in the following categories:

- Oral reference doses and inhalation reference concentrations (RfDs and RfCs, respectively) for chronic non-carcinogenic health effects.
- Hazard identification, oral slope factors, and oral and inhalation unit risks for carcinogenic effects.

International Toxicity Estimates for Risk Database (ITER)
Toxicology Excellence for Risk Assessment
Web: http://www.tera.org/ITER/

ITER is a free Internet database of human health risk values and cancer classifications for over 600 chemicals of environmental concern from multiple organizations worldwide. It presents risk data in a tabular format for easy comparison, along with a synopsis explaining differences in data and a link to each organization for more information.

Risk Assessment Information System
US Department of Energy

Web: http://rais.ornl.gov/

Database of toxicity values and information used to disseminate risk tools and supply information for risk assessment activities.

Toxicological Data Network (TOXNET)

US National Library of Medicine
Web: http://toxnet.nlm.nih.gov/

A central clearinghouse for 14 separate databases on toxicology, hazardous chemicals, environmental health, and toxic releases.

CHAPTER

26

Environmental Toxicology: Terrestrial

C.C. BARTON, AND S.C. SCHMITZ

INTRODUCTION

Exposure to hazardous chemicals in soil and sediments can occur in animal species that live or spend a significant amount of time in terrestrial environments and in humans through dermal exposure and incidental ingestion of soil and sediments.

Dermal and incidental exposure in humans generally represents a small percentage of the total potential exposure to chemicals in the environment. The majority of the exposure to hazardous chemicals in the environment comes from exposure to drinking water and to air that contains higher levels of environmental contamination. An exception to this occurs in some younger children who exhibit pica behavior which is an abnormal appetite for non-food substances such as soil. This type of eating disorder can sometimes result in serious health problems such as lead poisoning.

The following is a list of resources on toxicology and the exposure to hazardous chemicals in the terrestrial environment. Included in the resources are books, journals, journal articles, and organizations that discuss the following topics:

- Soil chemistry
- Cleanup of contaminated soil and sediments
- Assessment of hazards and risk of exposure to soil contaminants
- Toxicity to soil invertebrates
- Impacts of pesticides on soil toxicity
- Fate and transport of chemicals in soils and sediments
- Case studies of exposure to chemicals in soils and sediments.

RESOURCES

Books

Buonicore AJ (Ed.) (1996)
Cleanup Criteria for Contaminated Soil and Groundwater, 2nd edition
ASTM Press, Philadelphia.

Book and diskette summarize cleanup criteria developed by the U.S. EPA under various legislative mandates.

Spark Donald L (2003)
Environmental Soil Chemistry
Academic Press, New York

Illustrates fundamental principles of soil chemistry with respect to environmental reactions between soils and other natural materials and heavy metals, pesticides, industrial contaminants, acid rain, and salts. Timely and comprehensive discussions of applications to real-world environmental concerns.

European Chemical Industry Ecology and Toxicology Centre (ECETOC) (1990)
Technical Report No. 40: Hazard Assessment of Chemical Contaminants in Soil
ECETOC, Brussels

Describes the hazard assessment process for soil contaminants. Also evaluates the significance of the presence of contaminants in the environment.

Hoffman D, et al (Eds.) (1995)
Handbook of Ecotoxicology Soil, Climatic, and Biological Constraints
CRC Press LLC, Boca Raton, FL

Focuses on toxic substances and how they affect ecosystems worldwide. Presents methods for quantifying

and measuring ecotoxicological effects in the field and in the lab, as well as methods for estimating, predicting, and modeling in ecotoxicology studies.

Ingersoll CG, Dillon T, Biddinger GR (Eds.) (1997)
Ecological Risk Assessments of Contaminated Sediments
SETAC, Pensacola, FL

Presents a critical evaluation of existing approaches to determining the risk of contaminated sediments. The text identifies principles and practices for this task designed to improve the process. The text pinpoints critical applications, such as product assessment, navigational dredging, and site cleanup, and pertinent issues such as ecological relevance and methodological uncertainty.

Lokke H, Van Gestel AM (1998)
Handbook of Soil Invertebrate Toxicity Tests
Wiley, New York

A comprehensive user guide to toxicity testing which provides readily accessible information on the results of terrestrial invertebrate testing. Presents guidelines for the application of new test systems for soil ecotoxicity testing.

Sheppard S, Bembridge J (Eds.) (1998)
Advances in Earthworm Ecotoxicology
SETAC, Pensacola, FL

Subject areas covered include bioavailability and internal load, the use of modeling to estimate long-term implications of impacts of toxic compounds on individuals for population survival, and other developments in earthworm research.

Tarradellas J, et al (Eds.) (1997)
Soil Ecotoxicology
CRC Lewis, Boca Raton, FL

Discusses the sources, fate, and transport of hazardous chemicals in soils. The fate (biodegradation and modeling) and the potential impacts of pesticides on soil ecosystems are emphasized, and methodologies for performing toxicity assessments are provided.

van Straalen NM, Krivolutsky DA (Eds.) (1996)
Bioindicator Systems for Soil Pollution
Kluwer, Dordrecht

Presents new approaches to the development of bioindication systems for the soil environment. The emphasis is on the use of inetebrates, as part of the soil life-support system. Discusses general ecotoxicological approaches, community and systems approaches, and various case studies in Eastern and Western Europe and the United States.

Yaron B, et al (1996)
Soil Pollution: Processes and Dynamics
Springer, Berlin

Investigates the properties of the interacting materials, pollutant partitioning between the soil phases, pollutant behavior in soils affected by environmental factors, and the principles to be considered in defining pollutant behavior.

Journals

Archives of Environmental Contamination and Toxicology
Springer, New York
Web: http://www.springeronline.com/journal/244

Archives of Environmental Contamination and Toxicology is a repository of significant, full-length articles describing original experimental or theoretical research work pertaining to the scientific aspects of contaminants in the environment. It provides a place for the publication of detailed, definitive, complete, credible reports concerning advances and discoveries in the fields of air, water, and soil contamination and pollution, human health aspects, and in disciplines concerned with the introduction, presence, and effects of deleterious substances in the total environment.

Environmental Toxicology
Wiley Periodicals, Inc., New Jersey
Web: http://www.interscience.wiley.com/jpages/1520-4081

The journal publishes in the areas of toxicity and toxicology of environmental pollutants in air, dust, sediment, soil, and water, and natural toxins in the environment.

Soil and Sediment Contamination
Taylor and Francis, Philadelphia, PA
Web: http://www.tandf.co.uk/journals/titles/15320383.asp

A bimonthly, internationally peer-reviewed publication; focuses on soil and sediment contamination from sludges, petroleum, petrochemicals, chlorinated hydrocarbons, pesticides, lead and other heavy metals.

Water, Air, and Soil Pollution
Springer, Netherlands
Web: http://www.springeronline.com/journal/11270

An international, interdisciplinary journal on all aspects of pollution and solutions to pollution in the biosphere. This includes chemical, physical, and biological processes affecting flora, fauna, water, air, and soil in relation to environmental pollution.

Journal Articles

Barnthouse LW (1995) Effects of ionizing radiation on terrestrial plants and animals: A workshop report. NTIS/DE96003937.

Bierkens J (1998) Comparative sensitivity of 20 bioassays for soil quality. Chemosphere 37: 2935–2947.

Farrell EP (1995) Atmospheric deposition in maritime environments and its impact on terrestrial ecosystems. Water Air Soil Pollut. 85: 123–130.

Grandjean P, et al (1995) Biomarkers in environmental toxicology state of the art. Clin. Chem 41: 1902–1904.

Kuylenstierna JCI, et al (1995) Terrestrial ecosystem sensitivity to acidic deposition in developing countries. Water Air Soil Pollut. 85: 2319–2324.

Lebourg A, et al (1996) Suitability of chemical extraction to assess risks of toxicity induced by soil trace metal bioavailability. Agronomie (Paris) 16(4): 201–215.

Li QQ, et al (2006) Persistent organic pollutants and adverse effects in humans. J. Tox. Environ. Health, 69: 1987–2005.

Liebl B, et al (1995) Toxicological evaluation of pollutants in soil – Concept of the AGU* and assessment of tolerable concentrations for metals. Arch. Toxicol. Suppl. 17: 446–452.

Oliver MA (1997) Soil and human health: A review. Eur. J. Soil Sci. 48(4): 573–592.

Overcash M (1996) European soil remediation research: 1992–1994. Crit. Rev. Environ. Sci. Technol. 26: 337–368.

Rangan U, et al (1997) Exposure and risk assessment with respect to contaminated soil: significance of biomarkers and bioavailability. Inter. J. Tox. 16: 419–432.

Samsoe-Petersen L, Pedersen F (1995) Development of guidance for terrestrial effects assessment. Arch. Toxicol. Suppl. 17: 406–419.

Suedel BC, et al (1996) Formulated sediment as a reference and dilution sediment in definitive toxicity tests. Arch. Environ. Contami. Toxicol. 30: 47–52.

Van Beelen P, Doelman P (1997) Significance and application of microbial toxicity tests in assessing ecotoxicological risks of contaminants in soil and sediment. Chemosphere 34(3): 455–499.

Will ME, Suter GW (1996) (Department of Energy) Toxicological benchmarks for potential contaminants of concern for effects on soil and litter invertebrates and heterotrophic process. NTIS/DE96007745.

Organizations

The Association for Environmental Health and Sciences
150 Fearing Street
Amherst, MA 01002
Phone: 413-549-5170
Fax: 413-549-0579
E-mail: paul@aehs.com
Web: http://www.aehs.com

The Association for Environmental Health and Sciences (AEHS) was created to facilitate communication and foster cooperation among professionals concerned with the challenge of soil protection and cleanup. AEHS members represent the many disciplines involved in making decisions and solving problems affecting soils, including chemistry, geology, hydrogeology, law, engineering, modeling, toxicology, regulatory science, public health, and public policy.

Databases

ARAMS™
ARAMS accesses various databases for defining chemical properties, bioaccumulation factors, toxicity reference values, and other inputs. Some databases are distributed with the software and reside on local disk storage along with the ARAMS software and models, while others are accessible over the Internet to allow seamless download and input of up-to-date information. Databases presently used by ARAMS include the following:

- FRAMES constituent database, which includes physicochemical properties required for fate/transport modeling, bioaccumulation factors, and human health toxicity reference values from IRIS and HEAST
- Range constituent database, which is like the FRAMES constituent database, but consists of chemicals expected to be found on firing ranges (Technical Report ERDC/EL TR-02-27 and MS Access 2000 database)
- Environmental Residue Effects Database (ERED) for aquatic ecological health effects
- Biota-Sediment Accumulation Factors (BSAF) (Clarke and McFarland 1991) for aquatic uptake
- Terrestrial Toxicity Database (TTD), which includes toxicity reference values and soil screening levels for terrestrial wildlife. TTD can be downloaded from here (42 MB) for access outside of ARAMS. The background report can also be downloaded here
- A species life history profiles database and a BAF database for use with terrestrial wildlife exposure

models was developed as part of the Terrerstrial Wildlife Exposure Model (TWEM) model package and is distributed with ARAMS and resides locally
- Linkage to the Web-based Risk Assessment Information System (RAIS). Database for download of chemical-specific factors (physicochemical properties, exposure factors, and bioaccumulation factors) and human health toxicity reference values

Reference

Clarke JU, McFarland VA (1991) Assessing Bioaccumulation in Aquatic Organisms Exposed to Contaminated Sediments. Miscellaneous Paper D-91-2, Waterways Experiment Station, Vicksburg, MS 39180.

ECOTOX

http://cfpub.epa.gov/ecotox/

The ECOTOXicology database (ECOTOX) is a source for locating single chemical toxicity data for aquatic life, terrestrial plants and wildlife. ECOTOX was created and is maintained by the U.S.EPA, Office of Research and Development (ORD), and the National Health and Environmental Effects Research Laboratory's (NHEERL's) Mid-Continent Ecology Division (MED).

ECOTOX integrates three previously independent databases-AQUIRE, PHYTOTOX, and TERRETOX-into a unique system which includes toxicity data derived predominately from the peer-reviewed literature, for aquatic life, terrestrial plants, and terrestrial wildlife, respectively.

CHAPTER

27

Environmental Toxicology: Wildlife

C.C. BARTON AND S.C. SCHMITZ

INTRODUCTION

Wildlife toxicology is the study of the effects of environmental contaminants on the reproduction, health, and wellbeing of wildlife. Some of the initial concern and impetus of the modern environmental movement was the result of the perceived impact of environmental chemicals to wildlife.

Wildlife will be exposed to environmental chemicals form the water they drink and in which they live, from the foods that they eat and from the air that they breathe. Some chemicals, such as mercury and PCBs, have the ability to bioaccumulate within the tissues of animals and can present a potential of toxicity to humans that may consume these animals as a source of food. Consumption of certain species of fish can present a health concern to individuals who eat large amounts of these fish species.

The following is a list of resources on toxicology and the exposure of hazardous chemicals to wildlife. Included in the resources are books, journals, journal articles, and organizations that discuss the following topics:

- Effects of chemicals on animal tissue
- Exposure of wildlife to pesticides
- Exposure to endocrine disruptors
- Population studies
- Impacts on ecosystems
- Toxicological impacts to reptiles, mammals, marine mammals
- Wildlife diseases
- Wildlife management
- Biomagnification.

RESOURCES

Books

Beyer WN, Heinz GH, Redmon-Norwood AW (1996)
Environmental Contaminants in Wildlife: Interpreting Tissue Concentrations
Lewis, Boca Raton, FL

Deals exclusively with the question: How much of a chemical in the tissues of an animal is harmful? This book contains not only discussions of different chemicals but also information for those doing the task of evaluating the harm of environmental contaminants to wildlife. Chemicals discussed in this book include organochlorine pesticides, PCBs, dioxins, PAHs, metals, selenium, and fluoride.

Brewer L, Fagerstone K (Eds.) (1998)
Radiotelemetry Applications for Wildlife Toxicology Field Studies
SETAC, Pensacola, FL

Represents the proceedings from a SETAC workshop on radiotelemetry in support of pesticide field studies. Includes the description and results of several radiotracking and radiotelemetry studies designed around U.S. EPA guidelines mandating registrants of pesticides to determine the 'unreasonable and adverse effects' of these pesticides on wildlife.

Gardner SC, Oberdorster E (2005).
Toxicology of Reptiles (New Perspectives: Toxicology and the Environment)
Taylor and Francis, New York

Toxicology of Reptiles cohesively summarizes much of the cutting-edge research taking place in fields such as reptilian endocrinology, neurophysiology, immunology, and ecology. This volume also addresses conservation needs along with the complications often associated with population studies. The text is easy to synthesize and apply in the evaluation and understanding of potential risks to reptiles from environmental contaminants. This book provides a comprehensive description of the current state of knowledge of reptilian toxicology from the perspective of target organ systems. It covers major contaminant classes within each chapter, focusing on contaminants of greatest concern.

Kendall R, Dickerson R, Giesy J, Suk B (Eds.) (1998)
Principles and Processes for Evaluating Endocrine Disruption in Wildlife
SETAC, Pensacola, FL

Uses a risk-based approach to provide current information, principles, and processes for evaluating the effects of endocrine-modulating chemicals on wildlife. This text is a reference tool for educational purposes and is useful to environmental and industrial managers and planners involved in environmental law and policies.

Kendall RJ, Lacher TE (Eds.) (1994)
Wildlife Toxicology and Population Modeling: Integrated Studies of Agroecosystems
CRC Press, Inc., Boca Raton, FL

The book examines the foundation of ecological modeling and its application in assessing the ecological risk assessment of agricultural chemical use. State-of-the-art techniques and methods of ecological modeling have been compiled to provide insight into what must be done to minimize the impact of agricultural chemicals and other toxic substances on the environment. *Wildlife Toxicology and Population Modeling* is encyclopedic in coverage, presenting useful tools for environmental decision-making and the latest in the theory and application of the science.

Peterle TJ (1996)
Wildlife Toxicology
Van Nostrand-Reinhold, New York

Presents an historical overview leading to current regulatory positions and follows with specifics of agent-induced changes. For specific chemicals, information regarding the breakdown and environmental partitioning, transport to and through natural systems, accumulation potential, lethal and chronic effects, and impact on ecosystems is provided, with a discussion of the evolutionary implications for man.

Shore RF, Rattner BA (Eds.) (2001)
Ecotoxicology of Wild Mammals (Ecological & Environmental Toxicology Series)
John Wiley and Sons Ltd., New York, NY

In examining the exposure and effects of environmental contaminants in wild mammal populations, this book addresses four core questions: (1) What exactly do we know about environmental contaminants in wild mammals? (2) What are the commonalities and differences between mammal orders/species in the effects that contaminants have? (3) How and to what degree of accuracy can we predict the adverse effects of environmental contaminants on mammalian wildlife? (4) How significant are contaminant insults compared with other density-independent and -dependent factors such as habitat loss, climatic factors, and disease?

Vos JG, Bossart G, Fournier M, O'Shea T (2002)
Toxicology of Marine Mammals (New Perspectives: Toxicology and the Environment)
Taylor and Francis, New York

Toxicology of Marine Mammals focuses on the effects of natural and introduced toxicants on organs and systems in marine mammals. It includes overviews on health status and contamination with chapters devoted to whales, pinnipeds, dolphins, polar bears, manatees, and sea otters. The concluding chapter addresses perspectives for the future. This volume features research from a vast geographic landscape, with case studies on intriguing areas of contamination such as the St. Lawrence River and the Baltic Sea. Toxicologists working in marine biology and veterinary medicine, conservation scientists, fisheries scientists, environmental scientists, and wildlife managers will all benefit from this comprehensive resource.

Journals

Bulletin of Environmental Contamination and Toxicology
Springer, New York, NY
Web: http://www.springerlink.com/content/1432-0800

The *Bulletin of Environmental Contamination and Toxicology* provides publication of significant advances and discoveries in the fields of air, soil, water, and food contamination and pollution as well as articles on methodology and other disciplines concerned with the introduction, presence, and effects of toxicants in the total environment.

Environmental Toxicology and Chemistry
Alliance Communications Group, Lawrence, KS

Web: http://etc.allenpress.com/entconline/?request=index-html

Environmental Toxicology and Chemistry is an international journal dedicated to furthering scientific knowledge and disseminating information on environmental toxicology and chemistry, including the application of these sciences to risk assessment.

Journal of Wildlife Diseases
Wildlife Disease Association, Inc., Lawrence, KS
Web: http://www.jwildlifedis.org

The *Journal of Wildlife Diseases* publishes the results of original research and observations dealing with all aspects of infectious, parasitic, toxic, nutritional, physiologic, developmental, and neoplastic diseases, environmental contamination, and other factors impinging on the health and survival of free-living or captive populations of wild animals, including fish.

Journal of Wildlife Management
The Wildlife Society, Bethesda, MD
Web: http://www.wildlifejournals.org

The *Journal of Wildlife Management* contains information from original research that contributes to the scientific foundations of wildlife management. Suitable topics include the results and interpretations of investigations into the biology and ecology of wildlife that can be used for management.

Journal Articles

Ankley GT, Villeneuve DL (2006) The fathead minnow in aquatic toxicology: past, present and future. Aquat. Toxicol. 78: 91–102.

Barata C, Porte C, Baird DJ (2004) Experimental designs to assess endocrine disrupting effects in invertebrates. A review. Ecotoxicology 13: 511–517.

Berny P (2007) Pesticides and the intoxication of wild animals. J. Vet. Pharmacol. Ther. 30: 93–100.

Chapman PM (2002) Integrating toxicology and ecology: putting the "eco" into ecotoxicology. Mar. Pollut. Bull. 44: 7–15.

Dowling VA, Sheehan D (2006) Proteomics as a route to identification of toxicity targets in environmental toxicology. Proteomics 6: 5597–5604.

Eason C, O'Halloran K (2002) Biomarkers in toxicology versus ecological risk assessment. Toxicology 181/182: 517–521.

Fent K (2004) Ecotoxicological effects at contaminated sites. Toxicology 205: 223–240.

Fent K, Weston AA, Caminada D (2006) Ecotoxicology of human pharmaceuticals. Aquat. Toxicol. 76: 122–159.

Freemark K, Boutin C (1995) Impacts of agricultural herbicide use on terrestrial wildlife in temperate landscapes: A review with special reference to North America. Agric. Ecosys. Environ. 52(2–3): 67–91.

Fry DM (1995) Reproductive effects in birds exposed to pesticides and industrial chemicals. Environ. Health Perspect. 103: 165–171.

Guillette LJ, Jr, Guillette EA (1996) Environmental contaminants and reproductive abnormalities in wildlife: implications for public health?. Toxicol. Ind. Health 12(3/4): 537–550.

Hinton DE, Kullman SW, Hardman RC, et al (2005) Resolving mechanisms of toxicity while pursuing ecotoxicological relevance? Mar. Pollut. Bull. 51: 635–648.

Jobling S, Tyler C (2006) Introduction: the ecological relevance of chemically induced endocrine disruption in wildlife. Environ. Health Prospect. 114: 7–8.

Jongbloed RH, Pijnenburg J, Mensink BJWG, et al (1994) Model for environmental risk assessment and standard setting based on biomagnification. Top Predators in Terrestrial Ecosystems, NTIS/PB96-105473.

Luebke RW, Hodson PV, Faisal M, et al (1997) Aquatic pollution-induced immunotoxicity in wildlife species. Fundam. Appl. Toxicol. 37: 1–15.

Luttik R, Mineau P, Roelofs W (2005) A review of interspecies toxicity extrapolation in birds and mammals and a proposal for long-term toxicity data. Ecotoxicology 14: 817–832.

Markwiese JT, Ryti RT, Hooten MM, Michael DI, Hlohowskyj I (2001) Toxicity bioassays for ecological risk assessment in arid and semiarid ecosystems. Rev. Environ. Contam. Toxicol. 168: 43–98.

Medina MH, Correa JA, Barata C (2007) Micro-evolution due to pollution: Possible consequences for ecosystem responses to toxic stress. Chemosphere 67: 2105–2114.

Mineau P (2005) A review and analysis of study endpoints relevant to the assessment of "long term" pesticide toxicity in avian and mammalian wildlife. Ecotoxicology 14: 775–799.

Miracle AL, Ankley GT (2005) Ecotoxicogenomics: linkages between exposure and effects in assessing risks of aquatic contaminants to fish. Reprod. Toxicol. 19: 321–326.

Nichols J, Bradbury S, Swartout J (1999) Derivation of wildlife values for mercury. J. Tox. Environ. Health 2: 325–355.

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Pesch B, Bruning T, Frentzel-Beyme R, et al (2007) Challenges to environmental toxicology and epidemiology: where do we stand and which way do we go? Toxicol. Lett. 151: 255–266.

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Tyler CR, Jobling S, Sumpter JP (1998) Endocrine disruption in wildlife: A critical review of the evidence. Crit. Rev. Toxicol. 28: 319–361.

Stamler C, Basu N, Man Chan H (2005) Biochemical markers of neurotoxicity in wildlife and human populations: Considerations for method development. J. Tox. Environ. Health 68: 1413–1429.

Organizations

The Nature Conservancy
4245 North Fairfax Drive, Suite 100
Arlington, VA 22203-1606
Phone: 703-841-5300
Web: http://www.nature.org

The Nature Conservancy is a leading conservation organization working to protect the most ecologically important lands and waters around the world for nature and people. The mission of The Nature Conservancy is to preserve the plants, animals, and natural communities that represent the diversity of life on Earth by protecting the lands and waters they need to survive.

The Society of Environmental Toxicology and Chemistry
1010 North 12th Avenue
Pensacola, FL 32501-3367
Phone: 850-469-1500
Fax: 850-469-9778
Email: setac@setac.org
Web: http://www.setac.org/

The Society provides a forum where scientists, managers, and other professionals exchange information and ideas for the development and use of multidisciplinary scientific principles and practices leading to sustainable environmental quality.

The Wildlife Society
5410 Grosvenor Lane, Suite 200
Bethesda, MD 20814-2144
Phone: 301-897-9770
Fax: 301-530-2471
Email: lisa@wildlife.org
Web: http://www.wildlife.org

The Wildlife Society (TWS), founded in 1937, is an international non-profit scientific and educational association dedicated to excellence in wildlife stewardship through science and education. Their mission is to enhance the ability of wildlife professionals to conserve diversity, sustain productivity, and ensure responsible use of wildlife resources for the benefit of society. TWS has a wildlife toxicology working group: http://www.wildlife.org/wg/toxicology.

Databases

See Databases section of 'Environmental toxicology: Terrestrial' chapter.

CHAPTER

28

Epidemiology

AMANDA S. PERSAD

'I have yet to see any problem, however complicated, which, when you look at it in the right way, did not become still more complicated.'

Paul Anderson

Quoted in Anderson & May, *Infectious Diseases of Humans: Dynamics and Control*, Oxford University Press 1991

INTRODUCTION

With the establishment of relationships between environmental and occupational exposures and adverse human health effects, epidemiology has gained increasing recognition due to its contribution to risk assessment. Loosely defined as the study of the distribution and determinants of health-related states in human populations, epidemiology, in terms of risk assessment, evaluates the association between exposure and disease risk in humans. Epidemiology studies have aided in identifying potential health hazards that stem from a host of exposures including occupation (e.g., radiation and leukemia), diet (e.g., vitamin A and liver toxicity), microorganisms (e.g., human papilloma virus and cervical cancer), hormones (e.g., hormonal drugs and birth defects), and the environment (e.g., lead and mental development).

Epidemiology studies are divided into two main categories, experimental and observational (Rothman & Greenland 1998). Experimental studies such as clinical trials are typically utilized in the pharmaceutical industry. In toxicology and risk assessment, observational study designs are more prevalent. These observational studies are subdivided into hypothesis-generating studies, which include case reports/series, ecological studies and some cross-sectional studies, and hypothesis-testing studies such as cohort and case-control studies. The latter study designs are favored as they convey more robust information about the association between an exposure and a potential disease risk, and have less potential for bias.

Causation and the criteria for causation have been a contentious issue in epidemiology. Early observational epidemiology studies dealt with acute, infectious diseases in which a pathogen or a causative agent could be readily traced and causation could be established with Koch's postulates. With environmental or occupational exposures and diseases with long latency periods, the establishment of a causal link is a challenge (Persad et al 2003). Of the many theories proposed for the determination of causal relationship between exposure and disease, Hill's criteria have been the most widely accepted (Hill 1965).

The field of epidemiology continues to evolve as genomics and molecular epidemiology yield tools to identify susceptible populations, biomarkers for exposure, and a better understanding of the underlying mechanisms linking exposure and health outcome. This chapter provides a list of resources that highlight the advances in epidemiology in the last 10 years.

References

Hill AB (1965) The environment and disease: association or causation? Proc. R. Soc. Med. 58: 295–300.

Persad AS, Stedeford T, Banasik M (2003) Linking exposure to disease: Causation in the scientific arena. Columns – Mold 3: 6–7, 57.

Rothman KJ, Greenland S (1998) Modern Epidemiology, 2nd Edition. Philadelphia: Lippincott Williams & Wilkins.

RESOURCES

Books

Aldrich T, Griffith J, Cooke C (2002)
Environmental Epidemiology and Risk Assessment
John Wiley & Sons Inc, Hoboken

Introduces environmental epidemiology and risk assessment through historical environmental incidents such as Chernobyl, Love Canal, and Seveso. This 'how to' book provides instruction on study design and conduct of epidemiology studies as well as considerations for disease mechanisms, disease clusters, and surveillance techniques.

Aschengrau A, Seage GR (2007)
Essentials of Epidemiology in Public Health, 2nd Edition
Jones and Bartlett Publishers, Sudbury

Covers the basic epidemiologic concepts and data sources. This introductory text contains full chapters on bias, confounding, effect modification and the role of statistics in epidemiology, and uses current examples from the epidemiologic literature throughout.

Bertollini R, Lebowitz MD, Saracci R, Savitz DA (1996)
Environmental Epidemiology: Exposure and Disease
Lewis, Boca Raton, FL

Identifies priorities for research relevant to public health in selected areas of environmental epidemiology. This text covers various areas of environmental epidemiology from three different points of view: environmental exposures, epidemiological methodology, and major disease groups.

Buffler P, Rice J, Bird M, Boffetta P (Eds.) (2004)
Mechanisms of Carcinogenesis: Contributions of Molecular Epidemiology
IARC, Lyon

Report based on the November 2001 'Mechanistic Considerations in Molecular Epidemiology of Cancer' workshop. This report highlights metabolic and biochemical issues in molecular epidemiology of cancer. Additionally, gene–environment interactions, gene–gene interactions, and hypothesis-generating tools for determining cancer etiology are also discussed.

Carrington M, Hoelzel AR (Eds.) (2001)
Molecular Epidemiology: A Practical Approach
Oxford University Press, Oxford

Provides a broad overview of molecular epidemiology emphasizing basic concepts and methodologies, recent advances in host genetics, and the relationship between pathologies and immune system genetics.

Checkoway H, Pearce N, Kriebel D (2004)
Research Methods in Occupational Epidemiology, 2nd Edition
Oxford University Press, New York

Introduces research approaches specific to occupational epidemiology. In addition to basic epidemiology concepts, this book discusses occupational health surveillance and exposure measurement. This text is designed to serve as both a textbook for courses on occupational epidemiology and as a practical handbook for practicing professionals.

Couturier AJ (Ed.) (2000)
Occupational and Environmental Infectious Diseases: Epidemiology, Prevention, and Clinical Management
OEM Health Information, Beverly Farms

One-stop resource for key information on the occupational and environmental infectious diseases. This book covers OSHA bloodborne pathogen standard, emerging and re-emerging infectious diseases, zoonotic diseases, traveler- related infections, biologic warfare/terrorism and ADA/FMLA issues.

Day INM (Ed.) (2002)
Molecular Genetic Epidemiology: A Laboratory Perspective
Springer-Verlag, Berlin

Describes established methodologies in population-based molecular genetics. This book is geared towards research scientists, pharmaceutical companies, and research clinicians interested in characterizations of clone banks, mapping of genomes, and linkage and association studies of single-gene and complex traits in humans, animals, and plants.

Elliott P, Cuzick J, English D, Stern R (Eds.) (1996)
Geographical and Environmental Epidemiology: Methods for Small Area Studies
Oxford University Press, New York

Address both the theoretical and practical issues that surface when describing the geographical distribution of disease. This book uses case studies to showcase problems faced when investigating apparent disease clusters.

United Nations Environment Programme, World Health Organization, International Labour Organisation, International Program on Chemical Safety (1983).

Frank G (2007)
Community Nutrition: Applying Epidemiology to Contemporary Practice, 2nd Edition
Jones and Barlett Publishers, Sudbury

Geared for a graduate-level audience, this textbook illustrates how epidemiology can be utilized in the field of community nutrition. This book provides up-to-date information on general population nutrition, dietary guidance, and nutrition in chronic disease among other topics.

Friedman GD (2004)
***Primer of Epidemiology, 5th* Edition**
McGraw-Hill, New York

Offers a concise introduction to the field of epidemiology. In 18 chapters, this primer covers basic principles, types of study designs, statistical overview, forefronts in epidemiology, and study problems with answers.

Friis RH, Sellers TA (2003)
Epidemiology for Public Health Practice, 3rd edition
Jones and Bartlett Publishers, Sudbury

Provides a comprehensive overview of the fundamentals of epidemiology. This textbook covers major topics ranging from study designs and methodology to quantitative analysis.

Gerstman BB (2003)
Epidemiology Kept Simple: An Introduction to Classic and Modern Epidemiology, 2nd Edition
Wiley-Liss, Hoboken

A concise textbook describing the fundamental concepts, principles, and methods of classic and modern epidemiology through real-life examples, exercises, and occasional humor.

Gordis L (2004)
Epidemiology, 3rd Edition
W.B. Saunders, Philadelphia

Describes the principles of epidemiology along with public policy and ethical concerns using an 'easy to understand' approach. This textbook utilizes figures, cartoons, and review questions to bolster the material presented.

Graham JD (Ed.) (1995)
The Role of Epidemiology in Regulatory Risk Assessment
Elsevier, Amsterdam

Based on the Proceedings of the Conference on the Proper Role of Epidemiology in Risk Analysis, Boston, MA, 13–14 October 1994.

Higginson J, Muir CS, Munoz N (2005)
Human Cancer: Epidemiology and Environmental Causes
Cambridge University Press, New York

Provides a global picture of the epidemiology of cancer and its environmental causes. This reference covers general epidemiological methods, suspected etiologies, specific cancer types, and legal and ethical issues related to cancer epidemiology.

Kelsy JL, Whittemore AS, Evans AS, Thompson WD (1996)
Methods in Observational Epidemiology, 2nd Edition
Oxford University Press, New York

Provides a complete overview of the design, conduct, and analysis of observational studies.

Khoury MJ, Little J, Burke W (Eds.) (2003)
Human Genome Epidemiology: A Scientific Foundation for Using Genetic Information to Improve Health and Prevent Disease (Monographs in Epidemiology and Biostatistics)
Oxford University Press, New York

Explores the role of epidemiology methods and its application in genomics. Using disease-specific case studies, this book illustrates the methodologic approaches used in genetic epidemiology.

Jekel JF, Katz DL, Elmore JG (2007)
Epidemiology, Biostatistics, and Preventive Medicine-with Student Consult Online, 3rd Edition
W.B. Saunders, Philadelphia

Integrates epidemiology, biostatistics, preventive medicine and public health in terms of clinical relevance. This textbook is designed for medical and public health students, using real-life medical examples and including USMLE-style questions with detailed answers and explanations.

Merril RM, Timmreck TC (2006)
Introduction to Epidemiology, 4th Edition
Jones and Bartlett Publishers, Sudbury

Introductory textbook that covers a broad scope of topics in epidemiology. This book is designed for practicing professionals in health care as well as undergraduate and graduate students in public health.

Morton RF, Hebel JR, McCarter RJ (2004)
A Study Guide to Epidemiology and Biostatistics, 5th Edition
Jones and Bartlett Publishers, Sudbury

Comprehensive study guide that introduces the fundamentals of epidemiology and biostatistics. The clear explanations in this book are accompanied by online self-assessment quizzes.

Nasca P, Pastidas H (2007)
Fundamentals of Cancer Epidemiology, 2nd Edition
Jones and Bartlett Publishers, Sudbury

Well-rounded textbook on cancer epidemiology. In addition to defining cancer and cancer etiology, the text includes discussions about cancer screening, interactions of genetic and environmental risk factors, and cancer prevention strategies.

National Research Council, Committee on Environmental Epidemiology (1997)
Environmental Epidemiology, Volume 2: Use of the Gray Literature and Other Data in Environmental Epidemiology
National Academy Press, Washington, DC

Describes effective epidemiological methods for analyzing data and focuses on errors that may occur in the course of analyses. Also investigates the utility of the gray literature in helping to identify the often elusive causative agent behind reported health effects.

Nieuwenhuijsen M (Ed.) (2003)
Exposure Assessment in Occupational and Environmental Epidemiology
Oxford University Press, Oxford

Outlines basic principles of exposure assessment. This reference identifies cutting-edge methods and application in assessing occupational and environmental pollution and subsequent adverse health effects.

Oleckno WA (2002)
Essential Epidemiology: Principles and Applications
Waveland Press Inc., Prospect Heights

Comprehensive textbook that covers the basic principles and methods of epidemiology. Geared for undergraduate and graduate students in the health professions, this book utilizes algorithms and annotated step-by-step solutions to assist students in grasping the principles of epidemiology.

Rothman KJ (2007)
Modern Epidemiology, 3rd Edition
Lippincott-Raven, Philadelphia

Covers the principles and methods of contemporary epidemiologic research. Specific research areas include infectious diseases; ecologic studies; disease surveillance; analysis of vital statistics; screening; and clinical, environmental/occupational, reproductive/perinatal, genetic, and nutritional epidemiology.

Scutchfield FD, Keck W (2002)
Principles of Public Health Practice, 2nd Edition
Delmar Learning, Clifton Park

Describes the characteristics of local, state, and federal agencies involved in public health practice. This resource examines current topics such as performance standards, the public health workforce, and international health.

Selvin S (2004)
Statistical Analysis of Epidemiologic Data, 3rd Edition
Oxford University Press, New York

Surveys many statistical methods with application to epidemiologic data. It draws from the fields of statistics, biostatistics, vital statistics, and epidemiology.

Steenland K, Savitz D (Eds.) (1997)
Topics in Environmental Epidemiology
Oxford University Press, New York

Presents a comprehensive overview of the epidemiology of common environmental exposures. This book highlights the design, analysis, and overall methodology of epidemiology studies. Additionally, topics such as risk assessment, meta-analysis, and exposure are also discuss**e**d.

Strom BL, Kimmel SE (Eds.) (2007)
Textbook of Pharmacoepidemiology
J. Wiley, Chichester

One-stop resource for pharmacoepidemiology. This textbook is designed for those seeking an introduction in pharmacoepidemiology as well as practicing professionals in need of a reference source. The book covers the range of methodologies used to evaluate safety and effectiveness of medicines, details of potential data sources, and evaluation issues.

Szklo M, Javier Nieto F (2005)
Epidemiology: Beyond the Basics, 2nd Edition
Jones and Bartlett Publishers, Sudbury

Intermediate-level textbook providing more rigorous discussion on fundamentals in epidemiology. Using real-life examples, the book broadens the readers' understanding of epidemiology by presenting topics such as sensitivity analysis, meta-analysis, and exploring the role of this field in medicine and public health.

Thomas DC (2004)
Statistical Methods in Genetic Epidemiology
Oxford University Press, Oxford

Presents an overview of statistical methods of data analysis through examples from the scientific literature. In addition, this comprehensive reference includes chapters on molecular biology, genetics, epidemiology, and statistics.

Wilkinson, P. (Ed.) (2006)
Environmental Epidemiology
Open University Press, New York

Resource for public health practitioners to assist with investigating and interpreting potential health hazards. This book covers five major areas: clusters, air pollution, radiation and hazardous waste, water and health, and climate change.

Guidelines on Studies in Environmental Epidemiology
World Health Organization, Geneva

Based on the October 1975 WHO Study Group on Epidemiological Methods for Assessment of the Effects of Environmental Agents on Human Health. The guidelines cover a broad spectrum of topics including study designs, exposure assessment, measurement, and interpretation of health effects, organization and conduct of studies, analysis, interpretation, reporting, and uses of epidemiology studies.

Journals

American Journal of Epidemiology (1952–)
Oxford University Press, Cary
http://aje.oxfordjournals.org

Publishes empirical research findings and epidemiology research methodology articles. The journal is geared towards epidemiologists and those who use epidemiological data.

American Journal of Public Health (1911–)
American Public Health Association, Washington, DC
http://www.ajph.org

Includes articles relating to original research, research methods, and program evaluation in the field of public health. This journal also serves as a forum for the analysis of health policy.

Annals of Epidemiology (1990–)
Elsevier for American College of Epidemiology, Philadelphia
http://www.annalsofepidemiology.org/

Peer-reviewed, international journal that emphasizes the use of epidemiology in a multidisciplinary approach to understanding disease etiology.

Cancer Epidemiology, Biomarkers and Prevention (1990–)
American Association for Cancer Research, Philadelphia
http://cebp.aacrjournals.org/

Includes peer-reviewed research articles on cancer causation, mechanisms of carcinogenesis, use of biomarkers, and the role of behavioral factors in cancer etiology prevention, and survivorship.

Epidemiology (1990–)
Williams and Wilkins and Epidemiology Resources, Cambridge
http://www.epidem.com

Publishes on a broad spectrum of epidemiologic topics including chronic, reproductive, environmental, psychosocial, infectious-disease and genetic epidemiology. Additionally, this journal places special emphasis on theory and methodology, and welcomes articles that explore the fundamentals of epidemiology.

Epidemiology and Infection (1987–)
Cambridge University Press, Cambridge

Includes articles that focus on the prevention and control of infectious diseases in both man and animals. In addition to microbiology, virology, immunology, tropical infections, this journal publishes articles on the clinical, social, and public health aspects of disease.

European Journal of Epidemiology (1985–)
Springer, Dordrecht
http://www.springerlink.com/content/1573-7284

Publishes a broad range of articles that relate to different aspects of epidemiology. Areas of interest include public health planning, preventive medicine, clinical trials, vaccinology, psychology, molecular biology, mathematical modelization, and computer sciences. This journal also considers articles that discuss social, economical, and political issues that influence the science.

Genetic Epidemiology (1984–)
Wiley-Liss, New York

Considers articles that explore the genetic etiology of human traits in families and populations. The journal includes articles on the relative contribution of genetic and environmental factors to human disease, applied research and statistical methodologies that advance the field of genetic epidemiology.

International Journal of Epidemiology (1972–)
Oxford University Press, London

Publishes research on a broad spectrum of epidemiology topics including research and application of findings from both communicable and non-communicable diseases studies as well as cutting-edge methodologies for data analysis.

Internet Journal of Epidemiology (2003–)
Internet Scientific Publications, Sugar Land
http://www.ispub.com/ostia/index.php?xmlFilePath=journals/ije/front.xml

Peer-reviewed, open access journal publishing articles from all aspects of epidemiology.

Journal of Clinical Epidemiology (1955–)
Elsevier, New York

Emphasizes research and application of epidemiology findings in the clinical setting.

Journal of Epidemiology and Community Health (1947–)
British Medical Association, London
http://jech.bmjjournals.com/

Includes original research, opinions and literature pertaining to all aspects of epidemiology and public health.

Journal of Exposure Science and Environmental Epidemiology (1999–)
Nature Publishing Group, New York
http://www.nature.com/jes

Publishes research on exposure assessment for toxic substances as well as advances in exposure analysis.

Ophthalmic Epidemiology (1994–)
Taylor and Francis, Abingdon

Publishes articles related to ophthalmic epidemiology, public health, and prevention of blindness.

Journal Articles

Acquavella J, Doe J, Tomenson J, et al (2003) Epidemiologic studies of occupational pesticide exposure and cancer: regulatory risk assessments and biologic plausibility. Ann. Epidemiol. 13: 1–7.

Ambrosone CB, Kadlubar FF (1997) Toward an integrated approach to molecular epidemiology. Am. J. Epidemiol. 146: 912–918.

Boffetta P (2006) Human cancer from environmental pollutants: the epidemiological evidence. Mutat. Res. 608: 157–162.

Calderon RL (2000) The epidemiology of chemical contaminants of drinking water. Food Chem. Toxicol. 38: S13–S20.

Calderon RL (2000) Measuring risks in humans: the promise and practice of epidemiology. Food Chem. Toxicol. 38: S59–S63.

Grandjean P (1995) Biomarkers in epidemiology. Clin. Chem. 41: 1800–1803.

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van den Brandt P, et al (2002) The contribution of epidemiology. Food Chem. Toxicol. 40: 387–424.

Vineis P, Kriebel D (2006) Causal models in epidemiology: past inheritance and genetic future. Environ. Health 5: 21.

Weed DL (2002) Environmental epidemiology: basics and proof of cause-effect. Toxicology: 181–182, 399–403.

Weed DL (2005) Weight of evidence: a review of concept and methods. Risk Anal. 25: 1545–1557.

Organizations

American College of Epidemiology
1500 Sunday Drive, Suite 102
Raleigh, NC 27607
Phone: 919-861-5573
Fax: 919-787-4916
Email: fkenan@firstpointresources.com
Web: http://acepidemiology2.org

American Public Health Association
800 I Street, NW
Washington, DC 20001
Phone: 202-777-2742
Fax: 202-777-2534
Email: comments@apha.org
Web: http://www.apha.org

Council of State and Territorial Epidemiologists
CSTE National Headquarters
2872 Woodcock Boulevard
Suite 303
Atlanta, GA 30341
Phone: 770-458-3811
Fax: 770-458-8516
Web: http://www.cste.org/

International Society of Environmental Epidemiology
c/o JSI Research and Training Institute

44 Farnsworth Street
Boston, MA 02210
Phone: 617-482-9485
Fax: 617-482-0617
E-mail: iseepi@jsi.org
Web: http://www.iseepi.org

International Society for Pharmacoepidemiology
5272 River Road, Suite 630
Bethesda, MD 20816
Phone: 301-718-6500
Fax: 301-656-0989
E-mail: ispe@paimgmt.com
Web: http://www.pharmacoepi.org

Society for Epidemiologic Research
PO Box 990
Clearfield, UT 84089
Phone: 801-525-0231
Fax: 801-774-9211
Email: membership@epiresearch.org
Web: http://www.epiresearch.org

Databases

National Health and Nutrition Examination Surveys (NHANES)
http://www.cdc.gov/nchs/nhanes.htm

Surveillance Epidemiology and End Results (SEER)
http://seer.cancer.gov/

Other Resources

Epimonitor: The Epidemiology Monitor
http://www.epimonitor.net

A monthly newsletter that provides updates on research and key developments in epidemiology as well as upcoming events and current job opportunities.

The Virtual Library: Health and Medicine: Epidemiology
University of California, San Francisco
http://www.epibiostat.ucsf.edu/epidem/epidem.html

Website that links government agencies and international organizations that are involved in epidemiology research.

CHAPTER

29

Ethical Considerations

STEVEN G. GILBERT

INTRODUCTION

The foundation of our decision making rests on knowledge gained by experience and research but is overlaid by individual values and a broader construct of ethics. Toxicological research and experience has provided enormous amounts of data which must be translated into information. This information along with our values and ethics guides our decision making. Garrett Hardin observed that 'It is our considered professional judgment that this dilemma has no technical solution.' (Hardin 1968). It is through our science and ethics that we must manage the commons combined with knowledge of our technology. The expanding influence of the toxicological sciences on individual, business, and societal issues confers a great responsibility that demands increasing sensitivity to the ethical, legal, and social implications of toxicology.

Multiple elements have converged to highlight the ethical dynamics of toxicology. There is greater recognition of the ethical dimension of decision-making that incorporates toxicological information. This has resulted in an increasingly well-defined framework for discussing our social and ethical responsibility. There is a growing recognition that ethics plays a crucial role in public health decision-making that often involves conflicts between individual, corporate, and social justice goals. Consensus has developed that all research involving humans or animals must be conducted in a responsible and ethical manner. Finally, it is incumbent upon individuals involved in toxicological research to be aware of biases and potential conflicts of interest and adhere to the highest ethical standards.

Aldo Leopold, arguably, America's first bioethicist wrote in 1949: 'A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise.' (Leopold 1949). This statement speaks to the essence of toxicology which is to understand the effects of chemicals on the biotic community. The health effects of chemicals on the community are clearly evident from our experiences with PCPs, lead, DDT, and other persistent chemicals. Subsequently, it was recognized that some segments of our society were deferentially at risk from chemical exposure which evolved into an appreciation of environmental justice. Environmental justice is now an important component of many community-based programs. In addition there is a growing appreciation for the direct financial cost to society as well as the individual cost related to environmental exposures many of which are not distributed equally across society.

Biomedical ethicists developed a more formal approach for health care based on the four principles of biomedical ethics, respect for autonomy, beneficence (do good), non-maleficence (do no harm), and justice (be fair) became well established as a basis for decision-making (Beauchamp et al 1994). These principles formed the foundation for rules and regulations regarding the conduct of human research and ultimately animal research. A further evolution is the development of community-based participatory research which takes into consideration issues at the community level. Incorporating elements of science and ethical philosophy into a single statement, the precautionary principle, acknowledges that ethics and values are part of the decision-making process with

regard to human and environmental health (see Chapter 43, *Precautionary Principle*).

Toxicologists are often involved in the interpretation of data that influence regulatory policy which has raised the possibility of conflicts of interest affecting the decision-making process. This has resulted in more emphasis on conflict of interest issues and on guidelines for individual disclosures. These issues are central to individual values and integrity and influence of interpretation and communication of research results. Many professional societies have established codes of ethics for their members.

The commitment to examine the ethical, legal, and social implications of the toxicological sciences has grown along with its influence on societal issues.

RESOURCES

Books

Beauchamp TL, Childress JF (1994)
***Principles of Biomedical Ethics*, 4th edition**
New York: Oxford University Press.

An overview of the philosophical foundations of biomedical ethics followed by a discussion of the four principles of biomedical ethics: respect for autonomy, nonmaleficence, beneficence, and justice.

Hayward T (2005)
Constitutional Environmental Rights
Oxford: Oxford University Press.

Addresses issues related to human rights to an adequate environment and why it is both feasible and necessary to incorporate into state constitutions.

Institute of Medicine (2002)
Integrity in Scientific Research: Creating an Environment That Promotes Responsible Conduct
United States: National Academies Press.

This report focuses on integrity and the elements that foster an environment that enable and encourage individuals to act with integrity.

Jonas H (1984)
The Imperative of Responsibility – In Search of an Ethics for the Technological Age
Chicago and London: The University of Chicago Press.

Examines the foundation of ethics in light of technological developments and advances in scientific knowledge. This is a broad overview but raise important issues for the toxicologist and risk management in a society dependent on chemicals.

Leopold A (1949)
A Sand County Almanac
Reprinted by Ballantine Books, 1991.

Aldo Leopold is arguably the first to express the basic concept of bioethics, while addressing of land use and the biotic community that exists with the land. A great orginal work, this is one of the foundational books of environmental and human ethics in United States.

Pojman LP (2005)
Environmental Ethics – Readings in Theory and Application
United States: Thomson Wadsworth.

Starting with an historical perspective on the development of environmental ethics and then reviews various ethical theories. It concludes with articles and essays on the practical consideration of ethics relevant to toxicology such as pesticides.

Shamoo AE, Resnik DB (2002)
Responsible Conduct of Research
New York: Oxford University Press.

Provides an introduction to the ethical issues involved in the conduct of biomedical research. Include are questions for discussion and case studies on topics of authorship, intellectual property, peer review, and conflict of interest.

Journals

The American Journal of Bioethics (2001–)
Taylor and Francis Group, London
http://www.bioethics.net/

Includes articles on wide range of bioethical issues.

Ethics in Science and Environmental Politics
Inter-Research Science Center
http://www.int-res.com/journals/esep/esep-home/

An international publication, ESEP provides a global stage for presenting, discussing, and developing issues concerning ethics in science, environmental politics, and in the new constructs of eco-ethics and econ-ethics.

***Online Journal of Health Ethic*s**
ISSN: 1551-4218
The University of Mississippi Medical Center
School of Nursing
2500 North State Street
Jackson, Mississippi 39216-4505
http://ethicsjournal.umc.edu/ojs/index.php

Provides a forum to inform ethical debates from a worldview that includes a wide range of articles.

Journal articles

Arcury TA, et al (2001) Farmworker pesticide exposure and community-based participatory research: rationale and practical.applications. Environ. Health Perspect. 109(Suppl 3): 429–434.

Cairns J (2003) Ethics in science: ecotoxicology. Ethics Science Environ. Politics,: 33–39.

Callahan D, et al (2002) Ethics and public health: forging a strong relationship. Am. J. Public Health, 92/2: 169–176.

Corburn J (2002) Environmental justice, local knowledge, and risk: the discourse of a community-based cumulative exposure assessment. Environ. Manage. 29/4: 451–466.

Gilbert SG (2005) Ethical, legal, and social issues: Our children's future. Neurotoxicology 26/4: 521–530.

Goldman LR (1998) Linking research and policy to ensure children's environmental health. Environ. Health Perspect. 106(Suppl 3): 857–862.

Goozner M (2004) Unrevealed: Non-disclosure of conflicts of interest in four leading medical and scientific journals. Center Sci. Publ. Interest. (Available online at: http://cspinet.org/new/pdf/unrevealed_final.pdf)

Hardin G (1968) The tragedy of the commons. The population problem has no technical solution; it requires a fundamental extension in morality. Science 162/859: 1243–1248.

Kass NE (2001) An ethics framework for public health. Am. J. Public Health, 91/11: 1776–1782.

Krimsky SA, Rothenberg LS (2001) Conflict of interest policies in science and medical journals: editorial practices and author disclosures. Sci. Eng. Ethics 7/2: 205–218.

Landrigan PJ, Schechter CB, Lipton JM, et al (2002) Environmental pollutants and disease in American children: estimates of morbidity, mortality, and costs for lead poisoning, asthma, cancer, and developmental disabilities. Environ. Health Perspect. 110/7: 721–728.

Lee C (2002) Environmental justice: building a unified vision of health and the environment. Environ. Health Perspect. 110(Suppl 2): 141–144.

Maurissen JP, Gilbert SG, Sander M, et al (2005) Workshop proceedings: managing conflict of interest in science. A little consensus and a lot of controversy. Toxicol. Sci. 87/1: 11–14.

Morello-Frosch R, Pastor M Jr, Porras C, Sadd J (2002) Environmental justice and regional inequality in southern California: implications for future research. Environ. Health Perspect. 110(Suppl 2): 149–154.

O'Fallon LR, Dearry A (2002) Community-based participatory research as a tool to advance environmental health sciences. Environ. Health Perspect. 110 (Suppl 2): 155–159.

Oleskey C, Fleishman A, Goldman L, et al (2004) Pesticide testing in humans: ethics and public policy. Environ. Health Perspect. 112/8: 914–919.

Rollin BE (2003) Toxicology and new social ethics for animals. Toxicol. Pathol. 31 (Suppl): 128–131.

Sharp RR (2003) Ethical issues in environmental health research. Environ. Health Perspect. 111/14: 1786–1788.

Weiss B (2001) Ethics assessment as an adjunct to risk assessment in the evaluation of developmental neurotoxicants. Environ. Health Perspect. 109 (Suppl 6): 905–908.

Wing S (2003) Objectivity and ethics in environmental health science. Environ. Health Perspect. 111/14: 1809–1818.

Organizations

American Board of Forensic Toxicology
Address: 410 North 21st Street
Colorado Springs, CO 80904
Phone: 719-636-1100
Fax: 719-636-1993
E-mail: ABFTOX@aol.com
Web: http://www.abft.org/Ethics.asp

Established to enhance standards for the practice of forensic toxicology, which includes a strong code of ethics.

Phoebe R. Berman Bioethics Institute
Johns Hopkins University
100 North Charles Street, Suite 740
Baltimore, MD 21201
Phone: 410-516-8500
Fax: 410-516-8504
E-mail: bioethic@jhsph.edu
Web: http://www.hopkinsmedicine.org/bioethics/

Since 1995, has promoted research and encouraged moral reflection among scholars, professionals, students, and citizens, while seeking to prepare the next generation of leaders in bioethics.

Center for Community Action and Environmental Justice (CCAEJ)
PO Box 33124
Riverside, CA 92519
Phone: 951-360-8451
Fax: 951)-360-5950
E-mail: admin@ccaej.org
Web: http://www.ccaej.org

Works to bring groups of people together to find opportunities for cooperation, agreement and problem solving.

The Center for Health, Environment and Justice
150 S. Washington St., Suite 300
Falls Church, VA 22040-6806
Phone: 703-237-2249
Fax: 703-237-8389
E-mail: info@chej.org
Web: www.chej.org

On a variety of levels works to bring together people to improve their environment.

Environmental Justice Associations and Organizations
National Council for Science and the Environment
1707 H Street N.W., Suite 200
Washington, DC 20006-3918
Phone: 202-530-5810
Fax: 202-628-4311
E-mail: info@NCSEonline.org
Web: http://ncseonline.org/

Information and website on environmental justice and minority programs.

Environmental Justice Resource Center
Children's Environmental Health Network
Clark Atlanta University
223 James P. Brawley Dr. at Fair St. SW
Atlanta, GA 30314
Phone: 404-880-6911
Fax: 404-880-6909
E-mail: ejrc@cau.edu
Web: http://www.ejrc.cau.edu, http://www.cehn.org/cehn/resourceguide/ejrc.html

Environmental Justice Strategy
U.S. Environmental Protection Agency
Mail Code: 2201A
1200 Pennsylvania Ave., NW
Washington, D.C. 20460-0001
Phone: 202-564-2515
E-mail: see web site
Web: http://www.epa.gov/compliance/environmentaljustice/

Access to U.S. EPA's efforts to address environmental justice issues, including information on the National Environmental Justice Advisory Council, which strives to integrate environmental justice issues across the EPA.

First Nations Environmental Network
P.O. Box 394
Tofino, B.C.
Canada V0R 2Z0
Phone: 250-726-5265
Fax: 250-725-2357
E-mail: councilfire@hotmail.com
Web: http://www.fnen.org

Works to bring together a broad construct of environmental protection based on the tradition of balancing the three aspects of our nature: mind, body and spirit.

The Hastings Center
21 Malcolm Gordon Road
Garrison NY 10524-4125
Phone: 845-424-4040
Fax: 845-424-4545
E-mail: mail@thehastingscenter.org
Web: http://www.thehastingscenter.org/

The Hastings Center is an independent, non-partisan, and non-profit bioethics research institute founded in 1969 to explore fundamental and emerging questions in health care, biotechnology, and the environment.

Johns Hopkins Center for Alternatives to Animal Testing (CAAT)
111 Market Place, Suite 840
Baltimore, MD 21202-6709
Phone: 410-223-1692
Fax: 410-223-1603
E-mail: caat@jhsph.edu
Web: http://caat.jhsph.edu/

A non-profit organization with the mission 'To be a leading force in the development and use of reduction, refinement, and replacement alternatives in research, testing, and education to protect and enhance the health of the public.'

Joseph and Rose Kennedy Institute of Ethics
Healy, 4th Floor
Georgetown University
Washington, DC 20057
USA
Phone: 202-687-8099
Fax: 202-687-8089
E-mail: schofies@georgetown.edu
Web: http://kennedyinstitute.georgetown.edu/

A comprehensive academic bioethics center with a library for those who research and study ethics and make public policy.

The National Tribal Justice Resource Center
4410 Arapahoe Ave, Suite 135
Boulder, CO 80303
Phone: 303-245-0786
Fax: 303-245-0785
E-mail: mail@tribalresourcecenter.org
Web: http://www.tribalresourcecenter.org/

Site dedicated to tribal justice systems, personnel and tribal law; serving as a resource center and national clearinghouse of information for Native American and Alaska Native tribal courts.

Office of Research Integrity
U.S. Department of Health and Human Services
1101 Wootton Parkway, Suite 750
Rockville, Maryland 20852
Phone: 240-453-8200
Fax: 301-443-5351
E-mail: AskORI@hhs.gov
Web: http://ori.dhhs.gov/publications/studies.shtml

Society of Toxicology
1821 Michael Faraday Drive, Suite 300
Reston, VA 20190
Phone: (703) 438-3115
Fax: (703) 438-3113
E-mail: info@toxicology.org
Web: Code of Ethics – http://www.toxicology.org/ai/asot/Code_of_Ethics.pdf/

The U.S. National Toxicology Society provides a good example of a members code of ethics.

Other resources

Animals and Alternatives in Testing: History, Science, and Ethics
Joanne Zurlo, Deborah Rudacille, and Alan M. Goldberg. The Johns Hopkins Center for Alternatives to Animal Testing (CAAT). See: http://caat.jhsph.edu/pubs/animal_alts/appendix_b.htm

Ethical Economics
Myers N. SEHN Networker, vol. 9 #6, December 2004. www.sehn.org/thenet.html

Ethics of the Environment: Precautionary Principle
UNESCO
http://portal.unesco.org/shs/en/ev.php-URL_ID=6252&URL_DO=DO_TOPIC&URL_SECTION=201.html

Ethics for Our Time
Schettler T, Myers, N. SEHN Networker, vol. 10 #1, March 2005 www.sehn.org/thenet.html.

Integrity in Scientific Research
http://www.aaas.org/spp/video/

CHAPTER

30

Everyday Exposures

ASISH MOHAPATRA, AND PERTTI J. HAKKINEN

INTRODUCTION

The objective of this chapter is to list information resources, including emerging and cutting edge ones, available in exposure and risk assessment as they relate to everyday exposures. Information resources have also been provided in the areas of exposure controls and other risk management measures so that reduction or elimination of some exposures can be effectively achieved.

A thorough quantitative analysis of exposure assessment information is critical to understand the complex everyday exposure patterns from a public health risk assessment perspective. Daily living can involve exposures up to thousands of chemicals from many sources. Documented non-occupational sources include consumer products, residential and other water, indoor and outdoor air, food and food packaging, beverages, toys, furniture, carpeting, paint, and other building materials, household dust containing chemicals from consumer products, outdoor soil, and soil tracked indoors.

The consumer product exposures can involve many products, perhaps 20 or more during a day, used alone or in combination, and a single product can include several hundred chemicals. The uses of household cleaning, personal care, and other types of products can lead to dermal, inhalation, and oral exposures. For example, oral exposures can occur for a toothpaste chemical, and a detergent residue or other component of a fabric being mouthed by a child.

The use of residential and non-residential water can lead to dermal, inhalation, and oral exposures, e.g., skin contact during showering and inhalation of chemicals volatilized during and after showering. Further, indoor and outdoor inhalation exposures to the chemicals in air can be in addition to deposition on and absorption into household materials (e.g., carpets and foods and food packaging), leading to dermal and oral exposures. While air levels are most often associated with inhalation exposure, other types of air-related exposures can occur, e.g., dermal uptake of chemicals found in vapors has been observed, as has the ability to swallow chemicals that enter the respiratory tract. The ingestion of the chemicals found in foods and beverages involves hundreds of chemicals, and breast milk is another documented source of exposure to many chemicals.

A recent area of strong research interest is the study of indoor air chemistry, including the reactions that can occur between ozone and the chemicals used in cleaning products, air fresheners, and paint. For example, the terpenes widely used in consumer products can react with ozone under product use conditions, leading to formation of formaldehyde, hydroxyl radical, and secondary organic aerosol (very small particles that can be inhaled).

Human behavior and decisions can play large roles in determining the sources of, and the types and levels of exposures to chemicals. For example, personal cleaning habits can help determine how clean a residence is kept. Other important personal behaviors and decisions include: (1) the types of consumer products that are purchased, (2) where and how the consumer and other occupants of the residence use the products, (3) how products might be used together for various cleaning tasks, and (4) whether kitchen or bathroom fans are used or windows are opened to

increase the circulation of air if certain consumer products are used.

According to Ott et al (2007), the classical *source-oriented approach* (that looks for contamination at the source and then calculates how much exposure there is at the receptor level) has been difficult in establishing a definitive linkage between exposure to pollutants and stressors from a source and its impact to a receptor (humans or animals). Furthermore, Ott et al (2007) has proposed that the emerging exposure science field should follow a *receptor-oriented approach* that approaches measurements of pollutants or stressors at the contact boundary of the person and then works backward from the personal exposure to find the actual source. This emerging approach has shown promise in identifying new sources of pollutants. This direct measurement of exposure has led to investigating new indoor sources in consumer grade products (e.g., toys and other products are a subject of rigorous testing and analysis for lead), building materials and human activities.

It is obvious that a person's daily exposure to a single chemical might come from many sources. Further, these sources, when combined over the minute-by-minute activities and locations, can possibly lead to daily exposures to hundreds of chemicals. The information resources provided include books and published reviews about everyday exposures to chemicals, publications covering some of the points noted above, professional societies and other organizations relevant to this topic, and useful web-based databases. Readers also interested in daily exposures to biological and physical agents can use the *Residential Exposure Assessment: A Sourcebook* chapters noted below, and the Loftness, Hakkinen, Adan, Nevalainen (2007) 'Elements That Contribute to Healthy Building Design' review as entry points.

Related Chapters

Environmental Toxicology – Air
Biotoxins
Chemicals: Cosmetics and Other Consumer Products
Chemicals: Drugs
Chemicals: Dust and Fibers
Chemicals: Metals
Chemicals: Pesticides
Chemicals: Solvents
Chemicals: Other Chemicals of Concern
Food and Nutrition
Mixtures
Nanotechnology
Physical Hazards
Poison Control Centers
Radiation

RESOURCES

Books

Baker SR, Driver J, McCallum D (eds) (2001)
Residential Exposure Assessment: A Sourcebook
Kluwer Academic/Plenum Publishers, New York, NY.
Hardcover: 394 pages
Language: English
ISBN: 0306465175

This book, initiated by the Society of Risk Analysis (SRA) and the International Society of Exposure Science (formerly the International Society of Exposure Analysis), is a compendium of information written by residential exposure experts about predictive methods and tools, monitoring methods, data sources, and key variables that characterize chemical, biological agent, and physical agent exposures in and around all types of residences (apartments, single-family homes, condominiums, farmhouses, mobile homes, row houses, retirement homes, and school dormitories). Residential exposure assessments are used to check indoor air quality, compliance with U.S. and other statutes, and as part of the evaluation of consumer product safety. Sample chapters include:

Burge H 'Biological Agents'

Driver J, Connor J, Jr, Guiseppi-Elie A, Hakkinen PJ, McCallum D, McKone T, Schreiber J, Spengler J, Tell J, Wallace L, Wood W, Youngren S 'General framework for assessing potential human exposures to chemical, biological, and physical agents in the residential environment.'

Whitmyre G, Dang W, Driver J, Eberhart M, Fell L, Hakkinen PJ, Jaycock M, Kennedy P, Osimitz T 'Consumer products and related sources.'

Claire A Franklin (author), John P Worgan
Occupational and Residential Exposure Assessment for Pesticides
Wiley Series in Agrochemicals & Plant Protection (Hardcover)
Hardcover: 438 pages
John Wiley and Sons Ltd
ISBN: 0471489891

This book focuses on the exposure to pesticides by agricultural workers and residential users of pesticides through inhalation and physical contact. It discusses more recently discovered risks such as pesticides on indoor carpets and includes new trends in data interpretation. This title complements the other title on pesticide exposure in the series: '*Pesticide Residues in Drinking Water*.'

NAS (National Academy of Sciences), Subcommittee on Flame-Retardant Chemicals, Committee on Toxicology, Board on Environmental Studies and Toxicology, National Research Council (2000)

Toxicological Risks of Selected Flame-Retardant Chemicals

National Academies Press; Washington, D.C.
http://www.nap.edu/catalog/9841.html (Executive summary)

The subcommittee was charged to review the toxicological and exposure data for 16 flame-retardant chemicals to assess potential health risks to consumers and the general population resulting from potential exposure to these chemicals in residential furniture. The subcommittee was also asked to identify data gaps and make recommendations for future research. The subcommittee was not charged or able, with the available data and resources, to evaluate adverse effects from occupational exposures, or the potential ecological effects that might result from the disposal of household furniture. The subcommittee assumed that human exposure to flame-retardant chemical-treated fabric in homes can occur potentially via skin contact, ingestion (specifically for infants or children who might suck or chew on fabric), inhalation of particles generated during abrasion of surface fibers, and inhalation of vapors off-gassing from treated fabric.

Robert A Howd, Anna M Fan (Eds) (2007)
Risk Assessment for Chemicals in Drinking Water
Hardcover: 392 pages
Wiley-Interscience
ISBN-10: 0471723444
ISBN-13: 978-0471723448

This is a comprehensive reference on state-of-the-art risk assessment methodologies for drinking water. The book discusses the major steps and goals in risk assessments and suggests ways to improve the methodologies and accuracy, while consolidating up-to-date information on the current principles and practices in one authoritative reference. It includes an overview of risk assessment practices and regulatory guidelines; describes the use of variability analysis, exposure analysis, physiologically based pharmacokinetics, and modeling for both cancer and non-cancer endpoints. Furthermore, it describes the practices of major organizations, including the USEPA, Health Canada, World Health Organization (WHO), and California Office of Environmental Health Hazard Assessment. It includes complete chapters on risk assessment for essential nutrients, arsenic, chloroform, and perchlorate. The book explains how to address susceptible sub-populations, including the elderly and infants and children, in risk assessments. The book covers the potential of using genomic and proteomic screens and addresses recent advances, emerging issues, and future challenges in various drinking water contaminant issues. This is stated to be the definitive resource for health and environmental scientists, toxicologists, risk assessors and managers, regulators, consultants, and other professionals responsible for the safety of drinking water.

M Schapiro (2007)
The Toxic Chemistry of Everyday Products and What's at Stake for American Power
Hardcover: 224 pages
ISBN: 978-1-933392-15-8
Chelsea Green Publishing, White River Jct., VT

This book 'shows how laws adopted by the European Union – where stricter consumer-safety standards are in place – have forced multinationals into manufacturing safer products.' It 'will change the way American consumers think about everyday products – from plastic softeners that can contribute to sexual malformations to lipstick additives that are potential toxins to the brain, liver, kidneys, and immune system. And it will stir them into forcing our government to take the lead of others, including the European Union, China, and countries in Central and South America.'

Stephen S Olin (Ed.) (1998)
Exposure to Contaminants in Drinking Water: Estimating Uptake through the Skin and by Inhalation
Hardcover: 256 pages
CRC Press
ISBN-10: 0849328047
ISBN-13: 978-0849328046

The book examines the state of science, identifies and reviews the available information resources; evaluates various models and approaches; and demonstrates the feasibility of developing estimates of the distribution of absorbed doses of contaminants in drinking water through contact with the skin and by inhalation. This book is the product of a 15-member expert working group formed by the Risk Science Institute (RSI) of the International Life Sciences Institute (ILSI) under a cooperative agreement with the U.S. Environmental Protection Agency's (USEPA) Office of Water. The authors are experts in exposure modeling and measurement; water chemistry; time-activity patterns; dermal and respiratory uptake; and the use of probability distributions in characterizing exposures.

Wayne R. Ott, Anne C. Steinemann, Lance A. Wallace (2006)
Exposure Analysis
ISBN: 1566706637
Number of pages: 533
CRC Press

This book is stated to be a first-of-its-kind resource in the emerging scientific discipline of 'exposure analysis.' It is a comprehensive source on the environmental pollutants that affect human health and it discusses human exposure through pathways including air, food, water, dermal absorption, and, for children, non-food ingestion. The existing knowledge and methodology for major pollutants such as VOCs, particles, and pesticides and basic mathematical methods and practical tools used by the exposure analyst are reviewed. This book provides the basic tools needed to identify sources, understand causes, measure exposures, and develop strategies for improving public health. Furthermore, the book summarizes existing definitions of exposure, dose, and related concepts and provides the mathematical framework at the heart of these conceptual definitions. Using secondhand smoke (SHS) as an example, the book illustrates how exposure analysis studies can change human behavior and improve public health. An extensive section on air pollutants considers volatile organic compounds (VOCs), carbon monoxide (CO), fine and ultrafine particles, and the latest personal air quality monitors for measuring individual exposure. Another detailed section examines exposures to pesticides, metals such as lead, and dioxin that may occur through multiple routes such as air, food, and dust ingestion. The book explores important aspects of dermal exposure such as the absorption of volatile organic compounds while showering or bathing and exposure through multiple carrier media. The authors describe quantitative methods that have been validated for predicting the concentrations in enclosed everyday locations, such as automobiles and rooms of the home. They also discuss existing laws and examine the relationship between exposure and national policies.

Journals

Journal of Exposure Science and Environmental Epidemiology *(JESEE*, formerly the *Journal of Exposure Analysis and Environmental Epidemiology*)
Nature Publishing Group (NPG); USA
Website: http://www.nature.com/jes/index.html

This publication includes peer-reviewed research important to exposure assessment for toxic substances, environmental epidemiology that includes a strong exposure analysis component, and related disciplines that advance the exposure assessment process. *JESEE* also publishes papers on exposure analysis such as measurements and modeling; mechanisms of exposure; development of molecular biomarkers; genomic, proteomic, and metabonomics studies that assess exposure in the context of health effects; studies on chemical, biological, and physical principles required to analyze human exposure from single and multiple routes; occupational exposure studies; and, population-based studies. It is the official publication of the International Society of Exposure Science (ISES), formerly the International Society of Exposure Analysis (ISEA).

There are no other peer-reviewed journals focused on 'Exposure Science, Assessment and Analysis' topic.

The following journals publish original research articles, reviews, and other experimental studies in exposure science, assessment, and analysis. Detailed information on these journals can be found elsewhere in this book. Other public-health-related journals carry exposure-science-related articles.

- *Environmental Health Perspectives*
- *Environmental Science & Technology*
- *Risk Analysis*
- *Science of the Total Environment*
- *Toxicology*
- *Toxicology Letters*
- *Toxicological Sciences*
- *Journal of Toxicology and Environmental Health* (critical reviews).

Journal Articles

Brauer M, Hurtle R, Lang B, Ott W (2000) Assessment of indoor fine aerosol contributions from environmental tobacco smoke and cooking with a portable nephelometer. J. Exp. Anal. Environ. Epidemiol. 10: 136–144.

Bruinen De Bruin Y, Hakkinen PJ, Lahaniatis M, et al (2007) Risk management measures for chemicals in consumer products: documentation, assessment, and communication across the supply chain. J. Exp. Sci. Environ. Epidemiol. 17: S55–S66.

Butte W, Heinzow B (2002) Pollutants in house dust as indicators of indoor contamination. Rev. Environ. Contam. Toxicol. 175: 1–46.

Chapman A (2006) Regulating chemicals – from risks to riskiness. Risk Anal. 26: 603–616.

de Rosa CT, El-Masri HA, Pohl H, Cibulas W, Mumtaz MM (2004) Implications of chemical mixtures in

public health practice. J. Toxicol. Environ. Health B Crit. Rev. 7: 339–350.

Destaillats H, Lunden MM, Singer BC, et al (2006) Indoor secondary pollutants from household product emissions in the presence of ozone: A bench-scale Chamber study. Environ. Sci. Technol. 40: 4421–4428.

Eaton KK, Anthony HM, Birtwistle S, et al (2000) Multiple chemical sensitivity: Recognition and management. A document on the health effects of everyday chemical exposures and their implications. J. Nut. Environ. Med. 10: 39–84.

Ferro AR, Kopperud RJ, Hildemann LM (2004) Elevated personal exposure to particulate matter from human activities in a residence. J. Exp. Anal. Environ. Epidemiol. 14: 34–40.

Guo H, Lee SC, Chan LY, Li WM (2004) Risk assessment of exposure to volatile organic compounds in different indoor environments. Environ. Res. 94: 57–66.

Haddad S, Tardif GC, Tardif R (2006) Development of physiologically based toxicokinetic models for improving the human indoor exposure assessment to water contaminants: trichloroethylene and trihalomethanes. J. Toxicol. Environ. Health 69: 2095–2136.

Hakkinen PJ, Kelling CK, Callender JC (1991) Exposure assessment of consumer products: human body weights and total body surface areas to use, and sources of data for specific products. Vet. Hum. Toxicol. 33: 61–65.

Hubbard HF, Coleman BK, Sarwar G, Corsi RL (2005) The effects of an ozone generating air purifier on indoor secondary particles in three residential dwellings. Indoor Air 15: 432–444.

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Klepeis NE, Nazaroff WW (2006) Modeling residential exposure to secondhand tobacco smoke. Atmos. Environ. 40: 4393–4407.

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Organizations and Web Portals

International Society of Exposure Science (ISES), formerly the International Society of Exposure Analysis (ISEA)

The ISES was established in 1989 to foster and advance the science of exposure analysis related to environmental contaminants, both for human populations and ecosystems. The membership promotes communication among all disciplines involved in exposure analysis, recommends exposure analysis approaches to address substantive or methodological concerns, and works to strengthen the impact of exposure assessment on environmental policy (excerpted from http://www.iseaweb.org/). For contact information check http://www.iseaweb.org/officers/to contact one of the executive members or officers of the society. Glossary of Exposure Analysis is available at http://www.iseaweb.org/glossary.php

Society of Risk Analysis (SRA) – Exposure Assessment Specialty Group (EAS)

The EAS Group includes SRA members interested in the role of exposure assessment in risk analysis. The Group promotes and fosters independent and collaborative research in all facets of exposure science to advance the state of the art and serves as a resource to the Society in matters concerning the role of exposure in risk analysis (http://www.sra.org/about_specialty_groups_overview.php#exp).

ExposureScience.Org

This website is intended as an independent public service and information resource for the scientific community. It is not officially affiliated with any government agency or industry group. The main authors of materials on this website are academic researchers. ExposureScience.Org hosts research projects in the field of exposure science, provides a forum for scientists and researchers to collaborate and exchange ideas in the emerging areas of exposure science, assessment, and analysis. It also provides public access to various scholarly materials and information resources related to the different exposure-science-related projects. The web portal allows downloading of published articles, reports, software, and data related to exposure science research work. The web portal also maintains private areas (member only) of the site where research discussions and posts can be made prior to any formal publication. To contact the executive body of this web portal, access http://www.exposurescience.org/contact.

Other Government and Non-government Agency Literature/Reports Resources

United States Environmental Protection Agency (USEPA)

http://www.epa.gov/heasd/ctepp/index.htm

Report Title: Protecting Children's Health: an EPA Study Measures the Levels of Commonly Used Chemicals in Homes and Day Care Centers

Report Title: Evaluating Exposures to Toxic Air Pollutants: A Citizen's Guide
http://www.epa.gov/ttn/uatw/3_90_023.html

(U.S.) Consumer Product Safety Commission (CPSC)
http://www.cpsc.gov/

The US CPSC is charged with protecting the public from unreasonable risks of serious injury or death from more than 15 000 types of consumer products under the agency's jurisdiction. The CPSC is committed to protecting consumers and families from products that pose a fire, electrical, chemical, or mechanical hazard or can injure children. The CPSC's work to ensure the safety of consumer products – such as toys, cribs, power tools, cigarette lighters, and household chemicals – contributed significantly to the 30% decline in the rate of deaths and injuries associated with consumer products over the past 30 years (excerpted from http://www.cpsc.gov/about/about.html).

The library section of the CPSC webpage has a lot of relevant information resources related to consumer products, safety and injury issues and household chemical exposure issues (http://www.cpsc.gov/library/library.html).

Health Canada
Consumer Products and Safety

'Health Canada helps protect the Canadian public by researching, assessing and collaborating in the management of the health risks and safety hazards associated with the many consumer products, including pest management products, that Canadians use everyday' (excerpted from http://www.hc-sc.gc.ca/cps-spc/index_e.html).

Relevant information resources available on:
Children's products (http://www.hc-sc.gc.ca/cps-spc/child-enfant/index_e.html);
Household products (http://www.hc-sc.gc.ca/cps-spc/house-domes/index_e.html);
Personal products (http://www.hc-sc.gc.ca/cps-spc/person/index_e.html);
Pest management products (http://www.hc-sc.gc.ca/cps-spc/pest/index_e.html).
Pest Management Regulatory Agency
http://www.pmra-arla.gc.ca/

Health Canada's Pest Management Regulatory Agency (PMRA) is the federal agency responsible for the regulation of pest control products in Canada. As the federal authority under the Pest Control Products Act (PCPA), the PMRA develops pest management policies and guidelines; promotes sustainable pest management; looks to improve the regulatory process to increase efficiency; enforces compliance with the PCPA; and, distributes pest management information to the general public and key stakeholders.

The primary objective of PMRA is to prevent unacceptable risks to people and the environment from the use of pest control products and the mission is to protect human health and the environment by minimizing the risks associated with pest control products in an open and transparent manner, while enabling access to pest management tools, namely, these products and sustainable pest management strategies (excerpted from http://www.pmra-arla.gc.ca/english/aboutpmra/about-e.html). Exposure prevention, toxicology and health effects related publications are available from their publication website (http://www.pmra-arla.gc.ca/english/pubs/pubs-e.html).

Europa Portal

It is the web portal of the European Union (http://europa.eu) that provides up-to-date coverage of European Union affairs and essential information on European integration. Web browsers can consult all legislation currently in force or under discussion, access the websites of each of the EU institutions and find out about the policies administered by the European Union under the powers devolved to it by the Treaties. Searches of the web portal for relevant documents can be made via http://europa.eu/geninfo/query/search_en.html.

European Commission
(http://ec.europa.eu/index_en.htm)

The Commission's Health and Consumer Protection directorate looks after health issues related to food safety, public health and consumer protection (http://ec.europa.eu/dgs/health_consumer/whoweare_en.htm).

European Commission, Joint Research Centre (JRC)
(http://ec.europa.eu/dgs/jrc/index.cfm)
European Commission – Joint Research Centre
Internal & external communication Unit
Email: mailto:jrc-info@ec.europa.eujrc-info@ec.europa.eu
JRC Switchboard
Phone: +39 0332 789111

The Institute for Health and Consumer Protection (IHCP)
(http://ihcp.jrc.ec.europa.eu)
IHCP Communication
Via E. Fermi 1-21020 Ispra (Varese)-Italy
Phone: +39 0332 785478
Fax: +39 0332 789059
Email: ihcp-contact@jrc.it

The Joint Research Centre (JRC) provides customer-driven scientific and technical support for the conception, development, implementation and monitoring of

EU policies. The IHCP of JRC has relevant information resources in exposure assessment, exposure databases, and health effects from exposure to consumer products and everyday chemicals use. The Physical and Chemical Exposure (PCE) unit of the IHCP primarily does work in the areas of exposure analysis. For additional information, readers are encouraged to check http://web.jrc.ec.europa.eu/pce/. The documentation section lists several key exposure-related research articles, documents, white papers, and proceedings, etc. (http://web.jrc.ec.europa.eu/pce/pce-documentation.html).

Some relevant reports and publications are listed below.

Bruinen de Bruin Y, Koistinen K, Yli-Tuomi T, Kephalopoulos S, Jantunen M (2006) A review of source apportionment techniques and marker substances available for identification of personal exposure, indoor and outdoor sources of chemicals. EUR 22349 EN

Dimitrios Kotzias et al (January 2006) 'Final Report of the INDEX Project, Critical Appraisal of the Setting and Implementation of Indoor Exposure Limits in the EU'. EUR 21590 EN 2005

Stylianos Kephalopoulos, Joop J van Hemmen, Katinka van der Jagt (Eds.) Global Net on 'Consumer Exposure Modelling' – Report of Workshop nr. 1 on 'Dermal Transfer and Penetration Algorithms', 20–21 June 2005, Intra (Italy), 2006 EUR 22521 EN/1

Stylianos Kephalopoulos, Athanasios Arvanitis, Mike Jayjock (Eds.) Global Net on 'Consumer Exposure Modelling' – Report of Workshop nr. 2 on 'Source Characterization, Transport and Fate', 20–21 June 2005, Intra (Italy), 2006 EUR 22521 EN/2

Stylianos Kephalopoulos, Athanasios Arvanitis, Matti Jantunen (Eds.) Global Net on 'Consumer Exposure Modelling' – Report of Workshop nr. 3 on 'Exposure Modelling Framework Issues', 20–21 June 2005, Intra (Italy), 2006 EUR 22521 EN/3

Yuri Bruinen de Bruin, Dimitrios Kotzias and Stylianos Kephalopoulos, 2004: 'Characterization of Indoor Sources (COSI), Emissions of Chemical Substances from Materials and Products', EUR 21500 EN 2005

Yuri Bruinen de Bruin, Dimitrios Kotzias and Stylianos Kephalopoulos, 2004: 'HEXPOC-Human Exposure Characterization of Chemical Substances; Quantification of Exposure Routes', EUR 21501 EN 2005

Non-government Agency Literature/Reports Resources

Ecology Center (Gearhart J, Posselt H) (2006)
Toxic at Any Speed. Chemicals in Cars and the Need for Safer Alternatives.
http://www.ecocenter.org/dust/ToxicAtAnySpeed.pdf

Environmental Working Group

Parent's Guide to Buying – Safety Guide to Children's personal care products

This new children's products safety guide will help parents navigate and find safer products with fewer ingredients linked to allergies, cancer, and other concerns for children (http://www.cosmeticsdatabase.com/special/parentsguide/).

Fragrance Products Information Networks (FPIN)
http://www.fpinva.org/

The objective of the site is to gather available information and make it readily available to the medical, scientific and regulatory communities, and the public. The purpose of this information network is to educate readers on health and environmental concerns related to fragrance so that consumers can make informed choices. The broad goal is to use education, science, and information to address very complex issues regarding fragrances exposure and health effects. Readers can find relevant exposure related documents on the website.

Green Peace International

Guide to Greener electronics – Toxic chemicals criteria in depth (9 November 2007) http://www.greenpeace.org/raw/content/international/press/reports/Guide-Greener-electronics-chemicals-criteria.pdf

Toxic Chemicals in Computers Reloaded (September 2007) http://www.greenpeace.org/raw/content/international/press/reports/laptopreport2.pdf

Greenpeace investigations into hazardous chemicals in our bodies and homes http://www.greenpeace.org/international/campaigns/toxics/chemicals-out-of-control/further-reading/Greenpeacehazardouschemicalsinvestigations

Databases

(U.S.) NATIONAL INSTITUTES OF HEALTH (NIH), National Library of Medicine (NLM)-Household Products Database
http://hpd.nlm.nih.gov/index.htm

Information in the Household Products Database is taken from a variety of publicly available sources, including brand-specific labels and Material Safety Data Sheets (MSDS) prepared by manufacturers. The database is designed based on classifying everyday U.S. consumer products into several categories such as;

- Auto products (http://hpd.nlm.nih.gov/cgi-bin/household/prodtree?prodcat=Auto+products);

- Inside the home products (http://hpd.nlm.nih.gov/cgi-bin/household/prodtree?prodcat=Home+inside);
- Pesticides (http://hpd.nlm.nih.gov/cgi-bin/household/ prodtree?prodcat=Pesticides);
- Landscape and yards (http://hpd.nlm.nih.gov/ cgi-bin/household/prodtree?prodcat=Landscaping/Yard);
- Personal care and use (http://hpd.nlm.nih.gov/ cgi-bin/household/prodtree?prodcat=Personal+care/use);
- Home maintenance (http://hpd.nlm.nih.gov/ cgi-bin/household/prodtree?prodcat=Home+maintenance);
- Arts and crafts (http://hpd.nlm.nih.gov/cgi-bin/household/prodtree?prodcat=Hobby/Craft)
- Pet care (http://hpd.nlm.nih.gov/cgi-bin/household/prodtree?prodcat=Pet+Care); and
- Home office products (http://hpd.nlm.nih.gov/cgi-bin/household/prodtree?prodcat=Home+Office)

Ingredients of each product are listed and MSDS associated with each ingredient are provided on this website. It is important to note that from a public health exposure prevention and management perspective, exposure criteria and limits provided in the MSDS list may not be applicable to residential and other non-industrial work environments.

'SKIN DEEP' COSMETIC SAFETY DATABASE

This is a personal care products safety database maintained by Environmental Working Group. Skin Deep Cosmetic Safety Database is a safety guide to cosmetics and personal care products designed by researchers at the Environmental Working Group. Skin Deep pairs ingredients in more than 25 000 products against 50 definitive toxicity and regulatory databases, making it the largest integrated data resource of its kind. Why did a small nonprofit take on such a big project? Because the FDA doesn't require companies to test their own products for safety.

(excerpted from http://www.cosmeticsdatabase.com/index.php)

Specific information on cosmetic ingredients can be obtained from http://www.cosmeticsdatabase.com/splash.php?URI=%2Fspecial%2Fparentsguide%2Fsummary.php

HUMAN EXPOSURE DATABASE SYSTEM (HEDS)

HEDS is the Human Exposure Database System that is being developed by the United States Environmental Protection Agency (USEPA), USA It is an integrated database system that contains chemical measurements, questionnaire responses, documents, and other information related to EPA research studies of the exposure of people to Environmental contaminants." (From USEPA website – accessed online – January 31, 2008). HEDS can be accessed at http://www.epa.gov/heds/ – Human Exposure Database System. Other exposure assessment and analysis related surveys, databases, research publications and exposure assessment software models can be found in the following web links under USEPA.

Radiation Related exposure in urban environments

http://www.epa.gov/radtown/enter-radtown.htm
RAD Town exposure web page from USEPA

This web page focuses on radiation-related exposure in urban environments in the USA.

TOTAL EXPOSURE ASSESSMENT METHODOLOGY (TEAM)

The Total Exposure Assessment Methodology (TEAM) was designed by the U.S. Environmental Protection Agency to develop and demonstrate methods to measure human exposure to toxic substances in air and drinking water. pTEAM refers to Particle exposure studies and vocTEAM refers to Volatile organic chemicals exposure studies. TEAM was initiated by RTI international for the US EPA in the 1970s. It represented the first use of statistically sampled populations to establish the relationships between an individual's exposure to toxic substances and actual substance absorption by body tissue. These data sets became key component in formulating human health risk assessments.

During a TEAM pilot project, a remarkable discovery was made. The monitored participants, like most Americans, spent 70% to 90% of their time indoors. For almost all chemicals of interest, exposures for those participants were higher than values taken by fixed outdoor monitors. Even in unpolluted locales, indoor air did not meet basic air quality standards From the TEAM results emerged a new emphasis on understanding and preventing indoor air problems (excerpted from RTI international website: http://www.rti.org/page.cfm?objectid=2EBA89BD-6BB0-4C14-938066C6237E1BC9).

(U.S.) DEPARTMENT OF HEALTH AND HUMAN SERVICES, CENTERS FOR DISEASE CONTROL AND PREVENTION (CDC)

National Biomonitoring Program from the Center for Disease Control (CDC), USA

'CDC's Environmental Health Laboratory conducts the National Biomonitoring Program (NBP). The Program specializes in biomonitoring, which is the direct measurement of people's exposure to toxic substances in the environment by measuring the substances or their metabolites in human specimens, such

as blood or urine. Biomonitoring measurements are the most health-relevant assessments of exposure because they indicate the amount of the chemical that actually gets into people (from all environmental sources (e.g., air, soil, water, dust, food) combined, rather than the amount that may get into them.' (Excerpt from http://www.cdc.gov/nceh/dls/national_biomonitoring_program.htm accessed February 3, 2008).

National Exposure Report from the CDC
http://www.cdc.gov/nceh/dls/national_exposure_report.htm

National Exposure Report from the CDC (the most extensive assessment ever made of the exposure of the U.S. population to selected chemicals of interest in the U.S. environment)

The report can be accessed from-http://www.cdc.gov/exposurereport/ or http://www.cdc.gov/exposurereport/3rd/pdf/thirdreport.pdf (accessed online January 31, 2008)

A summary of US exposure and estimation program from various federal departments can be found at http://www.scorecard.org/chemical-profiles/ref/exp.html.

Human Exposure Monitoring Program (HEMP)
Wood Buffalo Environmental Association (WEBA)
http://www.wbea.org/content/view/31/72/

The Fort McMurray, Alberta based non-governmental organization WBEA has initiated an ongoing Human Exposure Monitoring Program (HEMP) to continuously monitor select individuals that are exposed to air contaminants in their everyday environments. This is the first long term human exposure monitoring program (conducted at the community level) in the world. Volunteer complete a screening survey and consent form and wear two types of personal air monitoring equipment at all times. Then they allow additional air monitoring equipment to be set up inside and outside their home. Further, they complete a time activity diary; a demographic, exposure, and health survey. Battery-operated monitors are replaced with new batteries. The HEMP program examines the relationship between concentrations of selected air contaminants in personal, indoor, and outdoor air and to examine the factors affecting human exposure to air contaminants. Further, trends in air contaminant levels (if any) are established that people of Wood Buffalo are exposed to in their everyday environments. These data may assist WBEA in establishing links between air quality of Fort McMurray region and its potential health related effects. Data collected from the program may also aid in future research and the development of other programs in the region. For additional information, contact:

Public Health Surveillance and Environmental Health
Alberta Health and Wellness
24th Floor Telus Plaza North Tower
P.O. Box 1360
10025 – Jasper Avenue
Edmonton, Alberta T5J 1S6
Phone: (780) 427-4518
Fax: (780) 427-1470
Internet: www.health.gov.ab.ca

Wood Buffalo Environmental Association
Suite #214, 9914 Morrison Street
Fort McMurray, Alberta
T9H 4A4
Phone: 780-799-4420
Fax: 780-715-2016
Email: wbea.ed@shawlink.ca

eNewsletters and Websites

Environmental Health News and Above The Fold daily news update
http://www.environmentalhealthnews.org/
http://www.environmentalhealthnews.org/subscribe.html

Product Safety daily newsletter
http://www.productsafetyletter.com/profile/

The Daily Green
http://www.thedailygreen.com/

Popular Articles from Magazines and Multimedia

Everyday Exposure To Radiation
http://www.chem.duke.edu/~jds/cruise_chem/nuclear/exposure.html

10 Everyday pollution solutions
http://www.ewg.org/solutions

Is Everyday Pollution Disrupting your Hormones
http://thyroid.about.com/od/toxictriggers/a/pollution.htm

Pollution in People – A Study of Toxic Chemicals in Oregonians
November 2007
http://www.healthandenvironment.org/articles/doc/2654

Everyday Carcinogens
http://www.stopcancer.org/pdf/bgpaper.pdf

The Human Toxome Project
http://www.ewg.org/sites/humantoxome/

National Geographic
October 2006

The Pollution Within – Everyday Chemical Exposure article http://ngm.nationalgeographic.com/ngm/0610/feature4/index.html (accessed online – February 8, 2008).

Human Exposure to Chemicals – PBS Science Report funded by National Science Foundation
June 24, 2005 http://www.pbs.org/newshour/bb/science/jan-june05/chemicals_5-24.html
(accessed online – February 08, 2008)

Everyday Exposure to Radiation fact sheet from Public Boardcasting System (PBS)
http://www.pbs.org/wgbh/pages/frontline/shows/reaction/interact/facts.html (accessed online – February 8, 2008)

What are the health impacts of Household Products?
http://www.helium.com/tm/557235/spend-indoors-75000-chemicals (accessed online – February 8, 2008)

Wendy Mesley – CBC Market Place

'Chasing the Cancer' a television documentary focusing on everyday exposure to cancer causing chemicals http://www.cbc.ca/consumers/market/files/health/cancer/index.html (accessed online – February 08, 2008)

Probing Chemicals Effect on Pregnancy, Can everyday exposure to household chemicals put baby at risk?
Calgary Herald 2006
http://www.canada.com/topics/bodyandhealth/story.html?id=5592619d-acf6-45f9-a810-aee5df00c1ed&k=4887 (accessed online February 8, 2008)

Anne Steinemann – The Water Center 2007 Oceans to Stars Lecture Series. Hidden Health Hazards: Everyday Exposures to Toxic Chemicals
http://water.washington.edu/Outreach/Events/SpecialEvents/oslsAS.html (accessed online – February 11, 2008)

CHAPTER

31

Food and Nutrition

WAVERLY THORSEN

INTRODUCTION

The study of food and nutrition toxicology is inherently interdisciplinary, encompassing the principles of both food and nutrition research, as well as the concepts of toxicological work. As such, research in this field can range from modeling the pharmacokinetics of micronutrients in the human body, to the measurement of pesticide residues in drinking water. This chapter presents a comprehensive review of selected resources available in the field of food and nutrition toxicology. Emphasis is placed on current and emerging research, particularly focusing on diet and health, dietary supplements, functional foods, nutrient–gene interactions, and drug–nutrient interactions.

This chapter is intended to encompass the many realms of food and nutrition toxicology including mechanistic and clinical research, as well as the risk assessment and regulatory aspects. Further information is available at each of the institutes and societies listed under the 'Organizations' section, and in the numerous peer-reviewed scientific literature presented in each of the journals listed. There is a wealth of additional information available from online internet sources, including database resources, and online newsletters and organization websites.

RESOURCES

Books

Abbas HK (ed.) (2005)
Aflatoxin and Food Safety
Food Science and Technology Series, no. 149
CRC Press, Boca Raton, FL

Focuses specifically on food safety concerns related to aflatoxin. Discusses the wide range of issues associated with the mycotoxin. Included are chapters on the economic costs of mycotoxin management in the United States, worldwide food safety perspectives, aflatoxin regulation and improvements and advances in analysis. Additionally, the human health component is addressed with a chapter on the epidemiology of aflatoxin exposure and human liver cancer.

Aggett PJ, Kuiper HA (Eds.) (2000)
Risk Assessment in the Food Chain of Children
Nestle Nutrition Workshop Series
Lippincott, Williams, and Wilkins, New York, NY

Comprehensive review of the many exposure routes and health effects of food contaminants in children. Chapters include potential hazard exposure through breast milk, the effect of perinatal exposure of PCBs and dioxins on the neurological and cognitive development in children, and the role of the gastrointestinal tract in handling hazards in the food chain. The final chapter discusses novel foods and novel hazards associated with those foods.

Altug T (2003)
Introduction to Toxicology and Food
CRC Press, Boca Raton, FL

The first five chapters of this book provide background and general information on toxicological principles including definitions, toxin classification, and toxication. Chapters 6, 8, and 9 focus particularly on food/

nutrition toxicology, discussing natural sources of toxicants in foods, food additives, and chemopreventers in the diet. Toxicity testing is also discussed and includes in vitro and in vivo studies, as well as epidemiological human studies and biomarker research.

Awad AB, Bradford PG (Eds.) (2006)
Nutrition and Cancer Prevention
CRC Press, Taylor and Francis, Boca Raton, FL

A reference that presents the current research on dietary modulation of human health and the development of cancer. Traditional micronutrients and their potential roles in cancer prevention and development are discussed, including vitamin A, vitamin C, and folic acid. Additionally, functional food components such as phytosterols, carotenoids, phytoestrogens, and flavanoids are also evaluated in terms of their roles in cancer mechanisms. The effect of lifestyle influences on cancer development, such as alcohol intake and obesity, are also addressed.

Baer-Dubowska W, Bartoszek A, Malejka-Giganti D (Eds.) (2005)
Carcinogenic and Anti-carcinogenic Food Components
CRC Press, Boca Raton, FL

The 17 chapters in this book provide a comprehensive evaluation of chemopreventive and genotoxic food components. Additionally, mechanisms of carcinogenesis are also discussed. Food components evaluated include polyunsaturated fatty acids, phenolic compounds, carotenoids, and flavanoids. The research is current and timely, for instance, an analysis of resveratrol, a compound found in red wine and grapes, thought to have anticarcinogenic properties, is found in Chapter 12.

Boullata JI, Armenti VT (Eds.) (2004)
Handbook of Drug–Nutrient Interactions
Humana Press, Totowa, NJ

Provides a thorough review of the influence of nutritional status and dietary intakes on drug effects, and on the influence of pharmaceuticals on nutritional status. Chapters include information on dietary supplement interactions with medications and the effects of foods on drug metabolism. The final section in the book focuses on drug–nutrient interactions in specific health conditions including patients with cancer, organ transplantation, and chronic infections.

Bowman BA, Russell RM (Eds.) (2006)
Present Knowledge in Nutrition, 9th edn
ILSI Press, Washington, DC

Reflects the growth in the science base and application of nutritional science to a wide variety of related disciplines. Principles of nutrition have evolved from the identification of their role in preventing deficiency states to the prevention of chronic rather than acute adverse states. Also includes a wealth of public health information related to nutrition.

Branen AL, Davidson PM, Salminen S, Thorngate J (Eds.) (2002)
Food Additives, 2nd edn
Marcel Dekker, New York, NY

Comprehensive review of food additives and toxicological effects. Includes topics from hypersensitivity of food additives to regulatory issues. Current food additive topics such as antioxidants, flavor enhancers, fatty acids, and sweeteners are also discussed. Describes both toxicological aspects as well as nutritional aspects of food additives.

Burdock GA (1996)
Encyclopedia of Food and Color Additives, 3 vols.
CRC Press, Boca Raton, FL

This reference set provides descriptions of all substances listed in the Everything Added to Food in the U.S. (EAFUS) database, including food additive categories and some substances not considered to be 'additives,' such as corn oil. Provides concise, understandable descriptions of the substances.

Burdock GA (2005)
Fenaroli's Handbook of Flavor Ingredients, 5th edn
CRC Press, Boca Raton, FL

This handbook is divided into two sections. The first section of the book reviews general information about natural flavor ingredients, such as the history, sensory mechanisms, human taste perception, and the nomenclature and classifications of flavor ingredients. The second section of the book contains an alphabetical listing of approximately 200 natural flavor ingredients. In terms of food and nutrition toxicology, this book is most helpful to toxicologists as a resource for natural flavor ingredients.

Clydesdale FM (Ed.) (1997)
Food Additives: Toxicology, Regulation, and Properties
CRC Press, Boca Raton, FL

Database (Priority-Based Assessment of Food Additives, PAFA) compiled by the Center for Food Safety and Applied Nutrition, Food and Drug Administration. Includes information on Everything Added to Food in the United States (EAFUS). On CD-ROM.

Dabrowski WM, Sikorski ZE (Eds.) (2005)
Toxins in Food
CRC Press, Boca Raton, FL

This reference examines natural and anthropogenic toxins in foods, including natural plant toxins, phyto estrogens, and bacterial toxins. Timely chapters on toxic components of food packaging materials and on the effects of processing on the nutritive qualities and toxicity of foods are also included. Moreover, food allergies, sensitivities, and intolerances are also discussed in the context of current associations between food and health.

De Vries J (Ed.) (1996)
Food Safety and Toxicity
CRC Press, Boca Raton, FL

Examines many current problems and changes in food safety and toxicity affecting food researchers, regulators, and many other interest groups. The main sections explore the relationship between the origin of potentially toxic compounds and ingestion, the possible consequence of this ingestion, and the prevention and minimization of health risks.

De'Mello JPF (Ed.) (2003)
Food Safety: Contaminants and Toxins
CABI Publishing, Cambridge, MA

Provides a comprehensive review of naturally occurring and anthropogenic contaminants in foods, and the impacts on food safety. Part one focuses on biotoxins (plant, bacterial, shellfish, and mycotoxins) in foods, while Part two describes anthropogenic contaminants (pesticides, polychlorinated biphenyls, polycyclic aromatic hydrocarbons, and nitrates) in foods. The third section of the book presents case studies on such topics as prion diseases in relation to meat and animal product safety, and genetically modified foods and human health.

Food and Nutrition Board, Committee on the Framework for Evaluating the Safety of Dietary Supplements (2005)

Dietary Supplements: A Framework for Evaluating Safety
National Academies Press, Washington, DC

Timely and informative reference on evaluating the safety of dietary supplements. An important application of toxicological principles to food and nutrition. Includes chapters on human and animal data and vulnerable groups/special populations. Also presents case studies for specific supplements and potential adverse health risks.

General Accounting Office (GAO) (2002)
Genetically Modified Foods
GAO-02-566 United States General Accounting Office, Washington, DC
Web: http://www.gao.gov/new.items/d02566.pdf

Reports on the possible risks and benefits of genetically modified foods. Evaluates the Food and Drug Administration's (FDA) procedures for assessing the safety of genetically modified foods, and provides recommendations to the FDA for improved screening. Provides a helpful background on genetically modified food biotechnology and identifies genetically modified foods currently approved for consumption. This report provides a current analysis of the risks and benefits of biotechnology and foods.

Goktepe I, Juneja VK, Ahmedna M (Eds.) (2006)
Probiotics in Food Safety and Human Health
CRC Press, Taylor Francis, Boca Raton, FL

A resource for comprehensive information on pre- and probiotics and human health. This book addresses the agricultural, nutritional, biochemical, and toxicological aspects of probiotics in the human food supply. This resource is timely in light of recent studies suggesting a role for probiotics in cancer prevention. The safety and regulation of probiotics in the food supply are also discussed.

Hamilton D, Crossley S (Eds.) (2004)
Pesticide Residues in Food and Drinking Water: Human Exposure and Risks
J. Wiley, Hoboken, NJ

A comprehensive summary of the complexities of human exposure to pesticide residues in foods and drinking water. This book examines a wide spectrum of toxicological and nutritional aspects including the environmental fate of pesticides and the effects of food processing on pesticide residues. Additional chapters include pesticide metabolism in plants (crops) and livestock, as well as International Standards for pesticide residues.

Hui YH (Ed.) (2001)
Foodborne Disease Handbook, 2nd edn
Marcel Dekker, New York, NY

In-depth discussion of the transmission, identification, diagnosis, treatment, and prevention of foodborne pathogens. Volume 1 covers diseases caused by bacteria, Volume 2 discusses diseases caused by viruses, parasites, pathogens, and discusses hazard analysis and critical control point (HAACP) systems, and Volume 3 discusses diseases caused by plant toxicants. Volume 4 discusses seafood and environmental toxins.

International Agency for Research on Cancer (1997)
Coffee, Tea, Mate, Methylxanthines, and Methylglyoxal
World Health Organization, Lyon

http://monographs.iarc.fr/ENG/Monographs/vol51/volume51.pdf

Volume 51 of the *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans.* Convened by expert panels to review all of the long-term toxicity information on the chemicals in the title with particular emphasis on cancer. This monograph presents a thorough review of this information. The panels concluded that there is limited evidence that coffee is carcinogenic to the human urinary bladder and there is inadequate information for other sites; that tea and mate drinking is not classifiable as to its carcinogenicity, and that caffeine, theophylline, theobromine, and methylglyoxal are not classifiable. This book is an excellent source for the specific long-term information available on the compounds.

International Agency for Research on Cancer (2004)
Some Drinking-Water Disinfectants and Contaminants, Including Arsenic
World Health Organization, Lyon
http://monographs.iarc.fr/ENG/Monographs/vol84/volume84.pdf

This monograph (volume 84), compiled and written by the World Health Organization, International Agency for Research on Cancer evaluates the scientific data on the carcinogenicity of specific drinking water contaminants, including naturally occurring arsenic, and disinfection by-products. The disinfection by-products reviewed include chloramine, chloral and chloral hydrate, and di- and tri-chloroacetic acid, as well as 3-chloro-4-(dichloromethyl)-5-hydroxy-2(5H)-furanone. Each compound is evaluated using the available exposure data, human and animal carcinogenicity data, and other relevant data.

Johns-Cupp M, Tracy TS (Eds.) (2003)
Dietary Supplements: Toxicology and Clinical Pharmacology
Humana Press, Totowa, NJ

Part one of this reference discusses legal and regulatory aspects of dietary supplements. Part two presents individual chapters on specific dietary supplements, and toxicological and clinical pharmacology are included. Individual monographs in Part two include over-the-counter steroids, coenzyme Q10, pyruvate, and red yeast rice extract, among others. The appendix provides a comprehensive summary table on dietary supplements.

Joint FAO/WHO Expert Committee on Food Additives (2006)
WHO Food Additive Series
World Health Organization, Geneva, Switzerland
http://www.who.int/ipcs/publications/jecfa/monographs/en/index.html

This important monographic series summarizes safety data on selected food additives and contaminants and individual volumes are based on meetings of the Joint FAO/WHO Expert Committee on Food Additives (JECFA). The data reviewed in these monographs form the basis for acceptable daily intakes (ADIs). Number 49, for example, published in 2001, covers the toxicological evaluation of certain veterinary drug residues in food.

Kotsonis FN, Mackey M (Eds.) (2002)
Nutritional Toxicology, 2nd edn
Taylor and Francis, New York

This reference contains chapters on the role of nutrients in protecting the body against toxicants. Also included are chapters on developments in food production. The book brings together diverse issues that are at the forefront in nutritional toxicology, including antioxidants and protection from free radicals, and interactions between foods, nutritional supplements, and drugs. A comprehensive resource for a quick reference or an in-depth reading.

Miliotis MD, Bier JW (Eds.) (2003)
International Handbook of Foodborne Pathogens
Marcel Dekker, New York, NY

Comprehensive resource of foodborne viruses and bacteria are both established and emerging. Also includes information on mycobacterium, marine biotoxins, and foodborne protista, among others. The second part of the book provides an interesting summary of the geographic incidence of foodborne illnesses by country/region. Risk assessment and hazard analysis and critical control point (HACCP) systems are also discussed.

Omaye ST (2004)
Food and Nutritional Toxicology
CRC Press, Boca Raton, FL

A thorough reference guide to concepts in food and nutrition toxicology. The book is divided into three sections which include (1) fundamental concepts, (2) toxicants in foods, and (3) food contamination and safety. It begins with a discussion of general toxicological principles (e.g., toxicokinetics and dose–response relationships), and then reviews dietary factors that influence toxicity. Both in vitro and in vivo laboratory toxicity testing method are also discussed. Individual microorganisms are reviewed including their mechanism of action and clinical symptoms in foodborne pathogens exposure. The book concludes with a discussion of emerging food safety issues.

Papas AM (Ed.) (1999)
Antioxidant Status, Diet, Nutrition, and Health
CRC Series in Contemporary Food Service
CRC Press, Boca Raton, FL

Integrates the biological, nutritional, and health aspects of antioxidant status. Topics examined include factors affecting and methods for evaluating antioxidant status in humans, effect of diet and physiological stage, and the role of antioxidant status in nutrition, health, and disease.

Pokorny J, Yanishlieva N, Gordon MH (Eds.) (2001)
Antioxidants in Food: Practical Applications
Woodhead Publishing Limited, and CRC Press, Boca Raton, FL

Contains 15 chapters on numerous aspects of antioxidants found in, and used in, foods from both plant and animal origin. An overview chapter on antioxidants and food stability describes mechanisms of oxidation and antioxidant effects. Additional chapters include information on antioxidants and health, natural antioxidants, and the regulation of antioxidants in foods (includes European Union, the United States, Australia, and Japan).

Preedy VR, Watson RR (Eds) (2005)
Reviews in Food and Nutrition Toxicity, Volumes 1–4
CRC Press, Boca Raton, FL

The four volumes of this reference provide a comprehensive review of the current research related to food and nutrition toxicity. Topics include food safety, food technology, and food and nutrition toxicology. The most recent volume (Volume 4) contains chapters on heavy metals in breast milk, selenium toxicity, and toxicological considerations of dietary sulfur, among other chapters. Environmental, toxicological, nutritional, and public health disciplines are integrated in each volume, providing an informative, interdisciplinary reference.

Shahidi F (Ed.) (1997)
Antinutrients and Phytochemicals in Food
American Chemical Society, Washington, DC

Volume 662 of the *ACS Symposium Series*. From the Preface: 'Antinutrients in foods are responsible for the deleterious effects that are related to the absorption of nutrients and micronutrients which may interfere with the function of certain organs . . . certain harmful effects might also be due to the breakdown products of these compounds.'

Shahidi F, Ho CT, Watanabe S, Osawa T (Eds.) (2003)
Food Factors in Health Promotion and Disease Prevention
American Chemical Society, Washington, DC

A comprehensive reference on numerous food components and their health effects. Mechanisms are also discussed. Includes a wide range of topics such as cancer chemoprevention by phytopolyphenols, and signal transduction, and modulation of cytokine gene expression by curcumin. The interaction between anthropogenic contaminants and nutritional components is also discussed in Chapter 11, which is entitled 'Green tea extracts prevent dioxin toxicity through the suppression of transformation of the aryl hydrocarbon receptor.'

Shils ME, Shike M, Ross AC, Caballero B (Eds.) (2006)
Modern Nutrition in Health and Disease, 10th edn
Lippincott, Williams, and Wilkins, New York, NY

An extremely thorough, up-to date reference for nutritional knowledge in health and disease. This book is divided into six parts which include historical nutrition landmarks, specific dietary components (e.g., macronutrients, minerals and vitamins), nutrition in biological systems, nutritional life-cycle requirements, prevention and management of disease, diets in population health, and regulatory information. Toxicological aspects of food and nutrition such as overdoses, tolerable upper limits, and bioavailability are presented in many of the chapters.

Tschanz C, Butchko HH, Stargel WW, Kotsonis FN (Eds.) (1996)
The Clinical Evaluation of a Food Additive: Assessment of Aspartame
CRC Press, Boca Raton, FL

Covers the rigorous scientific, regulatory, and clinical testing and evaluation applied to aspartame. The book provides an overview of the food additive evaluation process and describes the clinical studies used to evaluate anecdotal medical complaints such as headaches, seizure, and allergic-type reactions.

Watson DH (Ed.) (2004)
Pesticide, Veterinary, and Other Residues in Food
Woodhead Publishing, Cambridge, MA

This reference provides a broad scope of information on food residues. Includes genetic factors in susceptibility to carcinogens, methods for analyzing residues in foods, and specific detection methods for various residues (pesticides, herbicides, fungicides). Also discusses individual contaminants as food residues, including dietary estrogens, polycyclic aromatic hydrocarbons, and polychlorinated biphenyls.

See also

Acamovic: *Poisonous Plants and Related Toxins* (Food-Toxicology)

American Institute for Cancer Research: *Nutrition and Cancer Prevention: New Insights into the Role of Phytochemicals* (Nutrition-Cancer)

Emerton: *Food Allergy and Intolerance* (Food Allergy-Toxicology)

Green: *Toxicology and Regulatory Process* (Toxicology-Regulation, FQPA, SDWA)

Heber: *Nutritional Oncology* (Cancer-Nutrition)

Hughes: *Diet and Human Immune Function* (Nutrition-Immunology)

Ioannides: *Nutrition and Chemical Toxicity* (Nutrition-Toxicity)

Kumpulainen: *Nutritional and Toxicological Quality Comparisons Between Organic and Conventionally Grown Foodstuffs* (Nutrition, Toxicology-Organic Foods)

McCabe: *Handbook of Food-Drug Interactions* (Food-Drugs)

Metcalf: *Food Allergy: Adverse Reactions to Food and Food Additives* (Food Allergy-Toxicology)

Smith: *Food Additives Databook* (Nutrition, Toxicology – Food additives)

Sullivan: *The Environmental Science of Drinking Water* (Water-Chemicals)

Tennant: *Food Chemical Risk Analysis* (Food-Risk Assessment)

Thompson: *Food-Drug Synergy and Safety* (Food-Drugs)

Watson: *Natural Food Toxicants* (Food-Toxicology)

Journals

Advances in Food and Nutrition Research (1948–1989 as *Advances in Food Research*)
Academic Press, San Diego, CA

Includes articles on the relationship between food and nutritional science. Scientific developments and emerging research in the field are presented. Example articles include the latest science on lycopene and cancer, and food components that reduce cholesterol absorption.

American Journal of Clinical Nutrition (1952–1954 as *Journal of Clinical Nutrition*)
American Society for Clinical Nutrition, Bethesda, MD
http://www.ajcn.org/

The journal of the American Society for Clinical Nutrition focuses on the relationship between nutrition and human health. Research articles include nutritional effects on cardiovascular disease development and prevention, and the role of nutrition in obesity. Results from studies on gene–nutrient interactions and nutritional epidemiology are also presented.

Food Additives and Contaminants (1984–)
Taylor and Francis, Philadelphia, PA

Presents research on analytical methodology, occurrence, persistence, safety-evaluation, detoxification, and surveillance of anthropogenic additives and contaminants in foods. Also includes regulatory issues. Overall research areas include pesticide and veterinary drug residues, environmental contaminants, migration from food packaging, and allergenicity of foods, among others.

Food and Chemical Toxicology (1963–1982 as *Food and Cosmetics Toxicology*)
Pergamon, New York, NY

Focuses on the toxic effects of natural and synthetic chemicals in the environment. Research is reported on the safety and health implications of food, water, and other consumer products as well as on industrial and agricultural chemicals and pharmaceutical products. Additional articles focus on the safety evaluation of novel or biotech foods. Articles in this journal combine the food science, toxicology, and chemistry disciplines.

Food and Drug Law Journal (1946–)
Commerce Clearing House, Chicago, IL

A journal from the Food and Drug Law Institute. Includes articles relating to regulation and legislation that impacts the food, drug, cosmetic, medical device, and healthcare technology industries. Also evaluates court decisions in food and drug law (e.g., intellectual property, antitrust, constitutional, and criminal law) and examines food and drug regulatory issues in other countries.

Journal of Agriculture and Food Chemistry (1953–)
American Chemical Society, Washington, DC
http://pubs.acs.org/journals/jafcau/index.html

Focuses on food and agriculture chemistry and biochemistry. Includes articles on topics of food composition, processing effects, and safety. Also examines the chemistry, toxicology, metabolism, and environmental fate of pesticides, veterinary drugs, and fertilizers.

Journal of Food Protection (1937–)
International Association for Food Protection, Des Moines, IA
http://www.ingentaconnect.com/content/iafp/jfp

Published by the International Association for Food Protection, this journal presents current research in food science and technology. Research articles related to food protection, food safety and quality, and food microbiology. Explores novel laboratory methods related to food safety and microbiology and presents an international scope.

Journal of Nutritional Biochemistry (1990–)
Butterworths, Stoneham, MA

Includes research articles on advances in the field of nutritional sciences. Focuses on cross-discipline research, presenting experimental nutrition data related to biochemistry, neurochemistry, molecular biology, toxicology, physiology, and pharmacology. Both in vitro and in vivo data are presented.

Journal of Nutritional and Environmental Medicine (1999–)
Taylor and Francis, Philadelphia, PA

This journal's main focus is on allergy and environmental medicine, particularly presenting studies with clinical relevance. Includes articles on nutritional toxicology, chemical sensitivity, nutrition and reproductive function, antioxidants in health and disease, relevant laboratory methods, and nutritional supplementation. Also includes state-of-the-art reports on applicable current clinical practice.

Journal of Nutrition (1928–)
American Society for Nutrition, Philadelphia, PA
http://jn.nutrition.org/

This journal presents research on all aspects of experimental nutrition research conducted in humans and other animal species. In terms of food and nutrition toxicology, research is published on diet and disease, nutrient–gene interactions, nutrition and immunology, nutrition and pharmacology and toxicology, nutrition and epidemiology, and vitamins and minerals.

Nutrition and Metabolism (2004–)
BioMed Central, Published online
http://www.nutritionandmetabolism.com/home/

This open-access, online journal (peer-reviewed) focuses on nutritional biochemistry and related clinical fields. Includes articles on the integration of nutrition, exercise physiology, and molecular and cellular biochemistry of metabolism. Also explores research on cell-signaling and nutrient–gene interactions.

Journal Articles

Cantani A (2006) Benefits and concerns associated with biotechnology-derived foods: can additional research reduce children health risks? Eur. Rev. Med. Pharmacol. Sci. 10(4): 197–206.

Centers for Disease Control and Prevention (2006) Ongoing multistate outbreak of *Escherichia coli* serotype O157:H7 infections associated with consumption of fresh spinach – United States, September 2006. MMWR 55(38): 1045–1046.

Corton JC, Brown-Borq HM (2005) Peroxisome proliferator-activated receptor gamma coactivator 1 in caloric restriction and other models of longevity. J. Gerontol. A Biol. Sci. Med. Sci. 60(12): 1494–1509.

Derr LE (2004) When food is poison: the history, consequences, and limitations of the Food Allergen Labeling and Consumer Protection Act of 2004. Food Drug Law J. 61(1): 65–165.

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Lucock MD (2006) Synergy of genes and nutrients: the case of homocysteine. Curr. Opin. Clin. Nutr. Metab. Care, 9(6): 748–756.

Mann SW, Yuschak MM, Amyes SJ, Aughton P, Finn JP (2000) A carcinogenicity study of sucralose in the CD-1 mouse. Food Chem. Toxicol. 38(Suppl.): S91–S97.

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glutathione-related enzymes. J. Nutr. Biochem. 16(10): 577–586.

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O'Brien J, Renwick AG, Constable A, et al (2006) Approaches to the risk assessment of genotoxic carcinogens in food: a critical appraisal. Food Chem. Toxicol. 44(10): 1613–1635.

Ramkumar KM, Anuradha CV (2005) Short term dietary restriction modulates liver peroxide in carbon tetrachloride-intoxicated rats. J. Basic Clin. Physiol. Pharmacol. 16(4): 245–256.

Rock CL, Lampe JW, Patterson RE, (2000) Nutrition, genetics, and risks of cancer. Ann. Rev. Public Health, 21: 47–64.

Sanders TA (2003) Food safety and risk assessment: naturally occurring potential toxicants and antinutritive compounds in plant foods. Forum Nutr. 56: 407–409.

Schrauzer GN (2003) The nutritional significance, metabolism, and toxicology of selenomethionine. Adv. Food Nutr. Res. 47: 73–112.

Sica DA (2006) Interaction of grapefruit juice and calcium channel blockers. Am. J. Hypertens. 19(7): 768–773.

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Winter CK (2002) Electronic information resources for food toxicology. Toxicology 173(1–2): 89–96.

Organizations

American Chemical Society
1155 Sixteenth Street, NW
Washington, DC 20036
Phone: 800-227-5558 (US only)
202-872-4600 (outside the US)
Fax: 202-872-4615
E-mail: help@acs.org
Web: http://acswebcontent.acs.org/home.html

The primary scientific society for all fields of chemistry. Consists of 33 technical divisions which include agriculture and food chemistry and chemical toxicology. The society supports interdisciplinary research in chemistry.

American Public Health Association
800 I Street, NW
Washington, DC 20001
Phone: 202-777-APHA
Fax: 202-777-2534
E-mail: comments@apha.org
Web: http://www.apha.org/

Represents the oldest and largest organization of public health professionals in the world. Promotes research on disease prevention and health promotion. Also is concerned and involved with federal and state policies related to public health.

American Society for Nutrition
9650 Rockville Pike, Suite L-4500
Bethesda, MD 20814
Phone: 301-634-7050
Fax: 301-634-7892
E-mail: sec@nutrition.org
Web: http://www.nutrition.org/

Formed in 2005 through the merger of the American Society for Nutritional Sciences, the American Society for Clinical Nutrition, and the Society for International Nutrition Research. Represents the premier research society for nutritional sciences. Promotes research in fundamental nutrition, multidisciplinary fields, and clinical research.

Federation of American Societies for Experimental Biology
9650 Rockville Pike
Bethesda, MD 20814
Phone: 301-634-7000
Fax: 301-634-7001
E-mail: webmaster@faseb.org
Web: http://www.faseb.org/

Serves as a federation of over 20 member societies including the American Society for Pharmacology and Experimental Therapeutics, American Society for Nutrition, and the Environmental Mutagen Society. FASEB's mission is to promote and advance biological science that leads to improvements in human health.

Food, Drug and Law Institute
1155 15 Street NW, Suite 800
Washington, DC 20005
Phone: 800-956-6293; 202-371-1420
Fax: 202-371-0649
E-mail: comments@fdli.org
Web: http://www.fdli.org/

A scientific society focused on major policy, legislative, regulatory, and enforcement actions related to food and drugs. Also provides and supports education and training in the regulatory programs of the Food and Drug Administration (FDA) and other governmental organizations.

International Association for Food Protection
6200 Aurora Avenue, Suite 200W
Des Moines, Iowa 50322
Phone: 515-276-3344; 800-369-6337
Fax: 515-276-8655
E-mail: info@foodprotection.org
Web: http://www.foodprotection.org/main/default.asp

International society focused on the latest developments (scientific, technical, and practical) in food safety and sanitation. Brings together individuals from all employment sectors, academia, government, and industry, concerned with food safety and protection.

International Life Sciences Institute
One Thomas Circle
Washington, DC 20005
Phone: 202-659-0074
Fax: 202-659-3859
E-mail: ilsi@ilsi.org
Web: http://www.ilsi.org

An international institute focused on promoting human health through scientific advancements. Specifically explores the interdisciplinary scientific issues related to nutrition, food safety, toxicology, risk assessment, and the environment.

Society of Toxicology
1821 Michael Faraday Drive, Suite 300
Reston, VA 20190
Phone: 703-438-3115
Fax: 703-438-3113
E-mail sothq@toxicology.org
Web: http://www.toxicology.org/

The primary scientific society promoting toxicological research in the United States and abroad. Focuses on advancing science to promote human, animal, and environmental health. Consists of 21 specialty sections which include food safety, carcinogenesis, and regulation and safety evaluation.

Databases

Agricola
United States Department of Agriculture, National Agricultural Library
http://agricola.nal.usda.gov/

Provides agricultural online access to scientific collections of the National Agricultural Library. Two bibliographic datasets are available in this database including the online public access catalogue (e.g., books, audiovisuals, serials) and the article citation database (i.e., abstracts and citations of journal articles).

CARDS Database
Computer Access to Research on Dietary Supplements, Office of Dietary Supplements, National Institutes of Health
http://ods.od.nih.gov/Research/CARDS_Database.aspx

A database of dietary supplement research projects that are federally funded (e.g., United States Department of Agriculture, Department of Defense, and the National Institutes of Health). Searches are conducted according to type of dietary supplement studied, the type of study, health outcomes or biological effects, a distinction between directly related and indirectly related research, and keywords, among other variables. Note: The Office of Dietary Supplements, National Institutes of Health supports an additional dietary supplement database called International Bibliographic Information on Dietary Supplements (http://grande.nal.usda.gov/ibids/index.php).

CFSAN Color Additives
Food and Drug Administration, Center for Food Safety and Applied Nutrition
http://www.cfsan.fda.gov/~dms/col-toc.html

Database on all aspects of food additives including background and historical information, color laws and regulations, certifications, petition processes, and specific color additive and cosmetic products. Also contains a link to the 'everything added to food in the US' (EAFUS) database (http://www.cfsan.fda.gov/~dms/eafus.html).

FDA Poisonous Plant Database
Food and Drug Administration, Center for Food Safety and Applied Nutrition, US
http://www.cfsan.fda.gov/~djw/plantox.html

Provides a compilation of studies conducted on the toxicity of plants available in the scientific literature. Latest update: March 2006, containing approximately 97 000 records. Where available, information on the plants' common name, family name, Latin name, and standard plant name are listed.

IARC Cancer Databases
International Agency for Research on Cancer
http://www.iarc.fr/ENG/Databases/index.php

IARC cancer databases contain multiple database resources. These include a monographs database on carcinogenic risks to humans, cancer epidemiology database, and a TP53 mutation database, among others. A comprehensive resource for cancer-related research.

Inform All Food Allergy Database
Institute of Food Research, Norwich, UK
http://www.foodallergens.info/database.html

Funded by the European Union, this database provides information on animal and plant food allergens. For each allergen listed, general food summaries, clinical and biochemical data are reported. This database contains information geared for both the layperson as well as the trained scientist.

Micronutrient Information Center
Linus Pauling Institute, Oregon State University
http://lpi.oregonstate.edu/infocenter/

Provides comprehensive information on micronutrients including vitamins, minerals, other nutrients (e.g., carnitine, choline, lipoic acid), and dietary phytochemicals, relating to disease prevention and health promotion. A nutrient index and disease index are also available. Information presented for individual micronutrients includes their function, metabolism, deficiencies, RDA values, disease prevention, sources, drug interactions, and safety.

NAPRALERT
Natural Products Database, Program for Collaborative Research in the Pharmaceutical Sciences, University of Illinois, Chicago
http://www.napralert.org/

Database of over 200 000 scientific papers and reviews on natural products. Topics include clinical studies of natural products, natural products and nutrition interactions, and metabolism and pharmacokinetics. Twenty-five percent of the database comes from abstracts, and 75% comes from original research articles. There is a nominal fee associated with citation retrieval from this database.

NDL, Nutrient Data Laboratory
United States Department of Agriculture, Agricultural Research Service
http://www.ars.usda.gov/Main/site_main.htm?modecode=12-35-45-00

Comprehensive listing of the macronutrient and micronutrient compositions of an exhaustive list of foods and food components. Also contains additional databases ('database products' at http://www.ars.usda.gov/Services/docs.htm?docid=5121) such as nutrient datasets for flavonoids, cholines, added sugars, and proanthocyanidins in selected foods.

PDQ – NCI Comprehensive Cancer Database
Physician Data Query, National Cancer Institute, National Institutes of Health
http://www.cancer.gov/cancertopics/pdq/cancerdatabase

Comprehensive cancer database with peer-reviewed summaries, clinical trials registry, and a directory of health professionals and organizations involved in cancer care. Databases include research on cancer treatment, screening, cancer prevention, genetics, and complementary and alternative medicine.

Other resources

Center for Food Safety and Applied Nutrition, Food and Drug Administration
http://www.cfsan.fda.gov/~dms/nutrlist.html

An on-line 'library' of selected non-FDA sources of food and nutrition information. Includes other governmental sources and non-governmental sources of food and nutrition information such as institutes, resource databases, and publications. Also lists selected food and nutrition list serves.

Food and Nutrition Information Center, USDA
http://fnic.nal.usda.gov/nal_display/index.php?info_center=4&tax_level=1

A website resource providing news, resource lists, database links, and additional information about food and nutrition. Particularly relevant for toxicology-related resources are the food safety and dietary supplement links. A section on 'Surveys, Reports, and Research' also provides additional information on research databases and reports.

FSNET, Food Safety Network
University of Guelph, Ontario, Canada
http://www.foodsafetynetwork.ca/en/

An online national repository of food-safety-related information. Online reports and publications on topics such as pesticides, risk assessment and analysis, agricultural biotechnology and genetic engineering. Access to list serves is also listed on the website.

International Life Sciences Institute
http://www.ilsi.org/Publications/ILSINews/

Website resource of the official link to the ILSI newsletter. Published quarterly, the newsletter provides updates on ILSI activities, publications, and research. Examples of article topics include agricultural biotechnology, and safety assessment for nutritionally enhanced biotech foods. There are also publication reviews for recently released ILSI publications.

Institute of Medicine, National Academies of Science
http://www.iom.edu/

Website resource with links to current IOM projects and report on numerous topics including food, nutrition, and diet, and public health and prevention. Dietary reference intakes, food safety, dietary supplements, and safety of genetically engineered foods are examples of report topics within the food and nutrition section.

National Center for Complementary and Alternative Medicine, NIH
http://nccam.nih.gov/news/newsletter/2006_summer/

The website for the NCCAM official newsletter, providing an outlet for dissemination of important research related to complementary and alternative medicine. A link for online notification for the latest issue is located under 'subscribe on-line'.

National Food Safety and Toxicology Center
Michigan State University
http://www.foodsafe.msu.edu/index.html

Website resource on food safety and toxicology. Contains links on consumer food safety, publications, and outreach. Also contains a link to the Center's newsletter, as well as links to other federal, state, and non-governmental food safety and toxicology sites.

CHAPTER

32

Forensic Toxicology

PETER R. STOUT

If you haven't published it, you didn't do it.

Dr. Irving Sunshine

INTRODUCTION

Forensic toxicology is a multidisciplinary field involving the detection and interpretation of the presence of drugs and other potentially toxic compounds in bodily tissues and fluids. These analyses and interpretations are conducted in a manner to be defensible in court.

Forensic toxicology continues to be a dynamic field with evolving technology applications. Tandem mass spectrometry methods, particularly liquid chromatography-tandem mass spectrometry (LC-MS/MS), have grown in importance. These technologies provide greater sensitivities and flexibility for the detection of larger and more polar compounds that are difficult or impossible to analyze with gas chromatographic methods. Continued development of immunoassays for a wider range of compounds has kept immunoassays a vital part of the analytical armamentarium. Time of flight mass spectrometry (TOF-MS) has also become more important in the field. Likely, the next few years will see the continued influence of LC-MS/MS as a dominant analytical instrument. This is particularly true as instrumentation becomes smaller, more affordable, reliable, and sensitive.

Human performance testing, specifically analysis and interpretation of driving under the influence of drugs (DUID) has received increased attention. Non-traditional or alternate matrices (hair and oral fluid) continue to attract attention with potential benefits but also continue to raise many questions for the interpretation of these results and the potential confounders limiting their use.

Doping control or 'sports testing' is a high-profile though small component of toxicology. This primarily involves the testing in urine or blood for compounds that are viewed to give unfair competitive advantages. Some compounds are used 'out of competition' or to aid in training while others are 'in competition' drugs that give an advantage at the time the athlete is competing.

The advent of more, larger peptide-based drugs will present analytical challenges for forensic toxicologists. Also the rising field of pharmacogenomics and the concept of the genetic autopsy may alter dramatically the interpretation of drug concentrations. As more evidence is gained about the interplay between an individual's geno- and phenotypes and their mxetabolic capacity, changes in dosing and in the interpretation of what is viewed to be toxic and therapeutic are likely to occur.

The following references provide an overview of the field from basic to advanced issues within the field. References include material for analytical issues as well as interpretive issues. Non-traditional matrices are also represented in the references.

RESOURCES

Books

Baselt RC (2001)
Drug Effects on Psychomotor Performance
Biomedical Publications, Foster City, CA

This text includes monographs on over 120 compounds. The monographs provide pharmacokinetic information, pharmacology and a summary of some laboratory studies on the drugs. Summaries of psychomotor studies on the drugs are also provided with an attempt to provide some information for the interpretation of psychomotor effects.

Baselt RC (2004)
Disposition of Toxic Drugs and Chemicals in Man, *7**th*** edn
Biomedical Publications, Foster City, CA

A compilation of mini-monographs of individual drugs and chemicals from A–Z. The 7th edition adds an additional 139 compounds to the prior edition. Monographs provide basic pharmacokinetic information about each drug, some metabolic information and some review of literature on the compound.

Drummer OH with Odell M (2001)
The Forensic Pharmacology of Drugs of Abuse
Arnold, London (Oxford University Press, U.S.)

This text provides a solid overview of the pharmacology of many drugs of abuse. It has some information on the analysis of these compounds in biological matrices. The text includes sections on stimulants, benzodiazepines, cannabis, opioids, ethanol and smaller sections on less widely abused drugs.

Eckert WG (Ed.) (1997)
Introduction to Forensic Sciences, 2nd edn
CRC Press, Boca Raton, FL

For students and practitioners, this text treats the various methods of applying forensic sciences in a logical and relatively non-technical fashion. Features new to this edition include DNA typing, computerized fingerprint classification, serology instrumentation, drug and law enforcement, updated historical perspective, and updated lists of sources and addresses. Includes a chapter specifically on forensic toxicology.

Garriott JC (Ed.) (1996)
Medicolegal Aspects of Alcohol
Lawyers & Judges Publishing Co.

A comprehensive overview of all aspects of alcohol, the most common drug used and abused. The book contains information on analysis and interpretation of alcohol. Also provides an excellent overview of alcohol metabolism.

Kintz P (Ed.) (2006)
Analytical and Practical Aspects of Drug Testing in Hair
CRC Press, Boca Raton, FL

A continuation of materials covered in *Drug Testing in Hair.* This text includes updated information on analytical techniques and issues and has a diverse collection of opinions about hair testing.

Levine B (Ed.) (2003)
Principles of Forensic Toxicology, *2**nd*** edn
AACC Press, Washington DC

For students and practitioners, this text provides a comprehensive grounding in all aspects of forensic toxicology. The text has chapters on the major disciplines within forensic toxicology, the major methodologies and monographs on the major drug classes.

Moffat AC, Osselton MD, Widdop B (Eds.) (2004)
Clarke's Analysis of Drugs and Poisons, *3**rd*** edn
Pharmaceutical Press, London

A greatly revised and updated new edition of the classic analytical toxicology text. Volume 1 provides expanded chapters on analytical techniques updated to reflect more modern practices. Volume 2 contains monographs for over 1700 drugs and compounds with reference spectra and other analytical data.

Smith FP, Siegel JA (Eds.) (2005)
Handbook of Forensic Drug Analysis
Elsevier Academic Press, San Diego, CA

Provides a serious and technical overview of the analysis of common illicit drugs. Also provides information on the collection and handling of drug evidence.

Journals

The American Journal of Forensic Medicine and Pathology (1980–)
Raven Press, New York, NY

Features articles with a pathology perspective. Many case reports with toxicology are presented in this journal.

Canadian Society of Forensic Science Journal (la Societe canadienne des sciences judiciaries) (1974–)
The Society – Canadian Society of Forensic Science
http://www.csfs.ca/journal/journal.htm

The *Canadian Society of Forensic Science Journal* is published quarterly and is devoted to the publication of original papers, comments and reviews in the various branches of forensic science. Matters of forensic interest in the social sciences or relating to law enforcement and jurisprudence may also be published.

Forensic Science Reviews
Central Police University Press, Taipei, Taiwan

Contains review articles on a variety of forensic disciplines. This journal has worked with the Society of Forensic Toxicology to publish monographs drugs and driving for various compounds. Published bi-annually.

Forensic Science International (1972–)
Elsevier, Atlanta, GA
http://www.elsevier.com/wps/find/journaldescription.cws_home/505512/description#description

Another widely read journal in forensic toxicology containing many international publications. Contains many methodological papers as well as more basic research. Published monthly.

Journal of Analytical Toxicology (1977–)
Preston Publications, Niles, IL
http://www.jatox.com

Widely read journal for forensic toxicology. A primary source for many investigators in the field. Published an annual special edition with papers from the Society of Forensic Toxicologists' annual meeting. Published monthly.

Journal of Forensic Sciences (1972–)
Blackwell Publishing Inc. Malden, MA
http://www.aafs.org/

The publication of the American Academy of Forensic Sciences. This journal is distributed to the membership of the Academy and contains articles in all of the forensic disciplines. Published six times per year.

Journal Articles

Chamberlain RT (1996) Role of the clinical toxicologist in court. Clin. Chem. 42(8 Pt 2): 1337–1341.

Drummer OH, Gerostamoulos J (2002) Postmortem drug analysis: analytical and toxicological aspects. Ther. Drug Monit. 24(2): 199–209.

Drummer OH (2004) Postmortem toxicology of drugs of abuse. Forensic Sci. Int. 10: 142(2–3): 101–113.

Flanagan RJ (2004) Developing an analytical toxicology service: principles and guidance. Toxicol. Rev. 23(4): 251–263.

Flanagan RJ, et al (2005) Analytical toxicology: guidelines for sample collection postmortem. Toxicol. Rev. 24(1): 63–71.

Flanagan RJ, Connally G (2005) Interpretation of analytical toxicology results in life and at postmortem. Toxicol. Rev. 24(1): 51–62.

Goldberger BA, Polettini A (2002) Forensic toxicology: web resources. Toxicology 25; 173(1–2): 97–102.

Kupiec TC, et al (2006) Pharmacogenomics for the forensic toxicologist. J. Anal. Toxicol. 30(2): 65–72.

Levine B (1993) Forensic toxicology. Anal. Chem. 65(5): 272A–276A.

Levine BS, et al (1990) Postmortem forensic toxicology. Clin. Lab. Med. 10: 571–589.

Marquet P (2002) Progress of liquid chromatography-mass spectrometry in clinical and forensic toxicology. Ther. Drug Monit. 24(2): 255–276.

Maurer HH (2004) Position of chromatographic techniques in screening for detection of drugs or poisons in clinical and forensic toxicology and/or doping control. Clin. Chem. Lab. Med. 42(11): 1310–1324.

Osselton MD (1992) Analytical forensic toxicology. Arch. Toxicol. Suppl. 15: 259–267.

Pounder DJ (1991) Forensic entomotoxicology. J. Forensic Sci. Soc. 31(4): 469–472.

Richardson T (2000) Pitfalls in forensic toxicology. Ann. Clin. Biochem. 37(1): 20–44.

Schulz M, Schmoldt A (2003) Therapeutic and toxic blood concentrations of more than 800 drugs and other xenobiotics. Pharmazie 58(7): 447–474.

Stafford DT, Logan BK (1990) Information resources useful in forensic toxicology. Fundam. Appl. Toxicol. 15: 411–419.

Van Bocxlaer JF, et al (2000) Liquid chromatography-mass spectrometry in forensic toxicology. Mass Spectrom. Rev. 19(4): 165–214.

Organizations

American Academy of Forensic Sciences (AAFS)
410 North 21st Street
Colorado Springs, CO 80904
Phone: (719) 636-1100
E-mail: reception@aafs.org
Web: http://www.aafs.org/

For nearly 60 years, the American Academy of Forensic Sciences (AAFS) has served a distinguished and diverse membership. Its nearly 6000 members are divided into ten sections spanning the forensic sciences. Membership represents all of the United States, and 55 other countries worldwide. The Academy's strength lies in its diversity of representation in forensic sciences allowing for interaction across fields not possible in other organizations. Each section provides opportunities for professional development, personal contacts, awards, and recognition.

American Board of Forensic Toxicology (ABFT)
410 North 21st Street

Colorado Springs, CO 80904
Phone: (719) 636-1100
Fax: (719) 636-1993
E-mail: ABFTOX@aol.com
Web: http://www.abft.org/

The Board is a non-profit organization that serves to certify individual professionals in toxicology. Two levels of individual board certification are offered a Diplomate and a Forensic Toxicology Specialist. The Board also accredits laboratories performing post-mortem and human performance testing (especially alcohol analysis). This is one of the few laboratory accreditations available for this type of laboratory.

Canadian Society of Forensic Science
La Société Canadienne des Sciences Judiciaires
P.O. Box 37040
3332 McCarthy Road
Ottawa, Ontario
Canada K1V 0W0
Phone: (613) 738-0001
Fax: (613) 738-1987
E-mail address: see contact page
Web: http://www.csfs.ca/

Founded in 1953 the Society now has approximately 500 members. The Society is organized into sections representing various fields of forensic sciences including forensic toxicology. The society strives to enhance the statue of forensic sciences through education and service to the field.

Forensic Toxicology Certification Board (FTCB)
Robert M. Sears
SC Law Enforcement Division, Forensic Services
PO Box 21398, Columbia, SC 29221-1398
Phone: (803) 896-7365
Fax: (803) 896-7542
E-mail: robsears@usit.net
Web: http://home.usit.net/~robsears/ftcb/index.htm

Founded in 1992, FTCB seeks to enhance the professionalism of practitioners in areas of forensic toxicology including Forensic Toxicology, Forensic Alcohol Toxicology and Forensic Drug Toxicology. This is achieved through educational and certification objectives.

The International Association of Forensic Toxicologists
Address enquires to regional offices (see website)
E-mail: info@tiaft.org
Web: http://www.tiaft.org/

This 45-year-old association has over 1400 members from all regions of the world. The stated aims of this association are to promote cooperation and coordination of efforts among members and to encourage research in forensic toxicology. The members come from the police force, medical examiners and coroners' laboratories, horseracing and sports doping laboratories, hospitals, departments of legal medicine, pharmacology, pharmacy and toxicology.

Society of Forensic Toxicologists, Inc. (SOFT)
One MacDonald Center
1 N.MacDonald Street, Suite 15
Mesa, AZ 85201
Phone: 1-888-866-SOFT (7638)
E-mail: office@soft-tox.org
Web: http://www.soft-tox.org/

Holding its first formal meeting in 1974, The Society of Forensic Toxicologists, Inc. (SOFT) is an organization composed of practicing forensic toxicologists and those interested in the discipline for the purpose of promoting and developing forensic toxicology. SOFT has approximately 1000 members and holds annual meetings around the country occasionally meeting in conjunction with TIAFT.

CHAPTER

33

Genetic Toxicology

ROBERT R. YOUNG

INTRODUCTION

Genetic toxicology is the study of the damage to deoxyribonucleic acid (DNA). Genetic toxicology has a wide range of information resources available that includes textbooks, journals, governmental agencies, professional associations, and websites containing bibliographic information, information on genetic toxicology and toxicology data. This chapter will identify various types of information resources that are available to workers in genetic toxicology. This chapter does not identify primary journal articles on specific topics in genetic toxicology. This is due to the large number of articles needed to adequately represent all aspects of the field and the fact that most of the fundamental articles are adequately reviewed or cited in the various print or web resources cited.

RESOURCES

Books (2000 and Later)

Genetic toxicology is a sub-discipline of toxicology. Reference material on genetic toxicology is often found in more comprehensive textbooks on toxicology than in books specifically on genetic toxicology. The following section presents both recent general toxicology textbooks with sections on genetic toxicology and genetic toxicology textbooks published since 2000.

Choy WN (2001)
Genetic Toxicology and Cancer Risk Assessment
Informa Healthcare, New York, NY, 390 pages. ISBN 0824702948.

Topics covered in this book include reviews of mechanisms of carcinogenesis, and the role of genetic toxicology in human cancer risk assessment. The book examines the regulatory use of standard ICH and OECD mutagenicity tests, the use of structure–activity relationship models, and the use of thresholds in carcinogenicity safety assessment.

Derelanko MJ, Hollinger MA (2001)
Handbook of Toxicology, Second Edition
CRC Press, Boca Raton, FL, 1440 pages. ISBN 0849303702.

This is a comprehensive textbook on toxicology with 33 chapters covering various areas of toxicology including genetic toxicology, carcinogenicity, risk assessment, and regulatory toxicology. The 24-page chapter on Genetic Toxicology, Chapter 15, provides an overview of the area and discusses the common assays used in genetic toxicology.

Gad S (2000)
In Vitro Toxicology
CRC Press, Boca Raton, FL, 410 pages. ISBN 1560327693.

In vitro models of toxicology testing are discussed in terms of the toxicity endpoint measured and target organ system. In vitro assays for mutagenicity are discussed.

Jacobson-Kram D, Keller KA (2005)
Toxicological Testing Handbook
Informa Healthcare USA, New York, NY, 520 pages. ISBN 0849338581.

This second edition provides an overview of toxicology with a chapter on Genetic Toxicology. Genetic

toxicology assays in routine regulatory use are discussed focusing on how the assays work, protocol design, and data evaluation. Others chapters cover the various disciplines of toxicology, guidance on study design, and global regulatory requirements.

Josephy PD, Mannervik B (2005)
Molecular Toxicology
Oxford University Press, USA, New York, NY, 608 pages. ISBN 0195176200.

This book focuses on the underlying genetic and molecular mechanisms of cellular, organ, and organism toxicology. Included in this second edition are discussions of drug metabolism, DNA damage and repair, and apoptosis.

Kirkland DJ (Ed.) (2005)
Basic Mutagenicity Tests: UKEMS Recommended Procedures
Cambridge University Press, Cambridge, UK, 158 pages. ISBN-10: 0521019052.

This book provides a review of the four standard genetic toxicology assays specified in global regulatory test guidelines for pharmaceuticals, industrial chemicals, and agricultural chemicals. Assays reviewed included the bacterial reverse mutation assay, in vitro mammalian cell cytogenetic assays, in vitro mammalian cell mutation assays, and in vivo cytogenetic assays. The book is based on consensus guidelines drawn up by industry, academia, and regulators in the UK in agreement with international testing guidelines.

Klaassen CD (Ed.) (2007)
Casarett & Doull's Toxicology, The Basic Science of Poison
McGraw-Hill Professional, New York, NY, 1280 pages. ISBN 0071470514.

This is the most recent revision of one of the most widely used textbooks in toxicology. Chapter 9 of this 33 chapter book covers genetic toxicology. This chapter, and Chapter 8 on chemical carcinogens, are the two primary chapters dealing with genotoxins and genotoxic carcinogens. Unit 2, consisting of Chapters 5, 6, and 7, covers toxicokinetics and the adsorption, distribution, excretion, and biotransformation of xenobiotics.

Wexler P (Ed.) (2005)
Encyclopedia of Toxicology
Academic Press, New York, NY, 2000 pages. ISBN 0127453547.

This second edition of this comprehensive encyclopedia of toxicology encompasses four volumes and 2000 pages. Genotoxicity is well represented by a genetic toxicology entry as well as specific entries based on type of genetic damage or assays that measure specific types of damage (e.g. Ames, chromosome aberrations, DNA adducts, and dominant lethal).

Books (Before 2000)

There are more genetic toxicology textbooks published before 2000 than after. In this group are a number of well-written, but somewhat dated, textbooks on genetic toxicology. These books still provide a good foundation for understanding genetic toxicology. They also provide a historical background for the development of the field of genetic toxicology and the regulations based on genetic toxicology.

Brusick DJ (1987)
Principles of Genetic Toxicology
Plenum Press, New York, NY, 308 pages. ISBN 0306425327.

One of the early textbooks on genetic toxicology, first published in 1980, and revised in 1987. This book provides a comprehensive review of the field as it existed in the 1980s. Good discussions of many assays in current use as well as other assays that are no longer routinely used.

Brusick DJ (1994)
Methods for Genetic Risk Assessment
CRC Press, Boca Raton, FL, 272 pages. ISBN 1566700396.

This was one of the first books to investigate the relationship of human exposure to genetically damaging agents and cancer risk assessment. The book reviews assays to evaluate genotoxicity, assessment of mechanisms for human exposure, measurement of actual exposure, and risk estimation strategies.

Flamm WG, Lorentzen RJ (1985)
Mechanisms and Toxicity of Chemical Carcinogens and Mutagens
Volume 12 of Advances in Modern Environmental Toxicology
Princeton Scientific Publishing, Princeton, NJ, 264 pages. ISBN 0911131124.

This book provides a general overview of the area of genotoxic carcinogens and the assays used to investigate chemical interactions with DNA.

Gold LS, Zeiger E (Eds) (1996)
Handbook of Carcinogenic Potency and Genotoxicity Database
CRC Press, Boca Raton, FL, 768 pages. ISBN 9780849326844.

Preclinical genotoxicity data have been used by regulatory agencies as a predictor of genotoxic carcinogens and human carcinogenic risk. This book provides the bridging data between predictive genetic toxicology assays and long-term rodent carcinogenicity assays. The book contains the Carcinogenic Potency Database (CPDB). The database includes extensive information from 5000 long-term carcinogenicity experiments on 1300 chemicals. Of interest to genetic toxicologists is the fact that the book also includes a summary of the NTP genetic toxicity test results on 1500 chemicals, which are referenced to the original publications, including the Salmonella (Ames) test, L5178Y mouse lymphoma cell mutation test, chromosome aberration and sister chromatid exchange test, and the sex-linked recessive lethal mutation test in *Drosophila melanogaster*.

Chemical Mutagens: Principles and Methods for Their Detection formed a 10-volume series of books, edited jointly or individually between 1971 and 1986, by Alexander Hollaender and Frederick de Serres. The 10 volumes are described below.

Hollaender A, De Serres FJ (Eds) (1971)
Chemical Mutagens: Principles and Methods for Their Detection, Volume 1
Plenum Publishing Corporation, New York, NY. 310 pages. ISBN 0306371014.

Hollaender A, De Serres FJ (Eds) (1971)
Chemical Mutagens: Principles and Methods for Their Detection, Volume 2
Springer-Verlag New York, NY, 300 pages. ISBN 0306371022.

Hollaender A (Ed.) (1973)
Chemical Mutagens: Principles and Methods for Their Detection, Volume 3
Plenum Press, New York, NY, 304 pages. ISBN 0306371030.

Hollaender A (Ed.) (1976)
Chemical Mutagens: Principles and Methods for Their Detection, Volume 4
Plenum Press, New York, NY, 304 pages. ISBN: 0306371049.

Hollaender A, De Serres FJ (Eds) (1978)
Chemical Mutagens: Principles and Methods for Their Detection, Volume 5
Plenum Press, New York, New York, 348 pages. ISBN 0306371057.

Hollaender A, De Serres FJ (Eds) (1980)
Chemical Mutagens: Principles and Methods for Their Detection, Volume 6
Plenum Press, New York, NY, 485 pages. ISBN 0306371014.

De Serres FJ, Hollaender A (Eds) (1982)
Chemical Mutagens: Principles and Methods for Their Detection, Volume 7
Plenum Press, New York, NY, 497 pages. ISBN 030640771.

De Serres FJ (Ed.) (1983)
Chemical Mutagens: Principles and Methods for Their Detection, Volume 8
Plenum Press, New York, NY, 386 pages. ISBN 0306413361.

De Serres FJ (Ed.) (1984)
Chemical Mutagens: Principles and Methods for Their Detection, Volume 9
Plenum Press, New York, NY, 306 pages. ISBN 0306416964.

De Serres FJ (Ed.) (1986)
Chemical Mutagen: Principles, and Methods for Their Detection, Volume 10
Plenum Press, New York, NY, 545 pages. ISBN 0306421712.

This series of books formed the basic reference text for many genetic toxicology laboratories for several decades. These volumes chronicled the evolving field of genetic toxicology. While some sections are technically dated today, the series provides a useful overview of genetic toxicology and the foundations of the field.

Li AP, Heflich RH (1991)
Genetic Toxicology
CRC Press, Boca Raton, FL, 504 pages. ISBN 0849388155.

This book provides a broad overview of various aspects of genetic toxicology. Topics covered include mechanisms of genetic damage, relationship of genetic damage to cancer, genetic toxicology assays, different classes of mutagenic agents, environmental monitoring, human monitoring, and regulations associated with genetic toxicology.

Moutschen J (1985)
Introduction to Genetic Toxicology
John Wiley & Sons, New York, NY, 202 pages. ISBN 0471901431.

An introductory book for the non-specialist translated from the original French edition. This book reviews the various types of agents that can damage DNA and methods to detect genetic damage.

Rossman TG (1992)
Induced Effects of Genotoxic Agents in Eukaryotic Cells
CRC Press, Boca Raton, FL, 167 pages. ISBN 1560322721.

This book reviews the molecular biology of genotoxic damage in mammalian and yeast cells.

Non-Technical Books

Burdon RH (2003)
The Suffering Gene: Environmental Threats to Our Health
McGill-Queen's University Press, Montreal, QC and Kingston, ON, Canada, 360 pages. ISBN 0773526560

This is a book written for the non-scientist on how chemicals and radiation in the environment can adversely affect the genetic health of humans. This book approaches genetic toxicology from the perspective of how environmental exposure to DNA-damaging agents adversely affects human health.

Frickel S (2004)
Chemical Consequences: Environmental Mutagens, Scientist Activism, and the Rise of Genetic Toxicology
Rutgers University Press, New Brunswick, NJ, 224 pages. ISBN 0813534135.

This book provides a history of the birth of the field of genetic toxicology. This non-technical book chronicles the scientific, social, and political forces that led to the establishment of the field that eventually became genetic toxicology. The awareness that chemicals could damage DNA and adversely affect human health led to research and eventually regulation of human exposure to DNA-damaging agents.

Journals

Environmental and Molecular Mutagenesis
Wiley-Liss, Inc
Hoboken, NJ
Web: www.interscience.wiley.com/journal/10009058/home

This is the official journal of the Environmental Mutagen Society.

European Journal of Genetic and Molecular Toxicology
European Environmental Mutagen Society
Web: www.swan.ac.uk/cget/ejgt1.htm

The *European Journal of Genetic and Molecular Toxicology* is an online journal published by the European Environmental Mutagen Society (www.swan.ac.uk/cget/ejgt1.htm).

Genes and Environment

The Japanese Environmental Mutagen Society publishes this journal in English. Their original journal, published in Japanese, was titled *Environmental Mutagen Research*. The journal changed its official language into English in 2006, and is now titled *Genes and Environment*.

Mutagenesis
Oxford University Press
Oxford, UK
Web: http://mutage.oxfordjournals.org/

Mutagenesis is the journal of the United Kingdom Environmental Mutagen Society.

Mutation Research
Elsevier Science B.V., Amsterdam, The Netherlands
Web: www.elsevier.com/wps/find/journaldescription.cws_home/600799/description#description

Mutation Research is the journal of record for Genetic Toxicology. The journal has three sections each with a different focus. A fourth journal, *DNA Repair*, is editorially separate from *Mutation Research* but is part of the *Mutation Research* series. The individual journal titles are:

- *Mutation Research – Fundamental and Molecular Mechanisms of Mutagenesis*
- *Mutation Research – Genetic Toxicology and Environmental Mutagenesis*
- *Mutation Research – Reviews in Mutation Research*
- *DNA Repair*: Responses to DNA damage and other aspects of genomic stability.

Journal articles

Gant TW (2007) Novel and future applications of microarrays in toxicological research. Expert Opin. Drug Metab. Toxicol. 3(4): 599–608.

Gatzidou ET, Zira AN, Theocharis SE (2007) Toxicogenomics: a pivotal piece in the puzzle of toxicological research. J. Appl. Toxicol. 27(4): 302–309.

Jacobson-Kram D, Contrera JF (2007) Genetic toxicity assessment: employing the best science for human safety evaluation. Part I: Early screening for potential human mutagens. Toxicol. Sci. 96(1): 16–20.

Ku WW, Aubrecht J, Mauthe RJ, Schiestl RH, Fornace AJ, Jr (2007) Genetic toxicity assessment: employing the best science for human safety evaluation Part VII: Why not start with a single test: a transformational alternative to genotoxicity hazard and risk assessment. Toxicol. Sci. 99(1): 20–25.

Lorge E, Gervais V, Becourt-Lhote N, Maisonneuve C, Delongeas JL, Claude N (2007) Genetic toxicity assessment: employing the best science for human safety evaluation part IV: a strategy in genotoxicity testing in drug development: some examples. Toxicol. Sci. 98(1): 39–42.

Lorge E, Lambert C, Gervais V, Becourt-Lhote N, Delongeas JL, Claude N (2007) Genetic toxicity assessment: employing the best science for human safety evaluation. Part II: Performances of the in vitro micronucleus test compared to the mouse lymphoma assay and the in vitro chromosome aberration assay. Toxicol. Sci. 96(2): 214–217.

Mussali-Galante P, Avila-Costa MR, Piñón-Zarate G, et al (2005) DNA damage as an early biomarker of effect in human health. Toxicol. Ind. Health, 21(7–8): 155–166.

Pfuhler S, Albertini S, Fautz R, et al (2007) Genetic toxicity assessment: employing the best science for human safety evaluation. Part IV: Recommendation of a working group of the Gesellschaft fuer Umwelt-Mutationsforschung (GUM) for a simple and straightforward approach to genotoxicity testing. Toxicol. Sci. 97(2): 237–240.

Pognan F (2007) Toxicogenomics applied to predictive and exploratory toxicology for the safety assessment of new chemical entities: a long road with deep potholes. Prog. Drug Res. 64. 217, 219–238.

Pottenger LH, Bus JS, Gollapudi BB (2007) Genetic toxicity assessment: employing the best science for human safety evaluation. Part VI: when salt and sugar and vegetables are positive, how can genotoxicity data serve to inform risk assessment? Toxicol. Sci. 98(2): 327–331.

Tweats DJ, Scott AD, Westmoreland C, Carmichael PL (2007) Determination of genetic toxicity and potential carcinogenicity in vitro – challenges post the Seventh Amendment to the European Cosmetics Directive. Mutagenesis 22(1): 5–13.

Witte I, Plappert U, de Wall H, Hartmann A (2007) Genetic toxicity assessment: employing the best science for human safety evaluation. Part III: the comet assay as an alternative to in vitro clastogenicity tests for early drug candidate selection. Toxicol. Sci. 97(1): 21–26.

Databases

The best sources for web-based bibliographic references and specialized information in the field of genetic toxicology are the various databases maintained by the US National Library of Medicine (NLM). The main web page of NLM (www.nlm.nih.gov) guides users to various menu options to access the information available from NLM. Notable for genetic toxicologists in this health resource menu are links to MEDLINE/PubMed® (Entrez) and the NLM Gateway. Medline Plus® (http://medlineplus.gov) provides access to the general public through a simplified web interface in English (http://medlineplus.gov/) and Spanish (http://medlineplus.gov/spanish/).

PubMed®
Web: http://pubmed.gov

PubMed provides access to MEDLINE and other health-related databases, with links to participating online journals and other related databases and web resources.

NLM Gateway
Web: http://gateway.nlm.nih.gov

Allows searches in multiple National Library of Medicine databases, i.e. PubMed, MedlinePlus, OMIN, DIRLINE, etc.

NLM Entrez
Web: www.ncbi.nlm.nih.gov/Entrez/

The Entrez search screen permits integrated searches across various databases at National Center for Biotechnology Information and NLM of interest to researchers in genetic toxicology and toxicogenomics.

TOXNET
Web: http://toxnet.nlm.nih.gov
http://toxnet.nlm.nih.gov/pda/ (ToxNet access via PDA devices)

Databases on toxicology, hazardous chemicals, and environmental health are maintained by the Specialized Information Services Division of NLM (http://sis.nlm.nih.gov/). There are multiple specialized databases that can be searched together, individually or in unique combinations. The following specialized databases of interest to genetic toxicologists may be reached from the TOXNET menu or directly from the weblinks below.

ChemIDPlus
Web: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?CHEM (ChemIDPlus Lite)
http://chem.sis.nlm.nih.gov/chemidplus (Advanced)

Two means to access a database that links a dictionary of over 370 000 chemicals to Medline and other NLM medical databases searchable by chemical structure.

HSDB (Hazardous Substances Data Bank)
Web: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB

Data file focusing on the toxicology of potentially hazardous chemicals.

TOXLINE (Toxicology Literature Online)
Web: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?TOXLINE

Online bibliographic information covering biochemical, pharmacological, physiological, and toxicological effects of drugs and other chemicals.

CCRIS (Chemical Carcinogenesis Research Information System)
Web: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?CCRIS

Carcinogenicity and mutagenicity test results for over 8000 chemicals.

DART (Developmental and Reproductive Toxicology)
Web: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?DARTETIC

Bibliographic database covering teratology and other aspects of developmental and reproductive toxicology.

GENE-TOX (Genetic Toxicology)
Web: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?GENETOX

Database created by the EPA and containing peer-reviewed genetic toxicology test data for over 3000 chemicals.

IRIS (Integrated Risk Information System)
Web: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?IRIS

Hazard identification and dose–response assessments for over 500 chemicals.

ITER (International Toxicity Estimates for Risk)
Web: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?iter

Risk information for over 600 chemicals from authoritative groups worldwide.

Multi-Database (Multi-Database Search)
Web: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?Multi

Search all factual chemical databases including HSDB, CCRIS, IRIS, GENETOX, and Lact-Med.

Government Agencies and Regulatory Information

US Food and Drug Administration
FDA Center for Drug Evaluation and Research (CDER)
Web: www.fda.gov/cder

This is one of five centers at the USFDA and is responsible for human drug registration. Many useful webpages are maintained in the CDER website including links to the following.

ICH Regulatory Guidelines provide the framework for genetic toxicology testing drugs, impurities and degredants of drugs in the US, Europe and Japan.
Web: http://www.fda.gov/cder/guidance/

Establishment of the Genetic Toxicology Review Committee to facilitate and harmonize review of preclinical genetic toxicology submissions to the various divisions within CDER.
Web: www.fda.gov/cder/mapp/7400.4.pdf

Guidance document titled 'Guidance for Industry and Review Staff: Recommended Approaches to Integration of Genetic Toxicology Study Results' published in January 2006. This document provides a framework for evaluating positive genetic toxicology data so as to minimize unnecessary repeat testing and to provide better insight into
Web: www.fda.gov/cder/guidance/6848fnl.pdf

FDA Center for Food Safety and Applied Nutrition (CFSAN)
Web: www.cfsan.fda.gov

FDA CFSAN is the center of FDA that deals with food safety. The first FDA guideline for mutagenicity testing of chemicals was developed by CFSAN and codified in the Draft Redbook II originally issued in 1993. A revised version, *Redbook 2000: Toxicological Principles for the Safety of Food Ingredients*, is available electronically at www.cfsan.fda.gov/~redbook/redtoca.html.

US Environmental Protection Agency
Web: www.epa.gov

Office of Pollution Prevention and Toxics (OPPT)
Web: www.epa.gov/opptint

EPA's Office of Pollution Prevention and Toxics (OPPT) (www.epa.gov/oppts) manages programs to evaluate new and existing chemicals and their risks. As part of this responsibility, OPPTS has developed harmonized testing guidelines including genetic toxicology test guidelines in section 870.
Web: www.epa.gov/opptsfrs/home/guidelin.htm

National Toxicology Program (NTP)
Web: http://ntp-server.niehs.nih.gov.

NTP is an interagency program supported by the NIEHS, the National Institute for Occupational Safety and Health (www.niehs.nih.gov/home.htm) (NIOSH, an institute of the Centers for Disease Control and Prevention) (www.cdc.gov/niosh/homepage.html), and the National Center for Toxicological Research (NCTR, a laboratory of the FDA) (www.fda.gov/nctr/

index.html). The NTP website provides genetic toxicology information taken from NTP-sponsored studies. An example of NTP genetic toxicology data is found in the NTP Testing Information and Study Results webpage (http://ntp-server.niehs.nih.gov/main_pages/NTP_ALL_STDY_PG.html).

Organization for Economic Cooperation and Development (OECD)
Web: www.oecd.org

OECD is the lead agency on harmonizing genetic toxicology test guidelines. OECD test guidelines are organized into four sections: physical chemical properties, effects on biotic systems, degradation and accumulation, and health effects. There are a series of approved genetic toxicology test guidelines for various genetic toxicology assays. This includes the four commonly performed assays: bacterial reverse mutation assay (OECD 471), In Vitro Mammalian Chromosome Aberration Test (OECD 473), Mammalian Erythrocyte Micronucleus Test (OECD 474), and In Vitro Mammalian Cell Gene Mutation Test (OECD 476). The titles of individual OECD test guidelines may be viewed at www.oecd.org/document/55/0,3343,en_2649_34377_2349687_1_1_1_1,00.html.

Associations and Professional Societies

Genetic toxicology has benefited from active professional societies at the international, regional, national, and local levels for almost 30 years. Various national or regional societies are listed by geographic region with affiliated local associations.

International Association of Environmental Mutagen Societies (IAEMS)
Web: www.iaems.net/about.asp
IAEMS Headquarters
1821 Michael Faraday Drive
Suite 300
Reston, Virginia 20190 USA
Phone: +1-703-438-3103

The IAEMS is the umbrella organization to which most national or regional associations are affiliated. This organization was formed to understand the mutational basis of human disease, environmental effects, and human risk for genetic-related disease. Other goals include facilitating international acceptance of testing methods, promoting science-based risk assessment, providing education and training, and promoting collaborative research at the international level.

United States

Environmental Mutagen Society (EMS)
1821 Michael Faraday Drive
Suite 300
Reston, VA 20190
Phone: +1-703-438-8220
Web: www.ems-us.org

EMS was organized in 1969. The website provides information on the society, membership, annual meetings, placement services, and publications. EMS publishes the journal *Environmental and Molecular Mutagenesis*.

There are also a number of regional genetic toxicology societies in the US. These associations tend to be volunteer-driven without formal headquarters. They are best contacted via their websites.

Genetic Toxicology Association (GTA), founded in 1975, serves the mid-Atlantic region of the US. The new GTA website is www.gta-us.org.

Genotoxicity and Environmental Mutagen Association (GEMS), founded in 1982, serves the North Carolina and southeast region of the US (http://gems-nc.org/).

Genetic and Environmental Toxicology Association (GETA) serves northern California (www.ems-us.org/GETA/).

Europe

European Environmental Mutagen Society
Web: www.eems-eu.org
EEMS, founded under the leadership of Dr. Frits Sobels in 1970, maintains a website where programs, meetings, and publications are listed. The EEMS publishes the journal *European Journal of Genetic Toxicology*.

Regional societies of EEMS are active in many European countries. The larger ones are found in Belgium, France, Italy, The Netherlands, and the United Kingdom. Germany, Austria and Switzerland are grouped in a German-speaking society. Denmark, Finland, Norway, Sweden, and Iceland are grouped in a Nordic society. Other societies include national associations in Armenia, Bulgaria, Croatia, Czech Republic and Slovakia, Greece, Hungary, Poland, Portugal, Russia, Serbia, Slovenia, and Spain. Contact information for each country is located at www.eems-eu.org or at the specific association websites below.

Belgian Environmental Mutagen Society (BEMS)
Web: http://cdfc00.ugent.be/bems/default.htm

BEMS, founded in 1980, seeks to encourage research into problems associated with environmental mutagens, organize scientific meetings, and to provide

guidance as needed to governmental and private industries.

Société Française de Toxicologie Génétique (SFTG)
Web: www.sftg.org

SFTG serves the French genetic toxicology community with a website that is maintained in both French and English.

Gesellschaft für Umwelt- Mutationsforschung e.V. (GUM)
Web: www.gum-net.de(German)

This German-speaking section of the EEMS, founded in 1971, promotes experimental mutation research, organized workshops and conferences, and promotes contacts between authorities, industry, and academia. Membership is primarily drawn from Germany, Austria, and Switzerland.

NordEMS
Web: www.nordems.dk

NordEMS, founded in 1982, is the Nordic society of EEMS European Environmental Mutagen Society. It serves members from Denmark, Finland, Norway, Sweden, and Iceland.

United Kingdom Environmental Mutagen Society (UKEMS)
Web: www.ukems.org

UKEMS, organized in 1977, serves genetic toxicologists in the UK. The UKEMS publishes the journal *Mutagenesis*.

Asia-Pacific Associations

Asian Association of Environmental Mutagen Societies (AAEMS)
Web: www.j-ems.org/aaems/aames_index.html

This is a relatively new organization that seeks to promote communication and scientific exchange among the Asian regional national associations and those researchers involved in genetic toxicology in the region. Member societies and contact information are provided on their website. National association members include the Chinese Environment Mutagen Society (CEMS), Korean Environment Mutagen Society (KEMS), Philippine Environment Mutagen Society (Philippine EMS), Thai Environment Mutagen Society (Thai EMS), Japanese Environment Mutagen Society (JEMS), and Indian Environment Mutagen Society (Indian EMS).

The Japanese Environmental Mutagen Society (JEMS)
Web: www.j-ems.org (Japanese version) and http://www.j-ems.org/en1/home.html (a more limited English version)

The JEMS is the most active genetic toxicology association in the Asia-Pacific region. The association hosts an annual meeting.

Mutagenicity and Experimental Pathology Society of Australasia (MEPSA)
Web: www.mepsa.org

MEPSA was formed in 1999 by combining two societies: the Australia and New Zealand Environmental Mutagen Society (ANZEMS) and the Australasian Society for Experimental Pathology (ASEP). The new society seeks to further the interests of the two pre-decessor associations by focusing on experimental pathology and environmental mutagenesis.

Latin America and Africa

Sociedade Brasileira de Mutagênese Carcinogênese e Teratogênese Ambiental (SBMCTA)
Web: www.sbmcta.org.br (Portuguese)

This Brazilian association, founded in 1989, supports research and scientific communication in the fields of genetic toxicology, carcinogenicity, and teratogenicity.

Asociación de Mutagenesis, Carcinogeneisi Y Teratogenesis Ambiental (ALAMCTA)
Web: www.iaems.net/membership.asp#ALAMCTA

ALAMCTA represents Spanish-speaking countries in Latin America.

Pan-African Environmental Mutagen Society (PAEMS)
Web: www.iaems.net/membership.asp#PAEMS

Organizations for the Development of 'Alternative' Genetic Toxicology Methods

Historically, genetic toxicology was one of the first scientific disciplines to focus on the development of in vitro assays to predict adverse in vivo effects. Decades ago, programs such as the US National Toxicology program supported validation of many of the standard genetic toxicology assays in routine use for product safety testing. Support for the development and validation of new genetic toxicology programs has moved in part on to new institutions with the mandate of developing 'alternative' methods. Alternative methods generally imply the reduction or elimination of animal models for safety testing.

European Centre for the Validation of Alternative Methods (ECVAM)
EC-Joint Research Centre
via E. Fermi 1
I-21020 Ispra (VA), Italy

Phone: +39-0332-789111
Web: http://ecvam.jrc.it

ECVAM supports the evaluation and validation of alternative assays to measure in vitro a wide range of toxicological endpoints previously detectable only in laboratory animals. ECVAM has supported work in several areas of genetic toxicology including evaluating the in vitro micronucleus test as an alternative to the in vitro chromosome aberration assay and both the in vitro Balb/3T3 and SHE transformation assays as alternatives to in vivo rodent carcinogenicity assays.

Interagency Coordinating Committee on the Validation of Alternative Methods (ICCVAM)
NIEHS
P.O. Box 12233, Mail Drop EC-17
Research Triangle Park, NC 27709, USA
Phone: +1-919-541-2384
Web: http://iccvam.niehs.nih.gov/

The NTP Interagency Center for the Evaluation of Alternative Toxicological Methods (NICEATM) administers the ICCVAM program. ICCVAM consists of representatives from 15 US Federal regulatory and research agencies that use, generate, or disseminate toxicological information. The Genetic Toxicity Working Group reviews and provides comments to sponsors on proposed validation studies, provides recommendations on test method nominations and submissions for alternative test methods related to genetic toxicity, and evaluates proposed test guidelines and activities relevant to genetic toxicity from the Organization for Economic Co-Operation and Development.

Japanese Center for the Validation of Alternative Methods (JaCVAM)
Division of Pharmacology, Biological Safety Research Center
National Institute of Health Sciences
1-18-1 Kamiyoga, Setagaya-ku
Tokyo 158-8501, Japan
Phone: +81-3-3700-9874

JaCVAM, supported through the Japanese National Institute of Health Sciences, sponsors the development and validation of alternative assays. Activities are often coordinated with ECVAM and ICCVAM. JaCVAM has taken a leadership role in the validation of the in vivo Comet assay (www.j-ems.org/archives/pdf/20070711.pdf) and is organizing a similar validation of the in vitro Comet assay.

CHAPTER

34

Mixtures

R.C. HERTZBERG, AND G. RICE

INTRODUCTION

Understanding the toxicity of realistic chemical exposures requires understanding joint toxicity from multiple chemicals. These exposures typically vary over time: the total exposure level, the relative proportions of component chemicals, and the exposures for each route are changing. Research on toxicology and risk assessment of multichemical exposures is then complicated because toxicologic interactions vary with exposure sequence, duration and route, as well as with total dose, relative chemical proportions, and endpoint.

Toxicological testing of even the most common chemical combinations is impractical, so research often focuses on efficient study designs and statistical methods that minimize the number of animals and dose groups, often only detecting departures from dose addition. Publications that identify interaction mechanisms are rare. Those that do most often report pharmacokinetic (e.g., metabolic) interactions; few articles describe interactions involving toxicological mechanisms or direct physical–chemical interactions (e.g., two chemicals combining to form a new chemical). Regulatory agencies, most notably the U.S. Agency for Toxic Substances and Disease Registry (ATSDR), U.S. Environmental Protection Agency (EPA), and (U.S.) National Institute for Occupational Safety and Health (NIOSH) have sponsored programs specifically to address mixture toxicity, but usually for only a few high-priority mixtures, such as combinations commonly found at Superfund sites, organophosphate pesticides, drinking water disinfection byproducts, and manufacturing dusts and fumes. Risk assessment methods are usually simple, involving variations on dose or response addition, sometimes including a default formula or factor for potential interactions. A few interaction databases have been constructed in the last 20 years, but none is current, and none contains descriptions of interaction mechanisms. Recently, research has moved toward in silico experimentation, i.e., the investigation of interactions by complex biologically based mathematical models that incorporate both interactions as well as other related physiological processes.

RESOURCES

Books/Documents

ATSDR (2004)
Guidance Manual for the Assessment of Joint Toxic Action of Chemical Mixtures
Agency for Toxic Substances and Disease Registry, U.S. Department of Health and Human Services, Public Health Service, Atlanta

Provides a discussion of specific methods used by ATSDR for addressing chemical mixture risk, including an extensive description of a weight of evidence approach for characterizing the quality of available pairwise interactions information. It also includes some approaches by other agencies (http://www.atsdr.cdc.gov/interactionprofiles/ipga.html).

Calabrese EJ (1991)
Multiple Chemical Interactions, Toxicology and Environmental Health
Chelsea, MI: Lewis Publishers.

Extensive collection of information on interactions involving chemicals and drugs, organized by chemical type and endpoint. It also includes a section on principles and concepts, one on regulatory approaches, and reproduces two EPA mixture risk publications as appendices. All sections are somewhat dated. For example, the principles section has no discussion of the cost-effective ray designs (whose publications started in the 1990s) and no discussion of ternary or more complex interactions. It does reflect most of the main regulatory procedures for mixtures in use at the time of publication, and thus is limited mainly to additivity approaches. The huge amount of toxicological information, however, remains highly useful.

Cornell J (1990)
Experiments with Mixtures: Designs, Models, and the Analysis of Mixtures Data, Second edition
New Tork: John Wiley and Sons, Inc.

Mainly statistical but addresses several issues related to mixture experiments, especially where the main variables are relative proportions of components.

Danish Veterinary and Food Administration (DVFA) (2003)
Combined Actions and Interactions of Chemicals in Mixtures: The Toxicological Effects of Exposure to Mixtures of Industrial and Environmental Chemicals (Fødevare Rapport 2003: 12)
Søborg: DVFA

Includes recommendations to the DVFA of risk assessment methods for mixtures. Contains extensive but brief discussions of different types of interaction processes grouped by the type of toxic effect, as well as one section on kinetics interactions. It is somewhat dated, e.g., no discussion of ternary interactions, nor of efficient experimental designs. Sections on interaction concepts, experimental designs, and regulatory methods are brief overviews (http://www.foedevarestyrelsen.dk/FDir/Publications/2003012/Rapport.pdf).

Goldstein R, Hewitt W, Hook J (Eds) (1990)
Toxic Interactions
Academic Press, New York.

Extensive discussion of experimental design, toxicologic principles for interactions in general (e.g., mixed function oxidase system) and then specific information on interactions in the liver, kidney, lung, and cardiac system. Some of the terms are dated, and the experimental design chapter is quite simple compared to current approaches, but the descriptions of toxicologic interaction processes are detailed and include good examples.

Health Council of the Netherlands (2002)
Exposure to Combinations of Substances: A System for Assessing Health Risks
The Hague: Health Council of the Netherlands.
Publication no. 2002/05

Emphasizes whole mixtures, fractions (component groups with similar properties), or components using a Hazard Index approach, and briefly discusses new methods such as pattern recognition for statistically establishing mixtures of similar composition. Although fairly consistent with the USEPA procedures, this report is more of a framework; few procedural details are presented.

Hertzberg RC, Rice GE, Teuschler LK (1999)
Methods for Health Risk Assessment of Combustion Mixtures
Roberts S, Teaf C, Bean J (eds) Hazardous Waste Incineration: evaluating the human health and environmental risks, pp. 105–148.
CRC Press, Boca Raton.

Presents the concepts of the EPA mixture risk guidance as applied to incineration, from whole mixture approaches to component-based interaction approaches.

Hertzberg RC, Rice GE, Teuschler LK, Wright J, Simmons JE (2007)
Health Risk Assessment of Chemical Mixtures in Drinking Water
New York: John Wiley & Sons, Inc.,
In Howd R, Fan A (eds) Risk assessment for chemicals in drinking water, pp. 123–170.

Presents a number of newer mixture risk assessment concepts developed at U.S. EPA and discusses mixtures exposure assessment issues.

Myers R, Montgomery D (2002)
Response Surface Methodology: Process and Product Optimization Using Designed Experiments, Second Edition
New York: Wiley

Extensive treatment of response surface techniques, applications, pitfalls, and concepts. Although mainly oriented toward data analysis (whatever the source), the guidance about experimental design is substantial and can easily be interpreted for toxicology research.

NIOSH (2005)
Mixed Exposures Research Agenda: A Report by the NORA Mixed Exposures Team
Cincinnati, OH: National Institute for Occupational Safety and Health, U.S. Department of Health and Human Services, Centers for Disease Control and Prevention.

The document articulates many of the issues involved with mixed exposures, recommends research strategies, and defines research priorities that could lead to improved interventions for protecting workers from mixed exposures (http://www.cdc.gov/niosh/docs/2005-106/).

NRC (National Research Council) (1988)
Complex Mixtures: Methods for in vivo Toxicity Testing
Washington, DC: National Academy Press.

Some excellent discussions of traditional mixture issues, including toxicity testing methods and interaction concepts, but is weakened by inconsistent terminology (e.g., mostly relates to simple mixtures, very little on truly complex mixtures) and by being somewhat dated.

Reffstrup T (2002)
Combined Actions of Pesticides in Food (Fødevare Rapport 2003:12)
Søborg: Danish Veterinary and Food Administration.

Extensive collection of interaction examples for pesticides. It includes brief summaries of some regulatory approaches and perhaps their brevity has led to the vague descriptions and to some misrepresentations. No discussion is included of experimental design nor of statistical methods for toxicology data analysis.

Rice G, Teuschler L, Simmons JE, Hertzberg R (2005)
Mixtures, Toxicology and Risk Assessment
San Diego: Academic Press
In Wexler P (Ed.) Encyclopedia of Toxicology, pp. 120–123.

This entry details the relative potency factor method, an application of dose addition.

Rothman KJ, Greenland S (1998)
Concepts of Interaction
Philadelphia: Lippincott-Raven Publishers
In Modern epidemiology, Chapter 18, 2nd edn., pp. 329–342.

Extensive discussion of the terminology and underlying concepts of interaction as used in toxicology, statistics and epidemiology, and how stratified analysis can benefit interaction studies.

U.S. EPA (1990)
Technical Support Document on Health Risk Assessment of Chemical Mixtures. EPA/600/8-90/064
National Center for Environmental Assessment, Cincinnati.

Contains a summary of available evidence on mixture dose–response, including an analysis of the studies in the USEPA Mixtox database, and discussions of whole mixture similarity criteria and of basic additivity concepts of mixture components.

U.S. EPA (2000)
Supplementary Guidance for Conducting Health Risk Assessment of Chemical Mixtures. EPA/630/R-00/002
Risk Assessment Forum, Washington, DC.

Extensive description of terminology, concepts, and procedures for component additivity, whole mixture assessment, and toxicologic interaction, including an interaction-based hazard index that quantitatively incorporates binary interaction information. It also includes the USEPA 1986 mixture guidelines in an appendix (http://cfpub.epa.gov/ncea/raf/recordisplay.cfm?deid=20533).

U.S. EPA (2002)
Region/ORD Workshop on Cumulative Risk Assessment
Office of Science Policy, Washington, DC

Workshop proceedings that include several presentations on research strategies and risk methods for various combinations of chemical and nonchemical stressors (www.epa.gov/osp/regions/cumrisk.htm).

U.S. EPA (2003)
Exposure and Human Health Reassessment of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) and Related Compounds. NAS Review Draft EPA/600/P-00/001Cb
Washington, DC, National Center for Environmental Assessment.

Comprehensive set of documents that describe sources of dioxin-like compounds in the United States, environmental levels, and background exposures, site-specific assessment procedures, and applications of toxicity equivalence factors (http://www.epa.gov/ncea/pdfs/dioxin/nas-review/).

U.S. EPA (2003)
The Feasibility of Performing Cumulative Risk Assessments for Mixtures of Disinfection By-Products in Drinking Water. EPA/600/R-03/051
U.S. EPA, Cincinnati, OH

Expands the EPA approaches for component additivity to include multiple exposure routes. It develops exposure estimates for 13 major DBPs, accounting for physicochemical properties of the DBPs and population activity patterns that affect the amount of human contact time with drinking water (e.g., tap water consumed, time spent showering, building characteristics). The cumulative relative potency factor approach is advanced that integrates dose addition and response addition to produce multiple-route, chemical mixture risk estimates using total absorbed doses

(http://cfpub.epa.gov/ncea/cfm/recordisplay.cfm?deid=56834).

U.S. EPA (2003)
Framework for Cumulative Risk Assessment. EPA/600/P-02/001F
Office of Research and Development, National Center for Environmental Assessment, Washington, DC

Extensive discussion of multiple issues affecting the joint toxicity of combinations of exposure to chemical and non-chemical stressors. Also discusses interactive impacts of socioeconomic factors, such as access to health care.

U.S. EPA (2006)
Considerations for Developing Alternative Health Risk Assessment Approaches for Addressing Multiple Chemicals, Exposures and Effects (External Review Draft)
Cincinnati, OH, Office of Research and Development, National Center for Environmental Assessment in collaboration with U.S. Department of Energy Argonne National Laboratory, Environmental Assessment Division (http://oaspub.epa.gov/eims/eimscomm.getfile?p_download_id=456398)

Focuses on the evaluation of health risks from exposures to multiple chemicals, including multiple exposure routes and times as well as multiple health endpoints. Qualitative and semiquantitative approaches are provided that simplify the number of potential combinations of chemicals, exposures, and effects to make the risk assessment more feasible.

Yang R (ed.) (1994)
Toxicology of Chemical Mixtures: Case Studies, Mechanisms, and Novel Approaches
New York, Academic Press.

Covers a wide range of topics, including experimental design, statistical estimation, dose–response models, bioassay protocols, toxicologic mechanisms, and regulatory methods.

Journal Articles

Altenburger R, Walter H, Grote M (2004) What contributes to the combined effect of a complex mixture? Environ. Sci. Technol. 38: 6353–6362.

Berenbaum MC (1981) Criteria for analyzing interactions between biologically active agents. Adv. Cancer Res. 35: 269–335.

Berenbaum MC (1989) What is synergy? [published erratum appears in Pharmacol Rev 1990 Sep;41(3):422]. Pharmacol Rev 41: 93–141.

Borgert CJ, Price B, Wells C, Simon G (2001) Evaluating chemical interaction studies for mixture risk assessment. Human Ecol. Risk Assess. 7: 259–306.

Carpy SA, Kobel W, Doe J (2000) Health risk of low-dose pesticides mixtures: a review of the 1985–1998 literature on combination toxicology and health risk assessment. J. Toxicol. Environ. Health Part B 3(1): 1–25.

Cassee FR, Groten JP, van Bladeren PJ, Feron VJ (1998) Toxicological evaluation and risk assessment of chemical mixtures. Crit. Rev. Toxicol. 28(1): 73–101.

Chou T, Talalay P (1984) Analysis of quantitative dose–effect relationships: the combined effects of multiple drugs or enzyme inhibitors. Adv. Enzyme Reg. 22: 27–55.

Dennison JE, Andersen ME, Dobrev ID, Mumtaz MM, Yang RSH (2004) PBPK modeling of complex hydrocarbon mixtures: gasoline. Environ. Toxicol. Pharmacol. 16(1–2): 107–119.

Feron VJ, Cassee F, Groten JP (1998) Toxicology of chemical mixtures: international perspective. Environ. Health Perspect. 106: 1281–1289.

Feron VJ, Groten JP (2002) Toxicological evaluation of chemical mixtures. Food Chem. Toxicol. 40(6): 825–839.

Foster KL, Mackay D, Parkerton TF, Webster E, Milford L (2005) Five-stage environmental exposure assessment strategy for mixtures: Gasoline as a case study. Environ. Sci. Technol. 39: 2711–2718.

Gennings C, Carter WH, Jr, Carchman RA, Teuschler LK, Simmons JE, Carney EW (2005) A unifying concept for assessing toxicological interactions: Changes in slope. Toxicol. Sci. 88(2): 287–297.

Krishnan K, Brodeur J (1991) Toxicological consequences of combined exposure to environmental pollutants. Arch. Complex Environ. Stud. 3: 1–106. Extensive collection of interaction studies.

Mason AM, Borgert CJ, Bus JS, Mumtaz MM, Simmons JE, Sipes IG (2007) Improving the scientific foundation for mixtures joint toxicity and risk assessment: contributions from the SOT mixtures project – introduction. Toxicol. Appl. Pharmacol. 223(2): 99–103.

Nelson BK (1994) Interactions in developmental toxicology: A literature review and terminology proposal. Teratology 49(1): 33–71.

Rao VR, Woo YT, Lai DY, Arcos JC (1989) Special issue – Database on promoters of chemical carcinogenesis. Environ. Carcinogen. Rev. – Part C J. Environ. Sci. Health 7(2): 1–278. This special issue is a print version of the entire database.

Seed J, Brown RP, Olin SS, Foran JA (1995) Chemical mixtures: Current risk assessment methodologies and future directions. Reg. Toxicol. Pharmacol. 22: 76–94.

Simmons JE, Richardson S, Speth T, et al (2002) Development of a research strategy for integrated technology-based toxicological and chemical evaluation of complex mixtures of drinking water disinfection byproducts. Environ. Health Perspect. 110(Supp 6): 1013–1024.

Simmons JE, Teuschler LK, Gennings C, et al (2004) Component-based and whole-mixture techniques for addressing the toxicity of drinking-water disinfection by-product mixtures. J. Toxicol. Environ. Health Part A 67: 741–754.

Teuschler LK (2007) Deciding which chemical mixtures risk assessment methods work best for what mixtures. Toxicol. Appl. Pharmacol. 223(2): 139–147.

Teuschler LK, Groten JP, Hertzberg RC, Mumtaz MM, Rice GE (2001) Environmental chemical mixtures risk assessment: current approaches and emerging issues. Comments Toxicol. 7: 453–493.

Teuschler LK, Klaunig J, Carney E, et al (2002) Support of science-based decisions concerning the evaluation of the toxicology of mixtures: a new beginning. Regul. Toxicol. Pharmacol. 36(1): 34–39.

Yang RSH (1996) Some current approaches for studying combination toxicology in chemical mixtures. Food Chem. Toxicol. 34: 1037–1044.

Yang RSH, El-Masri HA, Thomas RS, et al (2004) Chemical mixture toxicology: from descriptive to mechanistic, and going on to in silico toxicology. Environ. Toxicol. Pharmacol. 18(2): 65–81.

Journals

Chemico–Biological Interactions

Environmental Health Perspectives

Regulatory Toxicology and Pharmacology

Risk Analysis

Toxicological Sciences

Toxicology and Applied Pharmacology

Newsletter

European Commission, Joint Research Centre

NOvel Methods for Integrated Risk Assessment of CumuLative Stressors in Europe (NoMiracle)

Web: http://nomiracle.jrc.it/default.aspx and http://nomiracle.jrc.it/webapp/subscribe.aspx

General Interest Work

Waldman P (2005) Advanced tests often detect subtle biological effects; are standards too lax? Getting in way of hormones. Wall Street Journal July 25, 2005.

Databases

HazDat

ATSDR/DOT, Atlanta

Web: http://www.atsdr.cdc.gov/hazdat.html

MixTox

U.S. EPA/NCEA, Cincinnati

Web: www.epa.gov/NCEA/pdfs/mixtures.pdf and www.epa.gov/NCEA/raf/pdfs/chem_mix/chem_mix_08_2001.pdf

IRSST

Montreal

Mixtures of substances in the workplace: utility for evaluating the chemical risk (Calculation of the Rm)

Web: http://www.irsst.qc.ca/files/outils/intertox/jsndx_ en.htm

Organizations

European Commission. Joint Research Centre

NOvel Methods for Integrated Risk Assessment of CumuLative Stressors in Europe (NoMiracle)

Web: http://nomiracle.jrc.it/default.aspx

U.S. Agency for Toxic Substances and Disease Registry (ATSDR)

Division of Toxicology, Atlanta

Web: http://www.atsdr.cdc.gov/mixtures.html

Interaction profiles at: http://www.atsdr.cdc.gov/interactionprofiles/

U.S. Environmental Protection Agency (EPA). Chemical Risk Assessment Branch

National Center for Environmental Assessment, Cincinnati.

Other EPA websites related to mixtures:

Dioxins risk assessment: http://www.epa.gov/ncea/pdfs/dioxin/nas-review/

Integrated Risk Information System: http://cfpub.epa.gov/ncea/iris/index.cfm

Assessing Pesticide Cumulative Risk: http://www.epa.gov/pesticides/cumulative/

U.S. National Institute for Occupational Safety and Health (NIOSH), Mixed Exposures

Web: http://www2a.cdc.gov/nora/noratopictemp.asp?rscharea=me

CHAPTER

35

Molecular, Cellular, and Biochemical Toxicology

JACQUES DESCOTES

INTRODUCTION

Molecular, cellular, and biochemical toxicology is an extremely wide area encompassing most, if not all in vitro and mechanistic aspects of current toxicological science. Therefore, the list of key references provided below can only be considered as an introduction. Textbooks covering key aspects including the most recent methods and techniques as well as issues of major concern are listed. Although articles devoted to this field can be found within almost any toxicology journal, quite a few are more exclusively devoted to articles devoted to molecular, cellular, and biochemical toxicology. The proposed list of books, journals, and journal articles is restricted to general recent reviews dealing with the most relevant aspects.

RESOURCES

Books

Boelsterli UA (2007)
Mechanistic Toxicology: The Molecular Basis of How Chemicals Disrupt Biological Targets
CRC Press, Boca Raton, FL

Gives insights into the processes and mechanisms underlying the toxicity of chemicals, and explains how foreign compounds exert their damaging effects on cells and tissues.

Davis, M. (2002)
Apoptosis Methods in Pharmacology and Toxicology: Approaches to Measurement and Quantification
Humana Press

Contains concise methods for the detection, mechanisms, and quantification of apoptosis that is critical for the design of toxicology and pharmacology studies.

Fishbein JC (2006)
Advances in Molecular Toxicology
Elsevier, Amsterdam

Describes most recent progresses in selected aspects of molecular toxicology with a focus on elucidation of mechanisms at the molecular level and on advances in technological approaches employed.

Gad SC, Strauss S (2000)
In vitro Toxicology
Taylor & Francis, New York

Covers a broad range of in vitro models for use in either identifying or understanding most forms of toxicity including irritation, sensitization, lethality, mutagency, and developmental toxicity, and a full spectrum of target organ systems such as skin, eye, heart, liver, kidney, nervous system. Each of these specialty areas is presented from a perspective of presenting the principal models and their uses and limitations.

Gibson GG, Skett P (2003)
Introduction to Drug Metabolism, 3rd Edition
Nelson Thornes, Cheltenham, UK

Provides an aid to teaching and a source of reference for postgraduates working in the drug metabolism field. Includes a number of examples from therapeutic agents as well as chemicals and environmental pollutants.

Hamadeh HK, Afshari CA (2004)
Toxicogenomics: Principles and Applications
John Wiley & Sons, New York

For specialists and non-specialists. Provides a description of key technologies in genomics, proteomics, metabonomics, and bioinformatics, as well as their applications to toxicology research.

Hensley K, Floyd RA (2003)
Methods in Biological Oxidative Stress
Springer, New York

Contributors detail best experimental methods for detecting free radicals and reactive oxygen species or their by-products, ranging from established standard protocols to advanced methodologies using HPLC, mass spectrometry, and electron paramagnetic resonance. Each technique is described in step-by-step detail. Useful notes explain the pitfalls to avoid and the chemical principles underlying each method.

Hodgson E, Smart RC (2001)
Introduction to Biochemical Toxicology
John Wiley & Sons, New York

Provides a good introductory text for graduate students on the underlying biochemical, molecular, and cellular mechanisms through which toxicants produce their adverse responses. The 3rd edition includes new chapters such as immunotoxicology, cutaneous toxicology, and molecular epidemiology.

Josephy PD, Mannervik P (2006)
Molecular Toxicology
Oxford University Press, New York

Explains the principles of toxicology in depth and from the perspective of modern biochemistry and molecular biology. Emphasizing molecular approaches, the book covers xenobiotic transformation, reactive intermediates, cloning, expression, and analysis of enzymes involved in biotransformation, molecular toxicology of aromatic amines, nitrosamines, PAHs, and chlorinated compounds.

Keohavong P, Grant SG (2004)
Molecular Toxicology Protocols
Humana Press, New York

Describes a collection of techniques for analyzing genotoxic exposure and detecting the resulting biological effects. Analytical methods that can be specifically applied to human populations and patients are emphasized.

Kubic TE, Burczynski ME (2003)
An Introduction to Toxicogenomics
CRC Press, Boca Raton, FL

Provides a comprehensive overview with a focus on toxicology. It introduces the basic principles of microarray/oligonucleotide array-based genomic analysis. The book then features the basics of data analysis and clustering methods such as genetic algorithms. Finally, it covers expression profiling in the field of toxicology and details both mechanistic and predictive studies.

Manahan SE (2002)
Toxicological Chemistry and Biochemistry
CRC Press, Boca Raton, FL

Describes the basic concepts of general, organic, and environmental chemistry and biochemistry. The book goes on to discuss biodegradation, bioaccumulation, and biochemical processes that occur in water and soil and describes xenobiotics analysis for determining toxicants and their metabolites in blood and other biological materials. A chapter on genetic aspects explains the ways in which chemical damage to DNA can cause mutations, cancer, and other toxic effects on specific body systems. The author also considers the role of genetics in determining individual susceptibilities to various toxicants. The second half of the book is devoted to the toxicological chemistry and biochemistry of various classes of chemical compounds.

Ortiz de Montellano PR (ed.) (2004)
Cytochromes P450: Structure, Mechanism and Biochemistry
Springer, New York

Summarizes the current state of research in the field of drug metabolism. The emphasis is on multidisciplinary approaches related to structure, mechanism, biochemistry, and regulation, and their relevance in human medicine.

Parvez H, Labbe G, Reiss C (2001)
Molecular Responses to Xenobiotics
Elsevier, Amsterdam, The Netherlands

Provides insight into the target(s), activity, and mechanism of action of xenobiotics, and reveals the detailed response and fate of the cell. The articles contained in this volume were written by leading experts in the field and each article is introduced with a tutorial, for those not familiar with the concepts and described methods.

Phillips IR, Shephard EA (2006)
Cytochrome P450 Protocols
Springer, New York

Describes the techniques for investigating the large superfamily of proteins that are of central importance in detoxifying or activating many foreign hydrophobic compounds, including therapeutic drugs, chemical carcinogens, and environmental pollutants. The focus is on P450 species from mammals, but the methods are also suitable for those from other sources. The techniques described are used for purifying, spectral analysis, expression in heterologous cells, determining functional capabilities, detecting and quantifying, gene expression and its regulation, and cell culture.

Plant N (2003)
Molecular Toxicology
Taylor & Francis, New York

Provides a concise introduction to the theoretical principles of molecular toxicology followed by specific examples. The book concludes with a section on toxicity assessment methods, where the impact of molecular biology is having a considerable impact, including DNA microarrays, proteomics, and bioinformatics.

Stacey GN, Doyle A, Ferro M, Doyle A, Ferro M (2002)
Cell Culture Methods for in Vitro Toxicology
Springer, New York

Introduces the reader to a range of techniques involved in the use of in vitro cell culture in toxicological studies. It deals with major cell types studied in the field of toxicology and will be useful for anyone wishing to start work with animal cell cultures or to refresh their knowledge relating to in vitro cell models. Prominent features of in vitro technologies also include regulation, biosafety, and standardization.

Tiffany-Castiglioni E (2004)
In Vitro Neurotoxicology: Principles and Challenges
Springer, New York

Reviews neurotoxicants of significance to human health, especially those for which metabolism and dose–response are well studied both in vivo and in vitro: lead, mercury, organophosphorus insecticides, polychlorinated biphenyls and dioxin, ethanol, and endogenous proteins. Chapters discuss neurodevelopmental and neurodegenerative diseases, including the concept of astroglia as depots for lead and other metals in the central nervous system and factors involved in the onset of puberty in females.

Van Den Heuvel JP, Greenlee WF, Perdew GH, Mattes WB (2002)
Comprehensive Toxicology: Cellular and Molecular Toxicology
Pergamon, New York

Volume 14 of the series *Comprehensive Toxicology* describes the use of extremely powerful molecular and cell biology techniques in toxicology. Each chapter contains a listing of major peer-reviewed articles and reviews and useful websites, and a broad introductory section that outlines the subsequent sections.

Warshawsky D, Landolph JR (2005)
Molecular Carcinogenesis
CRC Press, Boca Raton, FL

Twenty-four chapters on the technical and historical aspects of the science of cancer. The first section details pathology, epidemiology, stress responses, DNA methylation, oncogenes, tumor suppressor genes, DNA repair, chemical mutation, and chemical, viral, and radiation carcinogenesis. The second part focuses on breast, thyroid, skin, brain, prostate, lung, bladder, and colon cancer, leukemia, immunology and immunotherapy, and gene therapy.

Zalups RK, Koropatnick DJ (2000)
Molecular Biology and Toxicology of Metals
CRC Press, Boca Raton, FL

Provides a review and analysis of the current state of knowledge of metal ion transport and metabolism in prokaryotic and eukaryotic cellular systems, and also deals with the influence of both essential and non-essential transition metals on gene expression and the ability of cells to respond to extracellular signals. It covers the latest information on specific metals and the biological molecules with which metals interact. It also details mechanisms in the handling and toxicity of metals in specific organ systems, and the role of metals in cell signalling and gene transcription in target cells.

Zawia NH (2004)
Molecular Neurotoxicology: Environmental Agents and Transcription
CRC Press, Boca Raton, FL

Ten contributions characterize the role of specific transcription factor families in neurotoxicity, various models of growth and neurodegeneration, the role of DNA repair in the nervous system, and the impact of neurotoxicants on a variety of cell signaling intermediates. Zinc finger transcription factors, the rel/nuclear factor-kappa B family of factors, transgenic animal models of specific neurodegenerative disorders, environmental toxins that selectively affect the central nervous system, and genetic studies on alcohol-related diseases are covered. An introductory chapter overviews methods of monitoring gene expression, recombinant DNA technology, and types of genetically engineered animals.

Journals

Biochemical and Molecular Medicine (alternatively known as *Biochemical Medicine* and *Biochemical Medicine and Metabolic Biology* and *Molecular Genetics and Metabolism*)
For a detailed description of this journal:
http://www. biolc.com/wps/find/journal description.cws_home/622920/ description#description.

Biochemical Pharmacology
This is an international journal published by Elsevier. Emphasis has been given on original work with reference to the interaction of drugs and non-therapeutic xenobiotics with biological systems. Specific emphasis is placed on findings that relate to the actions and metabolism of drugs and toxic substances at the biochemical and molecular levels. Furthermore, submissions in the areas of behavioral and physiological pharmacology and toxicology are also considered if studies are described and directed at defining mechanisms of action. Other areas that are represented in the journal include, but are not limited to, cancer chemotherapy, neuropharmacology, inflammation/immunopharmacology, antimicrobials, behavioral, respiratory, gastrointestinal, cardiovascular, and endocrine pharmacology and toxicology. Submissions relating to either pharmacodynamics or pharmacokinetics are also considered. As per Elsevier, reports based on experiments conducted with mixtures, plant, or animal extracts will not be considered for publication unless the chemical structures and concentrations of all substances are known. Submissions to the journal must be in English.

Furthermore, the journal publishes reports such as 'full-length Research Papers' containing the results of original research on an issue of relevance to pharmacology and 'Commentaries' that are commissioned articles which provide the author's view on a selected topic of interest to pharmacologists (taken from http://www.elsevier.com/wps/find/journaldescription.cws_home/525454/description#description).

Cell Biology and Toxicology
This is an international journal primarily devoted to research publications at the cellular level. It publishes papers of high scientific values in the areas of cell biology, genetic, molecular, and cellular toxicology. Further, it presents scientific reports that deal with the basic biology and with the physiological, pharmacological, and toxic response of cellular systems. Studies of subcellular and cellular systems derived from both prokaryotic and eukaryotic cell types are also included. Studies of toxic effects may include, but are not limited to, cytotoxicity, mutagenicity, carcinogenicity, and teratogenicity. Specifically, the journal emphasizes approaches to cellular studies or molecular structure activity correlations that provide relevant scientific information leading to the decreased use of experimental animals. Furthermore, it publishes papers describing original research results, reviews, announcements of scientific meetings or courses, and availability of funding, fellowships, and scholar-ships (excerpted from http://www.springer.com/life+sci/cell+biology/journal/10565).

Chemical Research in Toxicology
This journal serves as an international research forum dedicated to the chemical basis of toxicological responses. Researchers present their latest findings on the molecular mechanisms by which chemical and biological toxic agents interact with living systems. Further, the molecular mechanisms of the cellular responses to toxic agents and the mechanisms by which the cellular responses to toxic agents affect the whole organism are also covered in the journal. This ultimately leads to presentation of results related to further investigations of the pathogenesis of disease; and the development and application of new methodologies for the study of the interaction of toxic agents with living systems. The journal publishes articles, communications, chemical profiles, reviews, mini-reviews, and perspectives on structural, mechanistic, and technological advances in research related to toxic effects of chemical agents. In addition, features entitled 'forum and letters to the editor' are published periodically. Based on the information on their website, this journal, beginning in 2008, will regularly publish two new features, 'Highlights selected articles from the current issue', and 'Spotlight', that highlights articles of interest from other journals. Additionally, guest editorials from leaders in the field will highlight relevant issues facing toxicologists around the world. Editorial Advisory Board members will also provide their perspectives on their latest research. This description is derived from http://pubs.acs.org/journals/crtoec/about.html.

Chemico-Biological Interactions
This is a journal covering topics such as molecular, cellular, and biochemical toxicology. It publishes reports and review articles that examine the molecular, cellular, and/or biochemical basis of toxicologically relevant outcomes. Specific importance is placed on mechanisms in terms of interactions between chemicals and biological systems. The results of such research may include all traditional endpoints caused by synthetic or naturally occurring chemicals, both in vivo and in vitro systems. Relevant health effect endpoints may include, but are

not limited to, carcinogenesis, mutagenesis, respiratory toxicology, neurotoxicology, reproductive and developmental toxicology, and immunotoxicology. This description is taken from: http://www.elsevier.com/wps/find/journaldescription.cws_home/505510/description# description.

Critical Reviews in Toxicology

This international journal has covered many facets of toxicological research and emerging issues in toxicology. It provides objective analyses of relevant topics such as mechanisms, responses, and assessment of toxicants. Articles can include coverage of commodity and specialty chemicals; for example, formaldehyde, acrylonitrile, and pesticides; pharmaceutical agents of all types; consumer products such as macronutrients and food additives; and environmental agents such as ozone and dioxin. Review articles can include toxicological effects ranging from subtle physiological alterations to overt toxicity manifested in major systems, i.e., respiratory, gastrointestinal, endocrine, urogenital, musculoskeletal, nervous, hematopoietic, and immunological. Specific emphases are also on cancer and developmental and toxicological effects. Furthermore, mechanisms of toxicant action at all levels of biological organization are also addressed – from macromolecules and cells up to integrated organisms and populations of laboratory animals and humans. This description has been excerpted from http://www.tandf.co.uk/journals/titles/10408444.asp.

Free Radical Biology and Medicine

This is an official international, interdisciplinary journal of the Society for Free Radical Biology and Medicine – An Affiliate Journal of the International Society for Free Radical Research (SFRR). The topics include chemical, biochemical, physiological, pathological, pharmacological, toxicological, and medical approaches to research on free radicals and oxidative biology. Publications related to original contributions dealing with all aspects of free radical and oxidant research including both in vitro and in vivo studies (excerpted from http://www.elsevier.com/wps/find/journaldescription.cws_home/525469/description#description).

In Vitro and Molecular Toxicology

According to the former editor of this journal, this publication has been discontinued. Subscriptions are no longer available (http://www.liebertonline.com/ivt?cookieSet=1).

This peer-reviewed journal offered a wide range of investigative work with respect to molecular and cellular basis and expression of diverse toxic phenomena. Major topics included methods, developments, and validation of in vitro toxicology tests; impact of in vitro methodology on product safety testing; and methods for in vitro to in vivo extrapolation (http://journalseek.net/cgi-bin/journalseek/journalsearch.cgi?field=issn&query=1097-9336).

Journal of Biochemical and Molecular Toxicology

This is an international journal that contains original research papers, communications, mini-reviews, and book reviews, primarily focusing on the molecular mechanisms of action and detoxication of exogenous and endogenous chemicals and toxic agents. The scope of the journal includes publications in the areas of effects on the organism at all stages of development, on organ systems, tissues, and cells as well as on enzymes, receptors, hormones, and genes. Furthermore, the biochemical and molecular aspects of uptake, transport, storage, excretion, lactivation and detoxication of drugs, agricultural, industrial, and environmental chemicals, natural products and food additives are all other subjects of publication. Of particular interest and relevance are aspects of molecular biology related to biochemical toxicology. These may include studies of the expression of genes related to detoxication and activation enzymes, toxicants with modes of action involving effects on nucleic acids, gene expression and protein synthesis, and the toxicity of products derived from biotechnology. Toxicologist those who are active investigators in this field are not the only group who may be interested in this journal but other scientists such as biochemists, molecular biologists involved in industrial and contract research and testing laboratories, and those who are involved in legal and regulatory work related to toxic chemicals will find this journal relevant to their areas of work. It is published bimonthly with one volume of 6 issues per calendar year. This description is taken from http://ca.wiley.com/WileyCDA/WileyTitle/productCd-JBT.html.

Journal of Molecular Medicine

It covers all aspects of human biology and pathophysiology and the emphasis is on the progress and precision in the understanding, prevention, diagnosis and treatment of human diseases. It publishes original papers, rapid communications, review articles and correspondence of the highest quality pertinent to all aspects of human biology and pathophysiology (excerpted from http://www.springer.com/biomed/molecular/journal/109?detailsPage = description).

Molecular and Cellular Proteomics

American Society of Biochemistry and Molecular Biology (http://www.asbmb.org/) publishes Molecular and Cellular Proteomics which are available (open access) at http://www.mcponline.org/.

Molecular Carcinogenesis
This journal publishes research papers on investigations of molecular aspects of the mechanisms involved in chemical, physical, and viral (biological) carcinogenesis. Areas of interest may include, but are not limited to, the structure, expression, or function of genes or gene products associated with normal growth and differentiation and alterations in neoplasia; characterization of genes or gene products expressed in preneoplastic or neoplastic cells; molecular studies that define a specific function of a tumor-associated protein or its effects on cellular function; virtually all research on molecular aspects of oncogenes, tumor suppressor genes, and their gene products; carcinogenesis studies in transgenic mice; and research on human tumor viruses (taken from http://ca.wiley.com/WileyCDA/WileyTitle/productCd-MC.html).

Molecular Pharmacology
The American Society for Pharmacology and Experimental Therapeutics is the publisher of this journal. It presents original applications of biochemistry, biophysics, genetics, and molecular biology associated with innovative pharmacologic research to elucidate basic problems in pharmacology and toxicology, including areas such as molecular mechanisms involved in drug receptor-effective coupling, xenobiotic metabolism, and antibiotic and anticancer drug action. This description has been excerpted from http://highwire.stanford.edu/cgi/journalinfo?qNum=all&journal_set=molpharm&sendit=Submit. The main website for the journal is http://molpharm.aspetjournals.org/.

Toxicology and Applied Pharmacology
This journal publishes original scientific research related to action of chemicals, drugs, or natural products to animals or humans. Research publications address mechanistic approaches to physiological, biochemical, cellular, or molecular understanding of toxicologic/pathologic lesions and to methods used to describe these responses. Papers concerned with alternatives to the use of experimental animals are encouraged. This description has been excerpted from http://www.elsevier.com/wps/find/journaldescription.cws_home/622951/description#description.

Toxicology in vitro
This journal is responsible for original research papers and reviews on the topic of application and use of in vitro systems for assessing or predicting the toxic effects of chemicals and elucidating their mechanisms of action. These techniques include utilizing cell or tissue cultures, isolated cells, tissue slices, subcellular fractions, transgenic cell cultures, and cells from transgenic organisms, as well as in silico modeling. The journal focuses on investigations that involve the development and validation of new in vitro methods (e.g. for prediction of toxic effects based on traditional and in silico modeling; on the use of methods in high-throughput toxicology and pharmacology; elucidation of mechanisms of toxic action; the application of genomics, transcriptomics, and proteomics in toxicology, as well as on comparative studies that characterize the relationship between in vitro and in vivo findings). Submissions of manuscripts that focus on the development of in vitro methods, their practical applications and regulatory use (e.g. in the areas of food components cosmetics, pharmaceuticals, pesticides, and industrial chemicals) are strongly encouraged. This short description of the journal has been taken from http://www.elsevier.com/wps/find/journaldescription.cws_home/800/description#description.

Journal Articles

Amacher DE (2002) A toxicologist's guide to biomarkers of hepatic response. Hum. Exp. Toxicol. 21: 253–262.

Amacher DE (2005) Drug-associated mitochondrial toxicity and its detection. Curr. Med. Chem. 12: 1829–1839.

Ballatori N, Villalobos AR (2002) Defining the molecular and cellular basis of toxicity using comparative models. Toxicol. Appl. Pharmacol. 183: 207–220.

Eisenbrand G, Pool-Zobel B, Baker V, et al (2002) Methods of in vitro toxicology. Food Chem. Toxicol. 40: 193–236.

Glavinas H, Krajcsi P, Cserepes J, Sarkadi B (2004) The role of ABC transporters in drug resistance, metabolism and toxicity. Curr. Drug Deliv. 1: 27–42.

Guengerich FP (2005) Life and times in biochemical toxicology. Int. J. Toxicol. 24: 5–21.

Hamadeh HK, Amin RP, Paules RS, Afshari CA (2002) An overview of toxicogenomics. Curr. Issues Mol. Biol. 4: 45–56.

Kalgutkar AS, Soglia JR (2005) Minimising the potential for metabolic activation in drug discovery. Expert Opin. Drug Metab. Toxicol. 1: 91–142.

Kauffman FC (2004) Sulfonation in pharmacology and toxicology. Drug Metab. Rev. 36: 823–843.

Kimura H, Sawada T, Oshima S, Kozawa K, Ishioka T, Kato M (2005) Toxicity and roles of reactive oxygen species. Curr. Drug Targets Inflamm. Allergy 4: 489–495.

Langman LJ, Kapur BM (2005) Toxicology: then and now. Clin. Biochem. 39: 498–510.

Lord PG, Nie A, McMillian M (2006) Application of genomics in preclinical drug safety evaluation. Basic Clin. Pharmacol. Toxicol. 98: 537–546.

Mates JM (2000) Effects of antioxidant enzymes in the molecular control of reactive oxygen species toxicology. Toxicology 153: 83–104.

Moggs JG, Orphanides G (2004) The role of chromatin in molecular mechanisms of toxicity. Toxicol. Sci. 80: 218–224.

Park BK, Kitteringham NR, Powell H, Pirmohamed M (2000) Advances in molecular toxicology – towards understanding idiosyncratic drug toxicity. Toxicology 153: 39–60.

Peraza MA, Burdick AD, Marin HE, Gonzalez FJ, Peters JM (2005) The toxicology of ligands for peroxisome proliferator-activated receptors (PPAR). Toxicol. Sci. 90: 269–295.

Rispin A, Stitzel K, Harbell J, Klausner M (2005) Ensuring quality of in vitro alternative test methods: Current practice. Regul. Toxicol. Pharmacol. 45: 97–103.

van de Water B, de Graauw M, Le Devedec S, Alderliesten M (2006) Cellular stress responses and molecular mechanisms of nephrotoxicity. Toxicol. Lett. 162: 83–93.

Vickers AE, Fisher RL (2004) Organ slices for the evaluation of human drug toxicity. Chem. Biol. Interact. 150: 87–96.

Wallace DR (2005) Overview of molecular, cellular, and genetic neurotoxicology. Neurol. Clin. 23: 307–320.

CHAPTER

36

Nanotechnology

RUTH LYDDY

INTRODUCTION

Nanotechnology is commonly considered to deal with particles in the size range <100 nm, and with the nanomaterials manufactured using nanoparticles. The approaches to the toxicology testing, and assessment of the human and environmental risks are undergoing rapid development. One risk assessment area of strong interest is the extent to which nanoparticle and nanomaterial toxicity can be extrapolated from existing data for particles and fibers.

The research and development of nanotechnology is very active globally, and nanotechnologies are already used in hundreds of products, including sunscreens, cosmetics, textiles, and sports equipment. Nanotechnology is also being developed for use in drug delivery, biosensors, and other biomedical applications. Further, nanotechnologies are also being developed for use in environmental applications, e.g., clean-up of environmental pollutants.

RESOURCES

Books and Monographs

Cao G (2004)
Nanostructures & Nanomaterials: Synthesis, Properties & Applications

Imperial College Press, London; Distributed by World Scientific Pub., Hackensack, NJ. 433p

A general introduction to technical aspects of nanomaterials and nanotechnology, including synthesis, characterization, properties, and applications of nanostructures and nanomaterials.

Donaldson K, Borm P (eds.) (2007)
Particle Toxicology
CRC Press/Taylor & Francis Group, Boca Raton, FL
ISBN 0849350921

Reviews the mechanisms and properties of pathogenic particles and their effects on target cells at various sites in the body; covers particle science biology, chemistry, and toxicology, plus mathematical modeling and human studies as avenues for future research.

Goldman L, Coussens C (eds) (2005)
Implications of Nanotechnology for Environmental Health Research. Roundtable on Environmental Health Sciences, Research, and Medicine, Board on Health Sciences Policy, Institute of Medicine
National Academies Press, Washington, DC.
ISBN 0-309-09577-8
Web: http://books.nap.edu/openbook.php?record_id=11248&page=R1

A panel of experts from academia, industry, and government examined the environmental health issues surrounding the emergence of nanotechnology. The report summarizes the discussions and presentations identifying additional research needs, processes for potential change, and gaps in our knowledge.

Gogotsi Y (ed.) (2006)
Nanomaterials Handbook
CRC Press, Boca Raton, FL
ISBN 0-8493-2308-8

Technical discussions describing all major classes of materials, written primarily for materials scientists and engineers, but useful as a reference resource for toxicologists.

Hester RE, Harrison RM (eds) (2007)
Nanotechnology: Consequences for Human Health and the Environment
Royal Society of Chemistry, Cambridge, UK.
ISBN-10: 0854042164

Broad overview of the sources, behavior, and risks associated with nanotechnology; describes the current range of uses for nanomaterials, and considers environmental and human health consequences of nanoparticles and nanotubes.

Hunt G, Mehta MD (eds) (2006)
Nanotechnology: Risk, Ethics and Law
Earthscan Publications, Ltd., London and Sterling, VA.
ISBN: 1844073580/ 978 1 84407 358 0

Considers the risks and benefits of nanotechnology, and the complex ethical and legal questions facing governments, the public, investors, and businesses worldwide.

Karn B, Masciangioli T, Zhang W, Colvin V, Alivisatos P (eds) (2005)
Nanotechnology and the Environment: Applications and Implications
ACS Symposium Series 890.
American Chemical Society, Washington, DC.

Discusses the environmental aspects of nanotechnology and nanoparticles, including risk assessment, toxicity, and fate in the environment.

Kumar CSSR (ed.) (2006)
Nanomaterials: Toxicity, Health and Environmental Issues, 1st Edition
Wiley-VCH, Weinheim.
ISBN: 978-3-527-31385-3

Offers an overview of nanoparticle-related risks to humans, air, water, and the general environment relative to particle type and size and exposed surroundings, bringing together both medical and nanotechnological aspects and covering all important nanomaterial classes: carbon materials, polymers, metals, and metal oxides.

Monteiro-Riviere NA, Tron CL (eds) (2007)
Nanotoxicology: Characterization, Dosing and Health Effects
Informa Healthcare, New York.
ISBN: 1420045148

Examines the interaction of nanomaterials with the biological system, including membrane transfer, screening methods, and impact on major organs.

Schmid G (ed.) (2006)
Nanotechnology: Assessment and Perspectives
Springer, Berlin and New York.
ISBN 354032819X

Evaluates the state of the art in nanoscience and nanotechnology, covering the natural sciences as well as philosophical, ethical, toxicological, and economic aspects, and considers possible future developments.

Theodore L, Kunz RG (2005)
Nanotechnology: Environmental Implications and Solutions
John Wiley, Hoboken, NJ.
ISBN 0471699764

Looks at nanotechnology's impact on the environment from the perspective of air, water, solid waste, health risks, and ethical considerations.

Zhao Y, Nalwa HS (eds) (2007)
Nanotoxicology: Interactions of Nanomaterials with Biological Systems
American Scientific Publishers, Stevenson Ranch, CA.
ISBN-10: 1588830888; ISBN-13: 978-1588830883

Includes 16 review chapters covering major aspects of the impact of nanomaterials on the human body, their interactions with biological systems, and their risk assessments; Summarizes the toxicological effects and biological properties (in vitro or in vivo) for a wide variety of man-made nano-structured materials.

Journals

International Journal of Nanomedicine (2006–)
Dove Medical Press, Ltd., Auckland, NZ
Web: www.dovepress.com/articles.php? journalid=5
ISSN 1176-9114/1178-2013

Focuses on the application of nanotechnology in diagnostics, therapeutics, and drug delivery systems throughout the biomedical field; highlights research and development leading to potential clinical applications.

Journal of Biomedical Nanotechnology (2005–)
American Scientific Publishers, Stevenson Ranch, CA
Web: www.aspbs.com/jbn/
ISSN 1550-7033

Covers applications of nanotechnology in biotechnology, medicine, biosciences, and all other related fields of life sciences encompassing both fundamental and applied research.

Journal of Nanobiotechnology (2003–)
BioMed Central
Web: www.jnanobiotechnology.com/

Provides open access articles covering all aspects of scientific and technological advances in the fields of medical, biological, and nanoscale sciences.

Journal of Nanoparticle Research (1999–)
Springer, The Netherlands
Web: www.springerlink.com/content/103348
ISSN: 1388-0764/1572-896X

Publishes interdisciplinary articles devoted to nanoparticle science and technology.

Nano Letters (2001–)
American Chemical Society, Washington, DC
Web: http://www.pubs.acs.org/journals/nalefd
ISSN: 1530-6984/1530-6992

Reports on fundamental research in all branches of the theory and practice of nanoscience and nanotechnology, including physical, chemical, and biological phenomena, processes, and applications.

Nanomedicine: Nanotechnology, Biology, and Medicine (2005–)
American Academy of Nanomedicine
Elsevier, New York
Web: www.sciencedirect.com/science/journal/15499634
ISSN: 1549-9634

Publishes basic, clinical, and engineering research in all aspects of nanomedicine, including diagnostic, experimental, clinical, and pharmacological nanomedicine and engineering,

Nanotoxicology (2007–)
Taylor & Francis, London
Web: www.tandf.co.uk/journals/titles/17435390.asp
ISSN: 1743-5390/1743-5404

Addresses research relating to the potential for human and environmental exposure, hazard, and risk associated with the use, production, and development of nano-structured materials.

Particle and Fibre Toxicology (2004–)
BioMed Central
Web: www.particleandfibretoxicology.com
ISSN: 1743-8977

Provides open access to peer-reviewed, multidisciplinary research and reviews on the toxicological effects of particles of all types, with increasing attention to nanoparticles.

The Virtual Journal of Nanotechnology Environment, Health & Safety (VJ-Nano EHS) (2006–)
The International Council on Nanotechnology (ICON) and Rice University's Center for Biological and Environmental Nanotechnology (CBEN)
Web: http://icon.rice.edu/virtualjournal.cfm

Draws on ICON's EHS Database to highlight recently published literature; contains citations and links to articles that have appeared in a variety of traditional journals and that are related to the environment and health impacts of nanotechnology, with a particular emphasis on nanomaterials.

Journal Articles

Baker GL, Gupta A, Clark ML, et al (2008) Inhalation toxicity and lung toxicokinetics of c60 fullerene nanoparticles and microparticles. Toxicol. Sci. 101(1): 122–131. Epub 2007 Sep 17.

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Borm PJA, Robbins D, Haubold S, et al (2006) The potential risks of nanomaterials: A review carried out for ECETOC. Part. Fibre Toxicol. doi: 10.1186/1743-8977-3-11.

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Hopsapple MP, Farland WH, Landry TD, et al (2005) Research strategies for safety evaluation of nanomaterials, Part II: Toxicological and safety evaluation of nanomaterials, current challenges and data needs. Toxicol. Sci. 88(1): 12–17.

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Liu J, Hopfinger AJ (2008) Identification of possible sources of nanotoxicity from carbon nanotubes inserted into membrane bilayers using membrane interaction quantitative structure-activity relationship analysis. Chem. Res. Toxicol.. [Epub ahead of print].

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Organizations

Center for Biological and Environmental Nanotechnology
Rice University
6100 Main Street, MS-63
Houston, Texas 77005
Phone: 713-348-4195
Fax: 713-348-8218
Email: tchamp@rice.edu
Web: http://cnst.rice.edu/

Funded by the National Science Foundation, CBEN's mission is to discover and develop nanomaterials that enable new medical and environmental technologies. Activities include research, educational and training programs, and public outreach for broader issues such as technology transfer, public acceptance, and workforce training.

Center on Nanotechnology & Society
565 W. Adams Street
Chicago Illinois
Phone: 312-906-5337
Email: info@nano-and-society.org
Web: www.nano-and-society.org/

Illinois Institute of Technology's Center on Nanotechnology and Society provides support and a clearinghouse for informed interdisciplinary research, education and dialogue on the ethical, legal, policy, business, and broader societal implications of nanoscale science and technology. Resources include NELSI Global Document Archive, webcasts, conferences, news articles, commentary, and links to extensive resources.

Environmental Defense
Web: www.environmentaldefense.org/go/nano

Environmental Defense is a non-partisan, non-profit organization working to promote the use of science to solve environmental problems, including a major initiative on nanotechnology issues. Key objectives include increasing risk research, improving regulatory policy, and establishing corporate standards of care. Their NanoRisk Framework is a joint project with DuPont to define a systematic process to identify, manage, and reduce potential health, safety and environmental risks of nano-scale materials across all life-cycle stages.

European Commission
Web: (Nanotechnology Home Page) http://cordis.europa.eu/nanotechnology/home.html
Web: (Nanotechnology Safety Aspects) http://cordis.europa.eu/nanotechnology/src/safety.htm

The European Commission is active in developing regulatory framework and risk assessment methodologies for the EU countries; it supports collaborative R&D into the potential impact of nanotechnology on human health and the environment via toxicological and ecotoxicological studies.

International Association of Nanotechnology (IANT)
1290 Parkmoor Avenue
San Jose, CA 95126 USA
Phone: 408-280-6222
Fax: 408-280-6255
Email: info@ianano.org
Web: www.ianano.org/

IANT is a non-profit organization that brings together government, industry, and academic sectors to foster scientific research and responsible business development through research, training, meetings, and congresses. Efforts focus on building nanotechnology and nanotoxicology framework and tools including guidelines, methodologies, regulations, policies, and standards.

International Council on Nanotechnology (ICON)
CBEN, MS-63
Rice University
P.O. Box 1892
Houston, TX 77251-1892
Phone: 713-348-8210
Fax: 713-348-8218
Web: http://icon.rice.edu/

ICON is an international multi-stakeholder organization for nanotechnology stewardship based at Rice University. It aims to assess, communicate, and reduce nanotechnology's environmental and health risks

while maximizing its societal benefit. Resources include reports and practice documents, electronic journal, and a bibliographic database.

(U.S.) National Institute for Occupational Safety and Health (NIOSH)
395 E Street, S.W., Suite 9200
Patriots Plaza Building
Washington, DC 20201
Phone: 1-800-CDC-INFO (1-800-232-4636); Outside the U.S. 513-533-8328
Fax: 513-533-8347
Web: www.cdc.gov/niosh/topics/nanotech

NIOSH conducts strategic planning and research and provides guidance on the occupational safety and health implications and applications of nanotechnology. Efforts focus on 10 critical topic areas including exposure and risk assessment, models and mechanisms of toxicity, dosimetry, and workplace safety. Website includes guidance and policy documents, links to resources, NIOSHTIC-2 bibliographic database, and a global online Nanoparticle Information Library.

Organisation for Economic Co-operation and Development (OECD)
2, rue André Pascal
F-75775 Paris Cedex 16
France
Phone: +33 1-45-24-82-00
Fax: +33 1-45-24-85-00
Web: www.oecd.org/department/0,3355,en_2649_37015404_1_1_1_1_1,00.html

OECD Environmental Directorate's Safety of Manufactured Nanomaterials program focuses on the implications of the use of nanomaterials for human health and environment safety, with emphasis on testing and assessment methods. The website includes a section with country surveys, reviews, guides, websites, and conference and workshop information for each country within the OECD membership.

Society of Toxicology (SOT)
1821 Michael Faraday Drive, Suite 300
Reston, VA 20190
E-mail: sothq@toxicology.org
Phone: (703) 438-3115
Fax: (703) 438-3113
Web: www.toxicology.org/

The Society of Toxicology (SOT) is a professional and scholarly organization based in the U.S. but with an international membership. The Nanotoxicology Specialty Section provides a forum for interaction and collaboration related to research on the pharmacokinetics, toxicity, exposure assessment, and risk assessment of nanomaterials. Its activities encompass such issues as screening and toxicity testing of nanomaterials, in vitro and in vivo dosimetry, risk assessment and risk communication, as well as conducting programs and conferences.

U.S. Environmental Protection Agency (US EPA)
National Center for Environmental Research
Ariel Rios Building
1200 Pennsylvania Avenue, NW
Washington, D.C. 20460
Web: http://es.epa.gov/ncer/nano/index.html

U.S. EPA's regulatory responsibility is to protect the environment and human health, and it is currently evaluating an appropriate policy framework for nanotechnology. The Nanotechnology section of their website highlights EPA's research in this area, and provides information on related research at EPA and in other organizations, including news, lectures, reports, publications, proceedings and symposia.

Databases

ICON Environmental, Health and Safety (EHS) database
Web: http://icon.rice.edu/virtualJournal.cfm

Sponsored by the International Council on Nanotechnology, the ICON Environmental, Health and Safety (EHS) database contains abstracts and citations for research papers related to the EHS implications of nanoscale materials.

NIOSH Nanoparticle Information Library
Web: www2a.cdc.gov/niosh-nil/index.asp

Global information on nanomaterials, including their health and safety-associated properties; intended to meet the needs of researchers, industrial users, and occupational health professionals. Scope includes information on material properties, surveillance and toxicology studies, origin/synthesis methods and information for contacting people who are developing nanomaterials.

NIOSHTIC-2
Web: www2a.cdc.gov/nioshtic-2/default.html

NIOSHTIC-2 is a searchable bibliographic database of occupational safety and health publications, documents, grant reports, and journal articles supported by NIOSH.

Project on Emerging Nanotechnologies Inventories of Current Research
Web: www.nanotechproject.com/index.php?id=18

Sponsored by the Woodrow Wilson International Center for Scholars and the Pew Charitable Trusts, the

global inventories catalogs primarily government-funded research into the human health, safety, and environmental implications of nanotechnology.

Websites

NanoForum
Web: www.nanoforum.org

Nanoforum is funded by the European Union and serves as Europe's nanotechnology information gateway, providing access to reports, white papers, funding opportunities, education, training, and events throughout Europe.

Nanotechnology Risk Resources Website
Web: www.nsec.wisc.edu/NanoRisks/NS--NanoRisks.php

The University of Wisconsin's Nanoscale Science and Engineering Center offers a useful section of their website for risk assessment and toxicology issues, containing references to papers, articles, and books on potential health and environmental risks of nanomaterials sorted by material or compound, body organ or biological effect studied, or other miscellaneous issues. Also included are links to government reports, websites, and regulatory materials.

Nanowerk
Web: www.nanowerk.com

Nanowerk LLC is a publisher in the area of nanoscience and nanotechnology whose website portal provides links to a nanomaterials database, news, conference and seminar listings, universities, labs, researchers, associations, networks and international initiatives involved in nanotechnology in 43 countries and regions.

OECD: Safety of Manufactured Nanomaterials
Web: http://www.oecd.org/department/0,3355en_2649_37015404_1_1_1_1_1,00.html

Global directory of links to publications, documents, and information listed by country.

SafeNano Initiative
Web: www.safenano.org

The SafeNano Initiative of the Institute of Occupational Medicine is the UK's premier site for information concerning the potential risks from nanoparticles and fibers. Website includes news and links to resources and current research and a database of documents and publications.

Newsletters

EH&S NanoNews
Web: www.ehsnanonews.com

Bimonthly newsletter published by Gradient Corporation highlighting news, government activities, and recent publications on risk, health, and safety issues of nanoparticles and nanotechnology.

NanoReg Report
Web: www.NanoRegNews.com

Biweekly newsletter dedicated to global nanotechnology regulatory news.

Nanorisk
Webe: www.nanorisk.org/

A bimonthly newsletter published by Nanowerk LLC covering the latest developments in nanotechnology research, and environmental, health and safety issues.

NIOSH: Focus On Nanotechnology
Web: www.cdc.gov/niosh/topics/nanotech/focus.html

Newsletter provides a regularly updated electronic report on new NIOSH developments related to research on Nanotechnology and Occupational Health.

Reports

National Institute for Occupational Safety and Health (NIOSH) (2006)
Approaches to Safe Nanotechnology: An Information Exchange with NIOSH
Web: www.cdc.gov/niosh/topics/nanotech/ safenano/

This 60-page document reviews current state of knowledge about nanoparticle toxicity and control, and invites commentary and exchange of information to promote nanotechnology worker safety.

European Commission, Scientific Committee on Emerging and Newly Identified Health Risks (2006)
European Commission Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) modified opinion on: The appropriateness of existing methodologies to assess the potential risks associated with engineered and adventitious products of nanotechnologies. (Adopted by the SCENIHR during the 10th plenary meeting of 10 March 2006)
Web: http://ec.europa.eu/health/ph_risk/committees/04_scenihr/docs/scenihr_o_003b.pdf

Scientific background and opinion on existing risk assessment methodologies and their applicability to nanotechnology and its products.

Ostiguy C, Lapointe G, Trottier M, Menard L, Cloutier Y, Boutin M, Antoun M, Normand C (2006)

Health Effects of Nanoparticles. Studies and Research Projects/ Report R-469
Institut de recherche Robert-Sauvé en santé et en sécurité du travail (IRSST), Montreal.
Web: www.irsst.qc.ca/en/_publicationirsst_100209.html

Review of current knowledge about nanoparticles, their synthesis and applications, health and safety risks, and the challenges in evaluating occupational exposure.

Davies J Clarence; Project on Emerging Technologies (2006)
Managing the Effects of Nanotechnology
Project on Emerging Technologies, Woodrow Wilson International Center for Scholars, Washington, D.C. 34p.
www.wilsoncenter.org/index.cfm?fuseaction=news.item&news_id=165552

The report analyzes the strengths and weaknesses of existing laws that apply to nanotechnology and outlines a possible new regulatory framework.

Aitken RJ, Creely KS, Tran CL (2004)
Nanoparticles: An Occupational Hygiene Review
HSE Books, Sudbury.
Research Report No. 274: Prepared by the Institute of Occupational Medicine for the Health and Safety Executive.
Web: www.hse.gov.uk/research/rrhtm/rr274.htm

This review focuses on potential routes and levels of exposure, industrial sources of exposure, control measures and potential trends in processes for manufacturing nanoparticle products.

Jong WH de, Roszek B, Geertsma RE; Rijksinstituut voor Volksgezondheid en Milieu (2005)
Nanotechnology in Medical Applications: Possible Risks for Human Health. RIVM report 265001002/2005
RIVM, Bilthoven, Netherlands
Web: www.rivm.nl/bibliotheek/rapporten/265001002.html

Report outlines recommendations for the development of guidance documents at a European level for the safety evaluation of nanotechnology products applied in medical technology; identifies needs for further research.

U.S. Environmental Protection Agency, Science Policy Council, Nanotechnology Workgroup (Feb. 15, 2007)
Nanotechnology White Paper (EPA/100/B-07/001)
U.S. Environmental Protection Agency, Washington, DC
Web: www.epa.gov/osa/nanotech.htm

Examines potential environmental implications, risks and applications of nanotechnology in support of efforts to develop a regulatory framework for nanotechnology.

International Organization for Standardization (ISO) (2007)
***'Workplace Atmospheres – Ultrafine, Nanoparticle and Nano-structured Aerosols – Inhalation Exposure Characterization and Assessment'* ISO/TR 27628:2007(E)**
Web: www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm? csnumber4423

Guideline focuses on nanoaerosols in the occupational setting, and covers exposure characterization, mechanisms of formation and transportation, and on industrial processes.

Other Resources

Nanosafe/Nanosafe2
Web: www.nanosafe.org/

Funded by the European Commission, this project is aimed at the safe and sustainable production and use of nanomaterials. Work is presently focused on development of methods for nanotoxicity evaluation, the development of monitoring devices and personal protective equipment, and analysis of regulatory issues.

National Nanotechnology Initiative (NNI)
Web: http://nano.gov/

The NNI provides a multiagency framework in the U.S. for efforts in nanoscale science, engineering, and technology, as well as their environmental, health, and safety impacts. NNI funds research, supports government and university laboratories, develops educational resources and supporting infrastructure and tools.

National Toxicology Program (NTP) – Nanotechnology Safety Initiative
Web: http://ntp.niehs.nih.gov/go/nanotech

The NTP has a broad-based research program to address potential human health hazards associated with the manufacture and use of nanoscale materials, to evaluate the toxicological properties of major nanoscale materials classes, and to develop model systems to investigate how nanoscale materials interact with biological systems.

Project on Emerging Nanotechnologies
Web: www.nanotechproject.org/

The Project on Emerging Nanotechnologies was established in April 2005 as a partnership between the Woodrow Wilson International Center for Scholars and the Pew Charitable Trusts. The Project's efforts are dedicated toward minimizing risk and engaging the public interest to realize potential benefits as nanotechnologies advance.

CHAPTER

37

Noise

GUANG-DI CHEN

I have often lamented that we cannot close our ears with as much ease as we can our eyes.

Richard Steele, 1720

INTRODUCTION

When considering noise in relation to sound, what is commonly meant is meaningless background sound of greater than usual volume. However, in the study of effect of noise on health, the 'noise' may mean any traumatic sounds (such as weapon noise in the field and pure tones at high intensity used in animal experiments in the lab to induce cochlear disruptions) and unwanted sounds (such as loud music from neighbors).

This section lists books and review papers that discuss auditory (and also non-auditory) effects of acoustic noise published since 1990. To fully appreciate scientific reports of noise-induced injuries in the ear, a basic understanding of acoustics, anatomy of the ear (especially the cochlea), and auditory physiology is required. A few of the listed books provide fundamental acoustics and anatomy/physiology of the ear. We would recommend *Occupational Exposure to Noise: Evaluation, Prevention and Control* by Goelzer B, Hansen CH, Sehrndt GA (2003), which can be downloaded from the World Health Organization (WHO) website: http://www.who.int/occupational_health/publications/occupnoise/en/index.html.

This section also lists journals, in which research papers of noise-induced hearing loss are usually published. *Noise and Health* is the journal devoted to research on all aspects of noise and its effects on human health. Another journal, in which many papers of noise study are published, is *Hearing Research*. Information on noise-induced hearing loss and its prevention can also be obtained from websites of several organizations, such as National Institute for Occupational Safety and Health (NIOSH), Occupational Safety and Health Administration (OSHA), National Institute on Deafness and other Communication Disorders (NIDCD), World Health Organization (WHO), and Noise Pollution Clearinghouse (NPC).

RESOURCES

Books

Axelsson A, et al (Eds) (1996)
Scientific Basis of Noise-Induced Hearing Loss
Thieme, Stuttgart

Papers are grouped into four sections, all with respect to noise-induced hearing loss: biological basis, experimental studies, auditory performance changes, and human studies.

Behar A, et al (2000)
Noise Control, A Primer
Singular

Covers sound and noise, hearing and hearing loss, auditory and non-auditory effects of noise, noise measurement, hearing protection devices, noise control, and occupational hearing conservation regulations and standards.

Berger EH, et al (Eds) (2000)
The Noise Manual, Fifth Edition
American Industrial Hygiene Association

Papers are grouped into four sections: Fundamentals of sound, vibration, and hearing; Elements of a hearing conservation program; Noise interference and annoyance; and Regulations, standards, and laws.

Borchgrevink HM (Ed.) (1990)
Effects of Noise and Blasts
Scandinavian Audiology, supplementum 34
Bardu Trykkeri A/S, Norway

Papers are grouped into four sections: Impulse noise and blasts – Damage risk criteria; Impulse noise – Selection of susceptible individuals; Treatment of noise induced hearing loss; Hearing loss and hearing protection.

Cowan JP (1994)
Handbook of Environmental Acoustics
Van Nostrand-Reinhold, New York

Provides easy to follow explanations of acoustic terminology, noise control design, and regulatory noise issues. Key aspects of environmental noise are clarified in basic language in such areas as common noise sources, current noise regulations, guidelines and standards, effects of noise on people and animals, relevant noise rating methods, and noise control designs.

Dancer AL, et al (Eds) (1992)
Noise-Induced Hearing Loss
Mosby/Year Book, New York

Examines noise-induced hearing loss from the perspectives of cochlear mechanisms, central changes, cofactors, performance changes, hearing protection, susceptibility and resistance to noise, and parameters of the exposure.

Dobie RA (1993)
Medical-Legal Evaluation of Hearing Loss
Van Nostrand-Reinhold, New York

Covers the physics of sound, normal hearing, disorders causing hearing loss, hearing evaluation, hearing conservation programs, and operational guidance for prevention of hearing loss. Case studies are used to illustrate both methods of analysis and typical reports.

Fay TH (Ed.) (1991)
Noise and Health
New York Academy of Medicine, New York

Discusses sources of noise and its effect on the cardiovascular, neuroendocrine, immunological, and gastrointestinal systems. Specific strategies for noise abatement and reviews of noise legislation are included. The last section deals with public awareness of the hazards of noise.

Goeltzer B et al (Eds) (2003)
Occupational Exposure to Noise: Evaluation, Prevention and Control
World Health Organization
This book can be downloaded from the following site:
http://www.who.int/occupational_health/publications/occupnoise/en/index.html

There are 12 chapters.
1. Fundamentals of acoustics; 2. The anatomy and physiology of the ear and hearing; 3. The pathophysiology of the ear; 4. Exposure criteria, occupational exposure levels; 5. Noise sources; 6. Sound measuring instruments; 7. Strategies for noise surveys; 8. Hearing measurement; 9. Hazard prevention and control programs; 10. Engineering noise control; 11. Personal measures and hearing conservation; 12. Sources of information

Henderson D et al (Eds) (2001)
Noise Induced Hearing Loss: Basic Mechanisms, Prevention and Control
Noise Research Network Publications, London

Papers are grouped into nine sections, all with respect to noise-induced hearing loss: genetics, mechanisms of cell death, physiological changes caused by noise, treatments and protection, combined exposures, measures of noise and its effects, potential diagnostic signs, human aspects of NIHL, and summary.

Humes LE et al (Eds) (2005)
Noise and Military Service: Implications for Hearing Loss and Tinnitus
The National Academies Press
Online available: http://www.nap.edu/catalog/11443.html#toc

There are 7 chapters.
1. Overview of the problem and introduction; 2. Noise-induced hearing loss; 3. Noise and noise-induced hearing loss in the military; 4. Tinnitus; 5. Responding to noise risks: Hearing conservation programs in the military; 6. Reports of audiometric testing in service medical records of military veterans; 7. Conclusions and comments.

Icon Health Publications (2004)
Noise-Induced Hearing Loss – a Medical Dictionary, Bibliography, and Annotated Research Guide to Internet References
Lightning Source Inc

This is a 3-in-1 reference book. It gives a complete medical dictionary covering hundreds of terms and expressions relating to noise-induced hearing loss. It also gives extensive lists of bibliographic citations. Finally, it provides

information to users on how to update their knowledge using various Internet resources. The book is designed for physicians, medical students preparing for Board examinations, medical researchers, and patients who want to become familiar with research dedicated to noise-induced hearing loss.

Kryter KD (1994)
The Handbook of Hearing and the Effects of Noise: Physiology, Psychology, and Public Health
Academic Press, San Diego

Presents the methods and results of research for quantitatively describing the major attributes of hearing and the effects of sound and noise on people.

NIOSH (1998)
Criteria for a Recommended Standard: Occupational Noise Exposure
DHHS (NIOSH) publication No. 98-126
Web: http://www.cdc.gov/niosh/docs/98-126/
There are seven chapters:

Chapter 1: Recommendations for a noise standard; Chapter 2: Introduction; Chapter 3: Basis for the exposure standard; Chapter 4: Instrumentation for noise measurement; Chapter 5: Hearing loss prevention programs (HLPPs); Chapter 6: Hearing protectors; Chapter 7: Research needs.

Palmer, K.T. et al (2001)
Occupational Exposure to Noise and Hearing Difficulties in Great Britain
Suffolk, England, Health & Safety Executive Books

The objectives of this research were to determine the prevalence of self-reported hearing difficulties and tinnitus in working-aged people from the general population, and to estimate the risks from occupational exposure to noise and the number of attributable cases nationally.

Prasher D, Canlon B (1999)
Cochlear Pharmacology and Noise Trauma
Noise Research Network Publication, London

The book contains 15 presentations with group discussions.

Seidman M, Moneysmith M (2006)
Save Your Hearing Now, The Revolutionary Program That Can Prevent And May Even Reverse Hearing Loss
Warner Wellness

About the telltale signs of hearing loss and what you can do about it.

Journals

Hearing Research (1978–)
Elsevier, Amsterdam, Netherlands
Web: http://www.sciencedirect.com/science/journal/03785955

The aim of *Hearing Research* is to provide a forum for papers concerned with basic auditory mechanisms. Papers on comparative aspects of hearing in animals and man, and on effects of drugs and environmental contaminants (such as noise pollution) on hearing function are also considered.

Noise and Health (1998–)
Noise Research Network (*nRn*) Publications, London, UK
Web: http://www.ucl.ac.uk/noiseandhealth/index.htm

Noise and Health is an international journal devoted to research on all aspects of noise and its effects on human health. An interdisciplinary journal for all professions concerned with auditory and non-auditory effects of occupational, environmental, and leisure noise. It aims to provide a forum for presentation of novel research material on a broad range of topics associated with noise pollution, its control, and its detrimental effects on hearing and health. It covers issues from basic experimental science through clinical evaluation and management, technical aspects of noise reduction systems and solutions to environmental issues relating to social and public health policy.

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Professional Organizations and Associations

Association for Research in Otolaryngology (ARO)
19 Mantua Rd. Mt. Royal, NJ 08061
Phone: 856-423-0041
Web: http://www.aro.org/

ARO is an international association of scientists and physicians dedicated to scientific exploration among all of the disciplines in the field of otolaryngology. Research efforts involve the ear, nose, head, neck and related functions including hearing, balance, speech, taste and smell among others.

National Institute for Occupational Safety and Health (NIOSH)
Cincinnati, Ohio 45226
Phone: 1-800-356-4674
Fax: 1-888-232-3299
Web: http://www.cdc.gov/niosh/homepage.html

NIOSH is an agency of the U.S. Department of Health and Human Services, being established to help assure safe and healthful working conditions for working men and women by providing research, information, education, and training in the field of occupational safety and health. It was created by Congress under the Occupational Safety and Health Act, signed by President Richard M. Nixon, on December 29, 1970.

For NIOSH topics or database about noise research and protection, go to the following sites:
http://www.cdc.gov/search.do?action=search&subset=niosh &queryText=noise
http://www.cdc.gov/niosh/topics/noise/workplacesolutions/toolsDatabase_alt.html

Occupational Safety and Health Administration (OSHA)
200 Constitution Avenue, Washington, D.C. 20210
Phone: 1-800-321-6742
Web: http://en.wikipedia.org/wiki/Occupational_Safety_and_Health_ Administration

OSHA is an agency of the U.S. Department of Labor. It was created by Congress under the Occupational Safety and Health Act, signed by President Richard M. Nixon, on December 29, 1970. Its mission is to prevent work-related injuries, illnesses, and deaths by issuing and enforcing rules (called standards) for workplace safety and health.

For information about noise, go to: http://en.wikipedia.org/wiki/Noise.

The National Institute on Deafness and Other Communication Disorders (NIDCD)
31 Center Drive, MSC 2320, Bethesda, MD 20892-2320
E-mail: nidcdinfo@nidcd.nih.gov
Web: http://www.nidcd.nih.gov/

NIDCD is one of the institutes that comprise the National Institutes of Health (NIH). NIH is the Federal government's focal point for the support of biomedical research. NIH's mission is to uncover new knowledge that will lead to better health for everyone. Established in 1988, NIDCD is mandated to conduct and support biomedical and behavioral research and research training in the normal and disordered processes of hearing, balance, smell, taste, voice, speech, and language.

For information about studies of noise and noise-induced hearing loss, go to: http://www.nidcd.nih.gov/health/hearing/

Noise Pollution Clearinghouse
Montpelier, VT 05601
Phone: 1-888-200-8332
Web: http://www.nonoise.org/

The Noise Pollution Clearinghouse is a national nonprofit organization with extensive online noise-related resources. The Noise Pollution Clearinghouse seeks to: raise awareness about noise pollution; create, collect, and distribute information and resources regarding noise pollution; strengthen laws and governmental efforts to control noise pollution; establish networks among environmental, professional, medical, governmental, and activist groups working on noise pollution issues; assist activists working against noise pollution.

World Health Organization (WHO)
Avenue Appia 20, 1211 Geneva 27, Switzerland
Phone: (+ 41 22) 791 21 11; Fax: (+ 41 22) 791 3111
Web: http://www.who.int/en/

The World Health Organization is the United Nations' specialized agency for health.

For information about studies of noise and noise-induced hearing loss, go to: http://search.who.int/search?ie=utf8&site=default_collection&client=WHO&proxystylesheet=WHO&output=xml_no_dtd&oe=utf8&q=noise+study&Search=Search.

CHAPTER

38

Occupational Health

ANDREW MAIER

INTRODUCTION

The broad area of occupational health practice includes professionals who share the goal of occupational injury and disease prevention. Practices that set out the measures and requirements for achieving this goal are embedded in regulatory requirements, professional consensus standards, professional guidelines documents, and programs implemented by the private sector. For example, in the United States, regulatory requirements in the field are encoded in the Code of Federal Regulations and enforced by the Occupational Safety and Health Administration (OSHA) under the Authority of the Occupational Safety and Health Act (1970). In addition, many important guidance documents, databases, and training resources are available from the National Institute for Occupational Safety and Health (NIOSH). Important consensus and voluntary standards related to occupational health are available from organizations such as the American National Standards Institute (ANSI) and ASTM International (formerly the American Society for Testing and Materials). Additional guidance documents are available from professional organizations such as the American Industrial Hygiene Association (AIHA) and the American Conference of Governmental Industrial Hygienists (ACGIH). There are international counterparts to many of these types of organizations.

Occupational health includes numerous specialty fields. Occupational health nurses and physicians perform medical surveillance activities along with the diagnosis and treatment of work-related injury and disease. Industrial hygienists are engaged in the recognition, evaluation, and control of occupational health risks. Industrial hygienists often provide training to workers on potential toxicological effects of exposure, conduct exposure evaluations, and develop risk management strategies to reduce the potential for adverse exposures. Occupational epidemiologists and toxicologists often provide a supporting role for occupational medicine professionals and industrial hygienists. Occupational epidemiologists provide support for assessing the incidence and prevalence of work-related diseases. Occupational toxicologists evaluate the effects of chemical agents on workplace health based on toxicology findings. These health professionals become involved in developing hazard communication information, setting safe exposure levels such as occupational exposure limits, and aiding in the assessment of the potential for work-related health effects from chemical exposure situations. The roles of these various professionals can overlap and a multidisciplinary team can become involved to address complex occupational health issues.

Professionals who work in these diverse aspects of the occupational health field share the need for accessing information related to the toxicology and adverse health effects of chemicals. Many of the resources used in occupational health practice are general resources shared by other specialties in toxicology. This chapter focuses on those resources of particular interest to occupational health. One such focus area is on the evaluation and management of occupational diseases and there are many core textbooks and diagnostic guides available. In addition, agencies such as OSHA and NIOSH provide guidance on occupational medical tests and surveillance for workplace exposures. There are numerous resources related to the

many facets of industrial hygiene, including those that address sources of occupational exposure, industrial hygiene assessment methods, as well as control strategies. Some of the reference works in the industrial hygiene field include material directly relevant to toxicology evaluations, and these references are the focus of this chapter. Hazard communication is an area of occupational health practice that receives significant focus, particularly due to the growing effort to adopt harmonized hazard communication and labeling systems internationally (see the separate chapter in this book on Hazard Communication for additional information resources). Finally, a significant focus of the field is the development of guidelines for assessing safe exposure.

A significant interface between toxicology and other occupational health professionals is in the development of occupational exposure limits (OELs). A major emphasis of the field is in developing OELs that provide the practicing occupational health professional with an estimate of the airborne concentration that is expected to be safe for all or nearly all workers who may be exposed over a working life-time. These OELs have varying exposure periods of interest depending on the nature of the chemical effect involved. OELs are commonly set on the basis of protection for a full shift exposure (a full shift time-weighted average or TWA), a shorter period of time such as 15 minutes for acute effects (often called a short-term exposure limit or STEL), or to protect from immediate effects (often called a ceiling limit). Such values are used to communicate hazards to workers, to provide an objective benchmark for ensuring control measures are adequate, and for triggering medical surveillance needs. OELs are established by many agencies around the world. Regulatory agencies such as OSHA establish legally enforceable standards, while other agencies (NIOSH) and professional organizations (AIHA and ACGIH) establish voluntary standards or guidance values. The names of the specific standards or values vary across organizations. In some cases the methodologies for deriving the standards or values differ, and reading the accompanying documentation and the underlying rationale for the exposure limits of interest is critical. Information resources for many of the agencies that provide such OELs are included below.

Much of the activity in the area of guidance for safe exposure focuses on airborne limits. However, methods for providing guidance for assessing dermal exposures are a growing area. Where such values do not exist, exposure guidance based on measuring estimates of the internal dose (e.g., blood, urine, exhaled air, etc.) may also be available. This latter consideration is included in the context of biological monitoring or biomarkers of exposure (see the separate chapter in this book on Biomarkers for additional information resources). While validated biomarkers are available for fewer chemicals than those that have traditional OELs, they have significant utility for integrating exposure across pathways and verifying the degree of actual dose to systemic target tissues. Many chemicals do not have adequate toxicology data to develop a quantitative estimate of a safe air concentration, but do have adequate hazard information. For such chemicals an alternative approach that makes use of hazard information to estimate potential OEL ranges and control strategies has been developed. This concept is called control banding or the application of performance-based standards. Some of the key publications in the field related to these alternatives to air concentration-based OELs are included below.

RESOURCES

Books

Industrial Hygiene Practice

DiNardi SR (ed.) (2003)
The Occupational Environmental: Its Evaluation, Control, and Management, Second Edition
AIHA Press, Fairfax, VA, USA.

One of the standard textbooks for occupational safety and health professionals. Covers all key areas of basic industrial hygiene methods and practice. The text also provides chapters related to topics in occupational toxicology, occupational risk assessment, and occupational exposure limits.

Perkins JL (2008)
Modern Industrial Hygiene
American Conference of Governmental Industrial Hygienists (ACGIH), Cincinnati, OH, USA.

A multivolume set focused on providing a comprehensive textbook and resource work with additional emphasis on examples and applications. Volume 1 focuses on industrial hygiene considerations related to recognition and evaluation of chemical exposure assessment. Volume 2 extends the focus to exposure assessment for biological agents, as well as chapters on other biological aspects of industrial hygiene practice such as physiology and toxicology for the respiratory tract and skin, biological monitoring, and the biological basis for occupational exposure limits.

Plog BA, Quinlan PJ (eds) (2001)
Fundamentals of Industrial Hygiene, Fifth Edition
National Safety Council, Itasca, IL, USA.

One of the standard textbooks for occupational safety and health professionals. Covers all key areas of basic industrial hygiene methods and practice. The text also provides chapters related to topics in occupational toxicology, including basic physiology, chemical toxicology, and the interpretation of exposure limits. This latest addition also includes chapters on occupational health nursing and occupational medicine.

Occupational Toxicology

Harbison R (ed.) (1998)
Hamilton and Hardy's Industrial Toxicology, Fifth Edition
Mosby-Year Book, Inc., Philadelphia, PA, USA.

The book is primarily organized as separate chapters on individual chemical agents in chemical classes of interest to occupational health. Each chapter describes basic industrial hygiene and exposure considerations for the chemical, key target organs for acute and chronic effects, pertinent diagnosis and surveillance methods, and a summary of mechanisms of toxicological action. In addition to the chemical-specific chapters that form the bulk of the book, general chapters on occupational diseases, chemical carcinogenesis, and reproductive toxicity are included.

Harris R, Bingham E, Cohrssen B, Powell CH (eds) (2000)
Patty's Industrial Hygiene and Toxicology, 5th Edition (13 Volume Set)
Wiley-Interscience, Hoboken, NJ, USA.

This comprehensive reference includes 13 volumes that cover methods and practical issues in industrial hygiene and toxicology along with providing chapters summarizing the toxicology data for selected chemicals and chemical classes. The methodology chapters cover in detail issues related to industrial hygiene and occupational toxicology practice. The chemical-specific toxicology chapters provide a detailed review of acute and chronic toxicity based on animal toxicology and human health effects information.

Hathaway GJ, Proctor NH (2004)
Proctor and Hughes' Chemical Hazards of the Workplace, Fifth Edition
Wiley, Hoboken, NJ, USA.

Provides introductory sections that review basic concepts in toxicology, clinical manifestations of exposure, occupational disease diagnosis, and industrial hygiene principles. The bulk of the text provides a stream-lined profile for over 600 chemicals found in the workplace. Entries for each chemical include data on chemical identity, exposure limits, physical properties, and exposure information. Toxicity information highlights acute and chronic effects (especially as related to known human exposure levels), including information on carcinogenic, mutagenic, and reproductive effects. Occupational medicine information includes treatment protocols and medical surveillance techniques (including biological monitoring).

Encyclopaedia of Occupational Health and Safety, 4th Edition
International Labour Office (ILO), Geneva, Switzerland
Web: http://www.ilocis.org/en/contilo.html (web access to entire content)

Covers the core allied fields encompassing occupational health and safety. The topics are written by internationally renowned experts, and are intended to provide jargon-free answers to the most critical questions involving health and safety in the workplace. The parts of the encyclopedia include the body, health care, management and policy, tools and approaches, psychosocial and organizational factors, general hazards, the environment, accidents and safety management, chemicals, industries based on biological resources, industries based on natural resources, chemical industries, manufacturing industries, textiles and apparel industries, transport industries, construction, services and trade, and guides.

Luttrell WE, Jederberg WW, Still KR (eds) (2008)
Toxicology Principles for the Industrial Hygienist
American industrial Hygiene Association, Fairfax, VA, USA.

This book has been written and edited by industrial hygienists and toxicologists. It is the most comprehensive toxicology reference specifically for the industrial hygienist. Emphasis is on basic principles and case studies that relate to the working environment. This toxicology reference presents 36 chapters divided into five sections, and includes case studies. The sections of the book include Understanding Toxicology, Sites of Action of Chemicals Found in the Workplace, Chemical Group Toxicology; Application of Toxicological Information; and Sources of Toxicological Information. Each chapter is written with the idea of what a toxicologist would tell an industrial hygienist in 15 minutes about the specific subjects.

Ullmann's Industrial Toxicology
Wiley-VCH. (2005) Hoboken, NJ, USA.

This two-volume set is condensed from the 40-volume Ullmann's Encyclopedia and covers information on

applying the science of toxicology in both the occupational and environmental setting. The articles provide the fundamentals necessary for understanding the effects of chemical hazards on humans and ecosystems. The set includes articles on industrial toxicology, ecotoxicology, process safety as well as occupational health and safety.

Winder C, Stacey N (eds) (2004)
Occupational Toxicology, Second Edition
Basingstoke: CRC Press. Taylor & Francis Ltd.

Provides an introduction to aspects of toxicology that relate to the workplace. The text describes effects of chemical exposures with chapters on specific target organs of particular relevance to occupational exposures such as the lungs, skin, liver, kidneys, and the nervous system. Chapters also describe toxic effects of classes of agents found in the workplace such as metals, pesticides, solvents, plastics, gases, and particulates. The importance of a multidisciplinary approach to the field is highlighted by covering interrelated aspects of hygiene, epidemiology, and occupational medicine.

Occupational Medicine and Nursing

Greenberg M, Hamilton R, and Phillips S (1997)
Occupational, Industrial, and Environmental Toxicology
Mosby-Year Book, Philadelphia, PA, USA.

Primarily a text for the occupational toxicologist, occupational physician, or clinical toxicologist. The material is presented to facilitate the diagnosis and treatment of occupational toxicology patients. The material is organized by occupation, industry, and environment and provides information on plausible exposures to chemical agents, systemic effects expected to arise from such exposures, and suggested treatments.

Hunter D, Adams PH, Baxter PJ, Aw T, Cockcroft A, Harrington JM (eds) (2000)
Hunter's Diseases of Occupations
Oxford University Press, New York, NY, USA.

A standard textbook in occupational medicine. The book covers diseases caused by occupations, and the assessment, management, and treatment of patients. The book is aimed at both clinicians dealing with specific patients and occupational physicians and other occupational health professionals who need to recognize, diagnose, or treat occupational disease. The newest edition builds on the comprehensive coverage of occupational diseases by addressing newer areas of concern arising from exposures connected with the newer technologies, and the effects of chemicals in the environment.

LaDou J (2006)
Current Occupational & Environmental Medicine, Fourth Edition
McGraw-Hill Medical, New York, NY, USA.

Covers common and important occupational and environmental diseases, injuries, and exposures. Includes the latest OSHA/NIOSH guidelines for occupational exposure standards, detailed diagnostic checklists to aid diagnosis and treatment, a step-by-step review of how to manage an occupational health and safety program, details on health risk analysis, legal aspects of occupational and environmental medicine, and preventive approaches to terrorist attacks on industry.

Levy BS, Wegman DH, Baron SL, Sokas RK (eds) (2005)
Occupational and Environmental Health: Recognizing and Preventing Disease and Injury
Lippincott Williams & Wilkins.

A comprehensive, practical guide to recognizing, preventing, and treating work-related and environmentally induced injuries and diseases. Chapters address the range of clinical and public health concerns arising from exposures in the workplace, and to agents released into the environment. The text is reinforced by presentation of case studies. This newest edition includes chapters on environmental health (including water pollution, hazardous waste, global environmental hazards), the role of non-governmental organizations in environmental health, and risk communication (i.e., responding to community environmental health concerns), and risk management topics (conducting workplace investigations and assessing and enforcing compliance with health and safety regulations).

McCunney RJ (ed.), Rountree PP (ed.), Barbanel CS (ed.), Borak JB (ed.), Bunn WB (ed.), McCunney RJ (author) (2003)
A Practical Approach to Occupational and Environmental Medicine, Third Edition
Lippincott Williams & Wilkins, Philadelphia, PA, USA.

This text provides a comprehensive and practical guide to the diagnosis, treatment, and prevention of occupational disorders. This latest edition emphasizes prevention. A comprehensive index provides reference ease for examination of all aspects of occupational and environmental medicine. The book was sponsored by the American College of Occupational and Environmental Medicine.

Oakley K (ed.) (2008)
Occupational Health Nursing, Third Edition
John Wiley & Sons Limited (the content of this edition was first published in 2002 by Whurr Publishers Limited), West Sussex, UK.

A textbook written specifically as a resource for students and practicing occupational health nurses. Formatted for quick reference on essentials in the field, with updated information on legislation and new guidance documents.

Rosenstock L, Cullen M, Brodkin C, Redlich C (2004)
Textbook of Clinical Occupational and Environmental Medicine, Second Edition
Saunders, Philadelphia, PA, USA.

Provides a comprehensive text addressing the detection, diagnosis, and treatment of the full range of disorders caused by physical, chemical, and biologic agents found in the occupational setting, and arising from environmental exposures. The text provides in-depth, authoritative guidance on clinical problems and analysis of legal and regulatory issues impacting the practice of occupational medicine.

Occupational Exposure Limit Documentation

American Conference of Governmental Industrial Hygienists (ACGIH) (2001)
Documentation of the Threshold Limit Values and Biological Exposure Indices, 7th Edition

Provides the underlying documentation and rationale supporting the Threshold Limit Value (TLV) and Biological Exposure Indices (BEI). A compilation of published documentation for occupational exposure limits (i.e., the TLVs) and biological exposure indices used for biological monitoring (i.e., the BEIs), as established by committees of the ACGIH. Each TLV document summarizes information on the basic chemical identity, physical properties, toxicokinetics, animal toxicology data, and human exposure experience. A rationale for the recommended TLV is provided. Each BEI document summarizes the data on toxicology, exposure, and toxicokinetics and provides a rationale for the recommended BEI.

American Industrial Hygiene Association (AIHA) Workplace Environmental Exposure Level (WEEL) Committee (2007)
2007 Workplace Environmental Exposure Levels (WEEL) Complete Set
AIHA Press, Fairfax, VA, USA.

A compilation of published documentation for occupational exposure limits (i.e., the WEELs), as established by a committee of the AIHA. Each WEEL document summarizes information on the basic chemical identify, physical properties, toxicokinetics, animal toxicology data, and human exposure experience. A rationale for the recommended WEEL is provided.

Brandys RC, Brandys BM (2007)
Global Occupational Limits for Over 5,000 Specific Chemicals
OEHCS Publications, Inc., Hinsdale, IL, USA.

A compilation providing a comprehensive listing of occupational exposure limits from organizations and agencies around the world.

Guide to Occupational Exposure Values

ACGIH, Cincinnati, OH, USA. (2008)

A concise handbook of occupational exposure limits from selected organizations and agencies.

The MAK-Collection for Occupational Health and Safety

Wiley-VCH, Hoboken, NJ, USA. (2007)

This latest edition provides the documentation for the maximum workplace concentrations established by the German Commission for the Investigation of Health Hazards of Chemical Compounds in the Work Area. The documentations provide the occupational exposure limits as well as supporting toxicity and epidemiology data.

Control Banding Guidance

Guidance for Conducting Control Banding Analyses
AIHA, Control Banding Working Group (2007)

The AIHA working group developed this guide covering key concepts, significant developments, and research needs associated with a control-based approach to identifying and controlling hazardous agents. Includes a comprehensive reference list, and study resources and other helpful aids for conducting control banding analyses.

Book Chapters

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Review Articles

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Kane LE, Barrow CS, Alarie Y (1979) A short-term test to predict acceptable levels of exposure to airborne sensory irritants. Am. Ind. Hyg. Assoc. J. 40: 207–229.

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Journals

AAOHN Journal – American Association of Occupational Health Nurses Journal

American Industrial Hygiene Association Journal

American Journal of Epidemiology

American Journal of Industrial Medicine

Annals of Occupational Hygiene

International Archives of Occupational and Environmental Health

International Journal of Occupational and Environmental Health

Journal of Occupational and Environmental Hygiene

Journal of Occupational Health

Journal of Occupational and Environmental Medicine

Occupational and Environmental Medicine

Occupational Hazards

Occupational Health

Occupational Health and Safety

Occupational Medicine

Occupational Medicine: State of the Art Reviews

Occupational Hygiene

Scandinavian Journal of Work, Environment and Health

Toxicology and Industrial Health

Web Portal

Osh.Net
Web: http://www.osh.net/

Osh.Net is a web portal for occupational health and safety resources and information, overseen by a team of licensed occupational health and safety experts, including certified industrial hygienists, safety specialists, registered nurses, occupational health physicians, and Internet communications professionals. Osh.Net seeks to provide access to information that is timely and from relevant and credible resources. They search the web for new and useful links, and update their links monthly through a hands-on screening process. Osh.Net monitors the OSHA, CDC, and NIOSH websites on a regular basis for the latest in governmental compliance news, and Osh.Net's writers interpret and provide insights on the latest federal standards or emerging health/safety issues.

Newsletters and Forums

Many of the leading organizations and agencies in the area of occupational health (as provided in the 'Organizations' section of this chapter) publish newsletters with information related to their organization as well as articles on issues that affect worker health.

In addition there are email groups and list servers dedicated to occupational health issues. One example is Occ-Env-Med-L (Occupational & Environmental Medicine for Clinicians & Public Health Professionals digest), a free discussion forum for clinical and public health professionals (only) about topics in Occupational & Environmental Medicine, housed at the University of North Carolina School of Public Health. http://occhealthnews.net/occ-env-.htm#Rules. Further, the Osh.Net web portal described above publishes an e-newsletter and provides access to an Osh.Net forum as an interactive resource to support the free exchange of occupational health and safety information. The e-newsletter has several thousand opt-in subscribers. The scope of the forum covers all aspects of health and safety, with specific sub-forums in place to discuss the OHSAS standards, OSHA and general Workplace and Occupational Safety.

Databases and Other Website-Based Resources

American Industrial Health Association (AIHA), Information by Topic Web pages (http://www.aiha.org/Content/Topics/). Numerous topics are included, e.g., asbestos, nanotechnology, and regulatory/standards issues.

Canadian Centre for Occupational Health and Safety (CCOHS), OSH Answers FREE! This is a searchable database for finding answers to hundreds of frequently asked health and safety questions. This web site also provides subscription access to other databases, including material safety data sheets (MSDSs), CHEMINFO, CHEMpendium™, RTECS®, OSH References, and Canadian enviroOSH. http://www.ccohs.ca/

European Union, European Agency for Safety and Health at Work. The website provides links to leading organizations from individual European Union countries that develop guidance documents on occupational health issues, including occupational exposure limits. http://osha.europa.eu/

International Labour Organization (ILO) – International Occupational Safety and Health Information Centre. The Centre provides a database of links to exposure limit information for many countries internationally. http://www.ilo.org/public/english/protection/safework/cis/index.htm

(U.K.) Health and Safety Executive (HSE), COSHH Essentials. This web site was developed to help firms comply with the U.K.'s Control of Substances Hazardous to Health Regulations (COSHH), and contains 'easy steps to control health risks from chemicals.' It provides advice for controlling the risks associated with chemicals for a range of common tasks, and takes users through a number of steps asking for information about the tasks and chemicals of interest. Direct advice for some processes, tasks, or services is also offered. http://www.coshh-essentials.org.uk/

(U.S.) National Institute for Occupational Safety and Health. Provides numerous databases containing occupational toxicology information, including occupational exposure limits (NIOSH Recommended Exposure Limits), industrial hygiene sampling and analytical methods, acute inhalation exposure values for respiratory protection selection (NIOSH Immediately Dangerous to Life or Health Values), medical surveillance and injury and illness statistics, and exposure statistics. http://www.cdc.gov/niosh/. Various safety and health topics have their own NIOSH web pages, e.g., control banding (http://www.cdc.gov/niosh/topics/ctrlbanding/). NIOSH resources and publications can be searched using NIOSHTIC (http://www2a.cdc.gov/nioshtic-2/default.asp)

(U.S.) National Institutes of Health, National Library of Medicine, HazMAP. A database searchable by agent, disease, or exposure that links basic information for chemicals and chemical classes on sources of exposure, exposure assessment information, and adverse effects, and occupational diseases. http://hazmap.nlm.nih.gov/

Organizations

American Association of Occupational Health Nurses. http://www.aaohn.org/ (note that there are numerous related organizations in other countries)

American College of Occupational and Environmental Medicine. http://www.acoem.org/

American Conference of Governmental Industrial Hygienists. http://www.acgih.org/

American Industrial Hygiene Association. http://www.aiha.org

Association of Occupational and Environmental Clinics (AOEC) http://www.aoec.org/

Canadian Centre for Occupational Health and Safety (CCOHS) http://www.ccohs.ca/

European Agency for Safety and Health at Work. http://osha.europa.eu/ (this website also provides links to many related organizations from individual European Union countries that develop guidance documents on occupational health issues)

International Commission on Occupational Health. http://www.icohweb.org/

International Labour Organization. http://www.ilo.org/global/lang--en/index.htm

International Occupational Hygiene Association. http://www.ioha.net/

Society of Toxicology – Occupational and Public Health Specialty Section. http://www.toxicology.org/ISOT/SS/ophss/

(U.S.) National Institute for Occupational Safety and Health. http://www.cdc.gov/niosh/.

(U.S.) Occupational Safety and Health Administration. http://www.osha.gov/.

CHAPTER

39

Genomics

MARK A. PERSHOUSE, MELISA BUNDERSON SCHELVAN, AND CORBIN SCHWANKE

The growing realization that we will have to understand our favorite biological molecules in the context of many thousands of others and that a wide net must be cast to be sure that we have, in fact, found the important ones … If one is going to fish, it is best to do so in teeming waters with the finest equipment and flawless technique.

John N. Weinstein, Science 282: 628–629, 1998

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INTRODUCTION

Genomics comprises several distinct areas of research; *transcriptomics*, the study of global RNA expression; *genotyping*, measurement of DNA polymorphisms and mutations; and *bioinformatics*, the systematic analysis of biological data generated by technologies such as genomics.

The field of genomics has had a rocky past, not only in toxicology, but in the biomedical sciences in general. This is due primarily to the nature of the studies. In a major shift from the research paradigm that has dominated research since the earliest philosophers and thinkers, genomics studies do not require a hypothesis. They are, in fact, considered 'hypothesis generating'. Other ways of describing the genomic approach are, '**not** hypothesis limited' (Staudt & Brown 2000) or 'discovery-based' investigations. For scientists trained from their earliest science fair projects in the absolute requirement for a testable hypothesis, genomics is indeed a 'fishing expedition' and unfamiliar territory. Mark Schena, in his early book entitled 'Microarray Biochip Technology' used the analogy of Galileo with one of the first telescopes. Galileo's investigations of the nature of the universe were indeed unfocused and discovery-based. He had no testable hypothesis because he was at a point in technological development where the questions being asked were inherently different than most scientific investigations to date. With the telescope he could ask for the first time, 'What is out there?', without a clear goal in mind. Genomics has been described as a similar technological leap in the history of science. With a robust microarray, an investigator can ask the simple, but profound question, 'When I change one variable in a cell; add a toxicant, a higher or lower dose, a longer or shorter exposure, or remove the function of a critical response gene, what gene expression changes take place in the cell (tissue, organism)?' These experiments have provided countless new hypotheses to follow, and begun the complex task of integrating knowledge of gene function with mechanisms of disease progression. Rather than proceeding one gene or protein at a time based only on historical knowledge, genomics allows the rapid focusing of our investigations to highly relevant pathways and genes. As the

technology becomes more available, reproducible, and inevitably more affordable, the pace of research will proceed at a faster pace. In the end, this is good news specifically for affected individuals and in general for all of biomedical science.

Resources utilized by genomics researchers rely heavily on rapidly changing digital resources, so some of the best resources are web-based. However, some printed texts have proven useful for those new to the field, as an introduction, or as a reference work to those more experienced in the field. Several are listed below. Peer-review journals have recently begun to emerge that focus almost entirely on genomic publications, but over the last 10–20 years, publications of genomic data have found their way into a large variety of journals in a multitude of disciplines. Thus, this list is rather long and represents only a handful of journal publishing genomics data.

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RESOURCES

Books

Mount DW, Baxevanis A, Ouellette BFF (2001)
Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. Third Edition
John Wiley & Sons, Inc., Hoboken NJ

This is an 18-chapter textbook that focuses on the use of relevant biological examples to explain methods for the computational analysis and organization of bioinformatics data. Beginning with an explanation of sequence and mapping databases, the book goes through predictive methodologies, intermolecular interactions and biological pathways, and assessing pairwise sequence similarity. It also covers different analysis methods as well as phylogenetic analysis, computational approaches in comparative genomics, using DNA microarrays to assay gene expression, proteomics and protein identification and the use of PERL to facilitate biological analysis.

Mount DW (2001)
Bioinformatics: Sequence and Genome Analysis, Second Edition
Cold Spring Harbor Laboratory Press

This textbook contains 13 chapters focusing on the computational analysis of DNA microarray data. This book covers all the basics of bioinformatics, including how to collect and store sequences in the laboratory, alignment of pairs of sequences, and introduction to probability and statistical analysis of sequence alignment, multiple sequence alignment as well as sequence database searching for similar sequences. There is also a chapter on phylogenetic prediction, RNA secondary structure, gene prediction and regulation and protein classification and structure prediction. The book finishes with a chapter on genome analysis, bioinformatics programming and analysis of microarrays.

Schena M (1999)
DNA Microarrays
Oxford University Press, Oxford, UK
Web: http://www.oup.com/uk/catalogue/?ci=9780199637768

Contains 10 chapters outlining a practical approach to DNA microarray technology. The book begins with an introduction to the fundamentals of biochips and follows with a description of full methodological details and current applications.

McClelland M, Pardee AB (Eds) (1999)
Expression Genetics: Accelerated and High-Throughput Methods
Biotechniques Update Series-Eaton Pub Co., Natick, MA

A collection of 37 papers from Biotechniques representing high-throughput techniques for analyzing or finding differentially expressed genes.

Krawetz SA, Womble D (2003)
Introduction to Bioinformatics: A Theoretical and Practical Approach
Human Press, Totowa, New Jersey
Web: Humanapress.com

This comprehensive book is divided into four sections including: (1) Biochemistry, cell, and molecular biology, (2) Molecular genetics, (3) The UNIX operating system, and (4) Computer applications. It is useful for assisting the genomic scientist with a basic review of biological systems as well as providing a foundation for using the tools necessary for analyzing the vast amount of data generated by microarrays.

Schena M (2003)
Microarray Analysis
John Wiley and Sons, Inc., Hoboken, NJ

This textbook-style resource contains 16 chapters covering the basics of microarray analysis all the way to future trends: chips in the clinics. This comprehensive book covers the basics of biochemistry, genes and

genomes, microarray surfaces, targets and probes, microarray manufacturing, detection, and informatics. There is also a chapter on methodological architecture, cleanroom technology, gene expression profiling as well as genetic screening and diagnostics.

Schena M (2000)
Microarray Biochip Technology
Eaton Publishing, Natick, MA

This textbook contains 15 chapters detailing a variety of DNA microarray applications from various vendors and research labs.

Speed T (Ed.) (2003)
Statistical Analysis of Gene Expression Microarray Data
Chapmand & Hall/CRC Washington, DC

This is a four-chapter book on interdiscliplinary statistics that starts with a description of model-based analysis of oligonucleotide arrays and issues in cDNA microarray analysis. The second chapter focuses on the design and analysis of comparative microarray experiments and is followed by a chapter on classification in microarray experiments. The final chapter explains the intricacies of clustering microarray data.

Journals

American Journal of Human Genetics (1949–)
University of Chicago Press, Chicago, IL
Web: http://www.journals.uchicago.edu/AJHG/journal/

The American Journal of Human Genetics is a record of research and review relating to heredity in humans; to the applications of genetic principles in medicine, psychology, anthropology, and social services; and to areas of molecular and cell biology relevant to human genetics. It is published monthly. The Journal is owned and controlled by The American Society of Human Genetics and is edited, in conjunction with the publisher, by a staff appointed by the Board of Directors of the Society.

Annals of Human Genetics (1954–)
Cambridge University Press, Cambridge, London
Web: http://www.blackwell-synergy.com/servlet/useragent?func=showIssues&code=ahg

The *Annals of Human Genetics* is an international journal publishing rigorously peer-reviewed research. The principal aim of the Annals is to increase understanding of the biology of human variation, both in disease and in health. In recent years it has become apparent that the study of population genetics is extremely relevant to molecular pathology. The interaction of these fields can greatly increase our understanding of the generation and maintenance of variation in the human genome.

BMC Genomics (2000–)
BioMed Central, London
Web: http://www.biomedcentral.com/1471-2164

BMC Genomics is an Open Access, peer-reviewed journal that considers articles on all aspects of gene mapping, sequencing and analysis, functional genomics, and proteomics.

Briefings in Functional Genomics and Proteomics (2002–)
Henry Steward Publications, London
Web: http://bfgp.oxfordjournals.org/

Briefings in Functional Genomics and Proteomics is an international forum for researchers and educators in the life sciences and reviews the techniques, protocols and approaches in genome and proteome research. The journal aims to provide a centralized resource for researchers in the fields of genomics and proteomics as well as give guidance to scientists new to these areas.

Cloning and Stem Cells (2001–)
Mary Ann Liebert, Inc. Larchmont, NY
Web: http://www.liebertonline.com/clo

The Journal publishes peer-reviewed research papers on the remarkable new opportunities in medicine, biology, and agriculture that arise from the demonstration of far greater than expected developmental plasticity in mammalian cells. Papers cover all aspects of cloning along with the culture and differentiation of stem cells from all stages of development from embryo to adult.

Current Opinion in Genetics and Development (1991–)
Current Biology, London
Web: http://sciencedirect.com/science/journal/0959437X

Cytogenetic and Genome Research (2002–)
S. Karger, Switzerland

In recent years, most of its papers have centered on genome research, including gene cloning and sequencing, gene mapping, gene regulation and expression, cancer genetics, comparative genetics, gene linkage and related areas.

DNA Research (1994–)
Universal Academy Press, Tokyo, Japan

Web: http://www.dnaresearch.oxfordjournals.org/

DNA Research is an internationally peer-reviewed journal which aims to publish the highest quality papers on structures and function of genes and genomes.

European Journal of Human Genetics (1992–)
Nature Publishing Group, London
Web: http://www.nature.com/ejhg/

The *European Journal of Human Genetics* is the official Journal of the European Society of Human Genetics, publishing high-quality, original research papers, short reports, News and Commentary articles and reviews in the rapidly expanding field of human genetics and genomics, including a new series on Practical Genetics. The journal covers molecular, clinical and cytogenetics, interfacing between advanced biomedical research and the clinician, and bridging the great diversity of facilities, resources and viewpoints in the genetics community.

Functional and Integrative Genomics (2000–)
Springer, Berlin
Web: http://link.springer-ny.com/link/service/journals/10142/index.htm

Functional and Integrative Genomics is devoted to large-scale studies of genomes and their functions, including systems analyses of biological processes. Topics covered include: whole genome analyses/bioinformatics/expression profiling, genomics (structural, comparative, integrative), proteomics, metabolomics, human disease genes and loci, and large-scale/high throughput analysis of biological systems.

Gene (1976–)
Elsevier, Amsterdam, North Holland
Web: http://sciencedirect.com/science/journal/03781119

The journal publishes papers on all structural, functional, and evolutionary aspects of genes, chromatin, chromosomes and genomes.

Genetics (1916–)
Genetics Society of America, Baltimore, MD
Web: http://www.genetics.org/

Genetics publishes contributions that present the results of original research in genetics and related scientific disciplines. *Genetics* is an official publication of the Genetics Society of America.

Genetics and Molecular Research (2002–)
FUNPEC, Ribeirao Preto, SP Brazil
Web: http://funpecrp.com.br/gmr/index.htm

Genetics and Molecular Research (GMR) publishes research articles, research reports, technical notes, scientific commentaries, news, views, and review articles on Genetics, Evolution and Molecular Biology. It is an exclusively online journal.

Genome (1987–)
National Research Council of Canada Ottawa, Canada
Web: http://pubs.nrc-cnrc.gc.ca/cgi-bin/rp/rp2_vols_e?gen

Genome publishes, in English or French, scientific reports on the mechanisms of genetics, cytogenetics, and evolution.

Genome Biology (2000–)
Genome Biology Ltd., London, UK
Web: http://genomebiology.com

Genome Biology serves the biological research community as an international forum for the dissemination, discussion and critical review of information about all areas of biology informed by genomic research. Key objectives are to provide a guide to the rapidly developing resources and technology in genomics and its impact on biological research, to publish large datasets and extensive results that are not readily accommodated in traditional journals, and to help establish new standards and nomenclature for post-genomic biology.

Genome Letters (2002–)
American Scientific Publishers Stevenson Ranch, CA
Web: http://www.aspbs.com/genomelett

Genome Letters is an international peer-reviewed journal with a wide-ranging coverage, consolidates research activities in all aspects of genome science, genome technology, bioinformatics, biotechnology and medicine into a single, and unique reference source.

Genome Research (1995–)
Cold Spring Harbor Laboratory Press, Cold Spring Harbor, NY
Web: http://www.genome.org

Among the topics considered by the journal are genome structure and function, comparative genomics, molecular evolution, genome-scale quantitative and population genetics, proteomics, epigenomics, and systems biology. The journal also features exciting gene discoveries and reports of cutting-edge computational biology and high-throughput methodologies.

Genomics (1987–)
Academic Press, San Diego, CA
Web: http://www.sciencedirect.com/science/journal/08887543

The goal of *Genomics* is to promote the understanding of the structure, function, and evolution of genomes in all kingdoms of life and the application of genome sciences and technologies to challenging problems in biology and medicine.

Human Gene Therapy (1990–)
M.A. Liebert, New York, NY
Web: http://www.liebertonline.com/hum

A rapid-publication peer-reviewed journal covering all aspects of human gene therapy. Publishes scientific papers on original investigations into the transfer and expression of genes in mammals, including humans. Improvements in vector development, delivery systems, and animal models, particularly in the areas of cancer, heart disease, viral disease, genetic disease, and neurological disease, are covered. Includes ethical/legal/regulatory papers related directly to the area of gene transfer into humans.

Human Molecular Genetics (1992–)
Oxford University Press, Oxford, UK; New York
Web: http://hmg.oupjournals.org

Human Molecular Genetics concentrates on full-length research papers covering a wide range of topics in all aspects of human molecular genetics. These include:

- the molecular basis of human genetic disease
- developmental genetics
- cancer genetics
- neurogenetics
- chromosome and genome structure and function
- gene therapy
- mouse and other models of human diseases
- functional genomics
- computational genomics.

The Journal of Gene Medicine (1999–)
John Wiley & Sons, Chichester, UK
Web: http://www3.interscience.wiley.com/cgi-bin/jhome/10009391

The Journal of Gene Medicine publishes high-quality original articles and reviews on the science of gene transfer and its applications in gene and cell therapy. Key areas of interest are the design and production of vectors, delivery and targeting, gene expression and regulation, preclinical studies including animal models, developmental aspects and clinical trials. The editors particularly welcome articles dealing with the methodological aspects of gene transfer in vivo, notably in the context of human studies. Papers presenting research into the mechanisms underlying gene transfer; the application and refinement of new technologies such as RNAi, stem cells and allied approaches such as DNA vaccines; or addressing more fundamental biological issues which could lead to more effective gene transfer are also encouraged.

Journal of Structural and Functional Genomics (2001–)
Kluwer Academic Publishers, Dordrecht, Boston
Web: http://www.kluweronline.com/issn/1345-711X

The scope of JSFG includes: Determination of the three-dimensional structures of gene products including those with unknown biological functions. Research and new methodologies for structural genomics including informatics, protein sample production, and structure determination. Discussion of results of structural genomics projects. Experimental and structure-based functional analysis.

Mammalian Genome (1992–)
Springer International, New York, NY
Web: http://link.springer-ny.com/link/service/journals/00335/

Mammalian Genome focuses on the experimental, theoretical, and technical aspects of genomics and genetics in mouse, human, and other species, particularly those aspects bearing on studies of gene function. Special emphasis is placed on: gene structure and expression studies; mutagenesis, the characterization of new mutations and the identification of animal models of human genetic disorders; genetic, physical, and comparative mapping, particularly for the study of gene function; genetic analysis of complex traits; informatics as related to genome analysis and functional genomics; novel technical approaches.

Molecular Genetics and Genomics (2001–)
Springer-Verlag, Berlin
Web: http://link.springer-ny.com/link/service/journals/00438/

Molecular Genetics and Genomics (MGG) covers all areas of genetics and genomics and encompasses experimental and theoretical approaches in all organisms.

Nature Genetics (1992–)
Nature Publishing Company, New York
Web: http://www.nature.com/ng/

Nature Genetics publishes the very highest quality research in genetics. It encompasses genetic and functional genomic studies on human traits and on other model organisms, including mouse, fly, nematode and yeast. Current emphasis is on the genetic basis for common and complex diseases and on the functional

mechanism, architecture and evolution of gene networks, studied by experimental perturbation.

Nature Reviews: Genetics (2000–)
Nature Publishing Group, London
Web: http://www.nature.com/nrg/

To an extent, all life scientists are geneticists because genetic technology and the accumulation of genomic information has enriched all of biology. You may or may not call yourself a geneticist, but if you work on genes you need to know about the latest developments. Nature Reviews Genetics will cover the full scientific breadth of modern genetics, capturing its excitement, diversity and implications.

Journal Articles

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Fritz J, et al (2000) Translating biomolecular recognition into nanomechanics. Science 14; 288(5464): 316–318.

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Organizations

Argonne National Laboratory-MCS
9700 South Cass Avenue
Building 221
Argonne, IL 60439-4844
Phone: 630-252-7162
Fax: 630-252-5986
Web: http://www-new.mcs.anl.gov/new/

The Mathematics and Computer Science division of the Argonne National Laboratory primarily focuses on increasing scientific productivity by providing expertise in computer science, applied computational mathematics, and computational science. Specifically, there is a bioinformatics group working on high-throughput comparative and evolutionary analysis of genomes.

The Broad Institute
7 Cambridge Center
Cambridge, MA 02142
Phone: 617-452-3000
Fax: 617-452-4588
E-mail: questions@broad.mit.edu
Web: http://www.broad.mit.edu/

The goal of The Broad Institute is to bring basic genomic research to medicine by joining collaborators from MIT, Harvard, and their affiliated hospitals.

EMBL – European Bioinformatics Institute
Wellcome Trust Genome Campus
Hinxton Cambridge
CB10 1SD
UK
Phone: +44 (0)1223 494 444
Fax: +44 (0)1223 494 468
E-mail: http://www.ebi.ac.uk/support/
Web: http://www.ebi.ac.uk/Information/

EMBL is a non-profit, academic research organization, focusing on services in bioinformatics. The EBL is part of the European Molecular Biology Laboratory (EMBL).

Genetics Society of America (GSA)
9650 Rockville Pike
Bethesda, MD 20814
Phone: 301-634-7300
E-mail: Society@genetics-gsa.org
Web: http://genetics.faseb.org/genetics/g-gsa/

A society made up of scientists and educators interested in the field of genetics. The GSA promotes genetic research through publication of the journal *Genetics*.

The Institute for Genomic Research (TIGR)
9712 Medical Center Drive

Rockville, MD 20850
Phone: 301-795-7000
Fax: 301-838-0208
Web: http://www.tigr.org/index.shtml

TIGR has helped set the pace for genomics laboratories around the world, exerting a profound impact as a catalyst for innovation. In its early days, TIGR – which was established through a grant from HealthCare Investment Corporation, Inc. – focused much of its research on identifying expressed human genes to help pinpoint the genetic components of diseases. With its work on those Expressed Sequence Tags, known as ESTs, the Institute helped inaugurate the era of molecular medicine.

Joint Genome Institute (JGI)
JGI Production Genomics Facility
2800 Mitchell Drive
Walnut Creek, CA 94598
Phone: 925-296-5670
Web: http://www.jgi.doe.gov/index.html

The JGI makes high-quality genome sequencing data freely available to the greater scientific community through its web portal. Having played a significant role in the federally funded Human Genome Project – generating the complete sequences of chromosomes 5, 16, and 19 – the JGI has now moved on to contributing in other critical areas of genomics research. While NIH-funded genome sequencing activities continue to emphasize human biomedical targets and applications, the JGI has since shifted its focus to the non-human components of the biosphere, particularly those relevant to the science mission of the Department of Energy.

Max-Planck-Institute for Molecular Genetics
Ihnestraße 63-73
14195 Berlin
Germany
Phone: (+49 30) 8413-0
Fax: (+49 30) 8413-1388
Web: http://seq.mpimg-berlin-dahlem.mpg.de/

Since its foundation in the sixties, research of the institute had focused on DNA replication and gene regulation in bacteria, bacterial phage and fungi and on the structure, function and evolution of ribosomes which were central to the research of H.-G. Wittmann.

Medical Genetics Institute
Cedars-Sinai Medical Center
8635 W. Third St., Suite 1070
Los Angeles, CA 90048
Phone: 1-800-CEDARS-1 (1-800-233-2771)
Fax: 310-423-9939
Web: http://www.csmc.edu/3992.html

A medical genetics institute providing a full range of care for genetic-based diseases as well as teaching programs and NIH-funded research on the genetic basis of disease.

National Center for Genome Resources (NCGR)
2935 Rodeo Park Drive East
Santa Fe, New Mexico 87505
Phone: 505-982-7840
Fax: 505-995-4432
E-mail: mailto:info@ncgr.org
Web: http://www.ncgr.org/

A non-profit life sciences research institute focusing on intersecting the use of mathematics and software to help control and cure infectious disease, global health, and nutrition.

Stanford Human Genome Center
975 California Ave.
Palo Alto, CA 94304
Phone: 650-320-5800
Fax: 650-320-5801
Web: http://www-shgc.stanford.edu/

Originally established as one of the first centers to generate maps of the human genome, the Stanford Human Genome Center now participates in several large-scale mapping projects and studies.

University of Washington Genome Center
Fluke Hall on Mason Road
Box 312545
Seattle WA, 98195
Phone: 206-685-7366
Fax: 206-616-5242
Web: http://www.genome.washington.edu/UWGC/index.cfm

The mission of the University of Washington Genome Center is 'to increase the knowledge about genomes and natural genetic variation. We believe that acquisition of genomic sequence data will increase our understanding of evolution and enhance our ability to identify disease and disease susceptibility, as well as to improve treating illnesses'.

Utah Genome Depot
South 2030 East, RM. 308
Salt Lake City, UT 84112
Phone: 801-585-5606
Fax: 801-585-7177
Web: http://www.genome.utah.edu/#

Based at the University of Utah, the Utah Genome Depot specializes in high-throughput genomic sequencing,

high-throughput resequencing, and library constructions and colony picking. They also have an informatics group.

Wellcome Trust Sanger Institute
Wellcome Trust Genome Campus,
Hinxton, Cambridge, CB10 1SA, UK
Phone: +44 (0)1223 834244
Fax: +44 (0)1223 494919
Web: http://www.sanger.ac.uk/

A genetic research institute organized to understand the role of gene function in health and disease through large-scale sequencing, informatics, and analysis of genetic variation.

Databases

Animal Genome Size Database

Sponsor: Gregory T.R.
Web: http://www.genomesize.com/index.php

The *Animal Genome Size Database* is a 'comprehensive catalogue of animal genome size data. Haploid DNA contents (C-values, in picograms) are currently available for 4295 species (2953 vertebrates and 1342 non-vertebrates) based on 5697 records from 607 published sources.'

The Arabidopsis Information Resource (TAIR)
Sponsor: TAIR is produced by the Carnegie Institution of Washington Department of Plant Biology, and the National Center for Genome Resources (NCGR).
Web: http://www.arabidopsis.org

TAIR is a database for the genetics and molecular biology of the higher plant species, *Arabidopsis thaliana*.

The Cancer Genome Atlas
Web: http://cancergenome.nih.gov/index.asp

'The Cancer Genome Atlas (TCGA) is a comprehensive and coordinated effort to accelerate our understanding of the molecular basis of cancer through the application of genome analysis technologies, including large-scale genome sequencing.'

The Comparative Toxicogenomics Database
Web: http://ctd.mdibl.org

The Comparative Toxicogenomics Database (CTD) elucidates molecular mechanisms by which environmental chemicals affect human disease.

dbSNP
Web: http://www.ncbi.nlm.nih.gov/SNP/
NCBI's database of single nucleotide polymorphisms.

E. Coli *Genome Project*
Sponsor: University of Wisconsin-Madison
Web: http://www.genome.wisc.edu/

'Having sequenced the *E. coli* K-12 genome, [the *E. Coli* Genome Project] maintain and update its annotation. [They] are creating a knockout of every gene, a clone of every ORF, and an extensive gene expression data set under a variety of physiological conditions. These clones and data sets are made available freely to the community.

[They] have also sequenced six additional enterobacterial strains which are pathogens closely related to *E. coli* K-12, and many plasmids. The comparative genomics aim of this effort is to characterize the gene pool of horizontally transferred elements and virulence determinants known as the pathosphere.'

Ensembl
Sponsor: The European Bionformatics Institute and the Sanger Institute

'Ensembl is a joint project between EMBL-EBI and the Sanger Institute to develop a software system which produces and maintains automatic annotation on selected eukaryotic genomes. Ensembl is primarily funded by the Wellcome Trust.'

Flybase
Sponsor: National Human Genome Research Institute, NIH; British Medical Research Council; and The Indiana Genomics Initiative
Web: http://flybase.bio.indiana.edu/

A database of drosophila genes and genomes.

The GDB Human Genome Database
Sponsor: RTI International
Web: http://gdbwww.gdb.org/

'The Official World-Wide Database for the Annotation of the Human Genome'.

International HapMap Project
Web: http://snp.cshl.org/

'The International HapMap Project is a partnership of scientists and funding agencies from Canada, China, Japan, Nigeria, the United Kingdom and the United States to develop a public resource that will help researchers find genes associated with human disease and response to pharmaceuticals.'

Mouse Genome Database List
Sponsor: Neurogenetics at UT Health Science Center
Web: http://www.nervenet.org/main.html

Nervenet.org and The Informatics Center for Mouse Neurogenetics 'hosts the Mouse Brain Library, an

expanding collection of high-resolution histological images, atlases, MRIs, and databases on brain structure of more than 120 different lines of mice. Nervenet also includes several useful genetics and gene mapping databases to download (SNP databases, Map Manager databases, and the Portable Dictionary of the Mouse Genome). The publications section includes revised, expanded, and annotated papers, tutorials, and reviews on neurogenetics, gene mapping, complex trait analysis, stereology, and the control of neuron number.'

National Center for Toxicogenomics
Web: http://www.niehs.nih.gov/nct/home.htm
NIEHS-centered website to look at genomics applications in toxicology.

The Pharmacogenetics and Pharmacogenomics Knowledge Base (PharmGKB)
Sponsor: Stanford University
Web: http://www.pharmgkb.org

'The PharmGKB database is a central repository for genetic, genomic, molecular and cellular phenotype data and clinical information about people who have participated in pharmacogenomics research studies. The data includes, but is not limited to, clinical and basic pharmacokinetic and pharmacogenomic research in the cardiovascular, pulmonary, cancer, pathways, metabolic and transporter domains.'

RCSB Protein Data Bank
Sponsor: Rutgers, the State University of New Jersey
Web: http://www.rcsb.org/pdb/home/home.do

'The RCSB PDB provides a variety of tools and resources for studying the structures of biological macromolecules and their relationships to sequence, function, and disease.'

Saccharomyces Genome Database (SGD)
Sponsor: SGD Curators (The SGD is in the Department of Genetics at the School of Medicine, Stanford University.)
Web: http://www.yeastgenome.org/

SGT is a database for the compilation of the genetics and molecular biology of *Saccharomyces cerevisiae*, or budding yeast.

SOURCE
Sponsor: Genetics Department at Stanford University
Web: http://source.stanford.edu/cgi-bin/source/sourceSearch

'SOURCE is a unification tool which dynamically collects and compiles data from many scientific databases, and thereby attempts to encapsulate the genetics and molecular biology of genes from the genomes of *Homo sapiens*, *Mus musculus*, *Rattus norvegicus* into easy to navigate GeneReports.'

Unigene
Sponsor: National Center for Biotechnology Information
Web: http://www.ncbi.nlm.nih.gov

'Established in 1988 as a national resource for molecular biology information, NCBI creates public databases, conducts research in computational biology, develops software tools for analyzing genome data, and disseminates biomedical information – all for the better understanding of molecular processes affecting human health and disease.'

The Zebrafish Model Organism Database (ZFIN)
Sponsor: NIH; University of Oregon
Web: http://zfin.org/cgi-bin/webdriver?MIval=aa-ZDB_home.apg

'FIN serves as the zebrafish model organism database. The long term goals for ZFIN are a) to be *the* community database resource for the laboratory use of zebrafish, b) to develop and support integrated zebrafish genetic, genomic and developmental information, c) to maintain the definitive reference data sets of zebrafish research information, d) to link this information extensively to corresponding data in other model organism and human databases, e) to facilitate the use of zebrafish as a model for human biology and f) to serve the needs of the research community.'

Other Resources

BCM Search Launcher: Baylor College of Medicine HGSC
Web: http://searchlauncher.bcm.tmc.edu/

A collection of molecular biology-related search and analysis services available on the web. The site features sequence alignment programs, gene recognition, vector trimming, and batch mode analysis.

BioIT World Magazine Online
Web: http://www.bio-itworld.com/

A cutting edge compilation of relevant literature, software, and resources in bioinformatics.

The Computational Biology and Functional Genomics Laboratory
Web: http://compbio.dfci.harvard.edu/

Dr. John Quackenbush and his laboratory have produced this site, which contains many resources for the analysis of microarray data and other genomic data sets.

DNA Microarray (Genome Chip) – Monitoring the Genome on a Chip
http://www.gene-chips.com/

This is a site that focuses on the DNA microarray technology and is maintained by Dr. Leming Shi. It contains information and links relevant for DNA microarray technology, articles on DNA microarray technology, academic links, industry links, data mining, software providers, protein chips, chemical microarrays, related meetings/workshops, and investment opportunities.

GoMiner: Gene Ontology Analysis at NCI
Web: http://discover.nci.nih.gov/gominer/

'GoMiner is a tool for biological interpretation of "omic" data – including data from gene expression microarrays. GoMiner leverages the Gene Ontology (GO) to identify the biological processes, functions and components represented in these lists. Instead of analyzing microarray results with a gene-by-gene approach, GoMiner classifies the genes into biologically coherent categories and assesses these categories.'

Y.F. Leung's Functional Genomics
Web: http://ihome.cuhk.edu.hk/%7Eb400559/

This website provides a compilation of web-based resources for genomics, microarray, bioinformatics and genome mapping and linkage analysis.

MGMD: The mammalian gene mutation databasez
Web: http://lisntweb.swan.ac.uk/cmgt/Pages/databaselinks.htm

This site features a compilation of mutation-related databases and websites. It also features a list of mutation databases by disease gene.

National Library of Medicine Genomic Links
http://www.nlm.nih.gov/pubs/factsheets/humangenome.html

A website maintained by the United States National Library of Medicine of the National Institutes of Health. Contains links to resources relating to the human genome, including a resource guide, gene-based links, sequence sites, genome maps, mapped markers, genetic variations, gene expression sites, and genetic disorders.

NC State Genetics Department
http://www.cals.ncsu.edu/genetics/net-resources.html

This site gives you a list of networked genetics and molecular biology research resources pooled by NC State University's Genetics Department. The list includes links to different agencies relevant to the study of genomics, genome projects and databases, general genomics websites, searching and tools, societies and publications, research centers, research groups, and other information resources.

NOVA Website featuring the QuickTime movie 'Cracking the code of life'
Web: http://www.pbs.org/wgbh/nova/genome/program.html

Educational video from the NOVA program about genomics. This two-hour program is divided into 16 chapters.

Science Magazine Functional Genomics Resources: Educational Resources
http://www.sciencemag.org/feature/plus/sfg/education/glossaries.dtl

A link through *Science Magazine* that directs you to online glossaries useful for keeping up with the rapid changes in terminology of genomics, bioinformatics, and gene medicine.

Virtual Library on Genetics
http://www.ornl.gov/sci/techresources/Human_Genome/genetics.shtml
The U.S. Department of Energy's Office of Science sponsors this Virtual Library on Genetics.

CHAPTER

40

Pathology

HUW BOWEN JONES

INTRODUCTION

Pathology is the study of the essential nature of disease in humans and other animals, especially those changes in organs and tissues that cause or are caused by disease. It is the study of the structural and functional manifestations of disease. This broad definition of pathology pertains as much to human clinical pathology as it does to the safety assessment of drugs and chemicals in animals. The role of the toxicological pathologist is to contribute to the understanding of the sequelae of administration of naturally occurring or human-made substances to laboratory animals and place them into the context of possible adverse human effects. Identification of toxin-induced tissue damage is a critical component of the understanding of human, animal, or environmental safety of xenobiotics that are to be administered to humans or domestic animals or, to which they may be exposed in the environment.

In experimental studies, the role of the toxicological pathologist in providing identification of the nature of perturbation in organs, tissues, and cells following histological examination is pivotal, often forming the basis for further investigations or elucidation of mechanisms of action. Painting the toxicological picture relies upon compilation of in-life observations and measurements, histopathology, hematology, and clinical biochemistry. Whilst the initial histopathological assessment involves examination of stained tissue sections by light microscopy, both diagnostic and investigative pathologists alike have at their disposal a variety of specific tools and techniques, such as, electron microscopy, image analysis, histochemistry, immunohistochemistry and in-situ hybridization to probe and identify the changes in composition of cells and tissues.

It is the nature of information that it ages and becomes out of date. However, the appearances of pathological lesions remain constant. It is the understanding of their pathogenesis, often requiring state-of-the-art technological applications that ultimately sheds new light and contributes to enhanced understanding. The information presented here represents general and specific sources in pathology with contextual references to toxicology. The potential source of information worldwide is enormous: therefore, the information provided below represents a small and subjective selection. The toxicological pathologist requires an understanding of toxicological mechanisms and for that reason, references to other relevant texts are provided.

RESOURCES

Books

Bacha WJ, Bacha LM (2000)
Color Atlas of Veterinary Pathology, Second Edition
Lippincott Williams and Wilkins

Histological processes described with color images of major tissues from eight different species and brief introduction to the different chapters. Excellent book for the veterinary pathologist.

Bancroft JD, Cook HC (1994)
Manual of Histological Techniques and their Diagnostic Application
Churchill Livingstone, Edinburgh, UK.

Includes scientific and medical background to the basic technical methodology used in histopathology. This book is primarily designed to cover practical techniques and includes 17 chapters.

Boorman GA, Eustis SL, Elwell MR, Montgomery CA, Jr, MacKenzie WF (Eds.) (1990)
Jubb KVF, Kennedy PC, Palmer N (Eds.) (1993)
Pathology of Domestic Animals, 4th Edition, 3 volumes
Academic Press, San Diego, CA.

Directed at veterinary pathologists, this book covers the spontaneous and chemically induced lesions present in domestic animals. The volume is organized by organ/organ system and includes 17 chapters. It is a key textbook on the subject.

Burkitt HG, Young B, Heath JW (1993)
Wheater's Functional Histology – A Text and Colour Atlas, 3rd Edition
Churchill Livingstone.

Human histology with color photographs and brief descriptions. A good atlas.

Cheville NF (Ed.) (1994)
Ultrastructural Pathology, An Introduction to Interpretation
Iowa State University Press, Ames, IO, USA.

Designed as a treatise on ultrastructural analysis to fill the gap between what is seen in the electron microscope and what the pathologist encounters in the laboratory. Electron microscopy of pathological tissues is covered in 15 separate chapters with full illustrations.

Cotran RS, Kumar V, Robbins SL, Schoen FJ (Eds.) (2004)
Robbin's Pathologic Basis of Disease, 7th edition
Saunders, Philadelphia, PA.

Integrates information of pathological processes and disorders into morphological, molecular, and genetic components. The information is presented in chapters employing logical, uniform approaches to facilitate readability and comprehension. The first several chapters focus on general principles in pathology with some excellent diagrams. The latter part of the book consists of human-specific pathological lesions. This has served as the standard reference for many years.

Craighead JE (1995)
Pathology of Environmental and Occupational Disease
Mosby, St. Louis, MO.

Addresses environmental and occupational disease. Occupational diseases are considered to be the result of specific types of exposure experienced in the workplace. The book integrates concepts of causation and pathogenesis in the context of the resulting disease and the tissue changes that accompany it.

Eroschenko VP, Di Fiore MSH (2007)
Di Fiore's Atlas of Histology: with Functional Correlations, 10th Edition
Lippincott Williams Wilkins, Philadelphia, PA.

Excellent association of structure with function with excellent quality schematic and micrographic illustrations alongside each other. Excellent introduction to histology, with a CDROM available.

Evans GO (Ed.) (1996)
Animal Clinical Chemistry. A Primer for Toxicologists
Taylor & Francis, London.

A comprehensive book detailing practical approaches to clinical chemistry and guides to the assessment of target organ toxicity.

Faccini JM, Abbott DP, Paulus GJJ (1990)
Mouse Histopathology, A Glossary for Use in Toxicity and Carcinogenicity Studies
Elsevier, Amsterdam.

Provides a bench reference for the lesions observed during the histopathological examination of tissues from routine toxicity studies for the assessment of toxicological or carcinogenic potential of a test substance. The authors have restricted their information base to the most commonly used mouse strain, the CD-1 mouse.

Ghadially FN (1996)
Ultrastructural Pathology of the Cell and Matrix, 4th Edition, 2 vols
Butterworth-Heinemann, Boston, MA.

Serves as an excellent textbook and atlas of cellular pathology, with each chapter including a discussion of normal structure and function. Each of 17 cellular organelles or matrix material is covered in a specific chapter. The ultrastructural pathologist's handbook.

Glaister JR (1986)
Principles of Toxicological Pathology
Taylor & Francis, Philadelphia, PA.

Global view across the principles of toxicological pathology and their applications, especially in target organ pathology and the pathology of laboratory animals. A basic text focusing on cellular processes in pathology.

Gopinath C, Prentice DE, Lewis DJ (1987)
Atlas of Experimental Toxicological Pathology
MTP Press, Lancaster, UK

Essential to those working in the fields of drug testing, experimental pathology, and clinical pharmacology. This is a comprehensive volume dealing with changes that are induced by a wide variety of agents in many species of animals. Each of 11 different organs/organ systems is discussed in detail with photomicrographic examples of common and rarer lesions. An excellent atlas of toxicological pathology lesions well illustrated with color micrographs complemented by a concise description with examples of toxins.

Grasso P (2002)
Essentials of Pathology for Toxicologists
Taylor & Francis, London

A basic text suitable for non-pathologists interested in understanding processes in pathology.

Greaves P (2007)
Histopathology of Preclinical Toxicity Studies
Elsevier Science, Amsterdam.

Focuses mainly on drug-induced pathology in preclinical studies of drug safety assessment. Relevance to human health is also discussed in several instances. An excellent text with informative photographs.

Greaves P, Faccini JM (1992)
Rat Histopathology, A Glossary for Use in Toxicity and Carcinogenicity Studies, 2nd Edition
Elsevier, Amsterdam.

Provides a detailed description of typical histopathological findings that support the use of the given diagnostic term, together with the expected circumstances that accompany the condition. Ample reference is made to human pathology since the aim of studying the rat is to extrapolate the findings to man. This is a valuable text for the pathologist working in toxicity testing.

Haschek EWM, Rousseaux CG (Eds) (2001)
Handbook of Toxicologic Pathology 2nd Edition
Academic Press, San Diego, CA.

An indispensable reference work for the toxicological pathologist. Volume 1 focuses on general toxicology and the second volume details target organ pathology with key examples. Volume 2 examines the interface between toxicology and pathology to provide an overview of structural alterations caused by toxicants and the mechanisms which result in those changes. The book is in textbook format and is intended for students in the fields of pathology, toxicology, and environmental health. After the introduction, the major organs or organ systems are examined in detail. A chapter on chemical carcinogenesis is included.

Hoffbrand AV, Pettit J (2001)
Essential Haematology, 4th Edition
Blackwell Science Inc., Malden, MA.

Comprehensive with detailed descriptions of characteristics of human diseases.

Jasani B, Schmid KW (1993)
Immunocytochemistry in Diagnostic Histopathology
Churchill Livingstone, Edinburgh, UK.

A relatively non-specialized text on the role and scope of immunocytochemistry in routine diagnostic histopathology. The target readership is students and practitioners with practical orientation. The text is organized to include introductory chapters, immunocytochemistry in both neoplastic and non-neoplastic disease states, and the organizational routine for providing such services.

Jensh RP (Ed) (2002)
Bloom and Fawcett's Concise Histology.
Hodder Education, UK.

Excellent basic text for students and non-specialists with numerous micrographs.

Jones TC (primary editor, with others) (1983–)
Monographs on Pathology of Laboratory Animals
Springer-Verlag, New York.

An ongoing series of valuable monographs, some already in their second edition, which has covered the following specific organs and systems:

1. Cardiovascular and musculoskeletal system
2. Digestive system
3. Endocrine system
4. Eye and ear
5. Genital system
6. Hematopoietic system
7. Integument and mammary glands
8. Nervous system
9. Respiratory system
10. Urinary system.

Junqueira LC, Carneiro J, Kelley RO (1992)

Basic Histology, 7th Edition
Prentice Hall International (UK) Ltd., London.

Excellent functional histology text with many helpful diagrams and micrographs.

Lewis SM, Bain BJ, Bates I (Eds) (2001)
Dacie and Lewis's Practical Haematology, 9th Edition
Churchill Livingstone, London.

Excellent with comprehensive practical text on human hematology.

Loeb WF, Quimby FW (Eds) (1999)
Clinical Chemistry of Laboratory Animals, 2nd Edition
Taylor & Francis, London.

Reference work of high standard. Multispecies biochemistry. Essential handbook for the clinical pathologist.

Maronpot RR, Boorman GA, Gaul BW (1999)
Pathology of the Mouse
Cache River Press, Vienna, IL.

A complementary text to the rat histopathology book by Boorman et al and features mouse strain differences. An excellent, detailed compendium with plenty of illustrations.

McGavin MD, Zachary JF (2007)
Pathologic Basis of Veterinary Disease, 4th Edition
Mosby Elsevier.

Essential reading for the veterinary pathologist. Focusses mainly on veterinary rather than toxicological pathology.

McGee JO'D, Isaacson PG, Wright NA, Dick HM (Eds) (1992)
Oxford Textbook of Pathology: (in 2 volumes) Volume 1: Principles of Pathology. Volume 2: Pathology of Systems
Oxford Medical Publications, Oxford, UK

Contains an excellent source of reference of the principles of human pathology with basic information across all organ systems and focuses on diagnosis. Toxicology is not a key feature but contains some references to toxicologically induced lesions.

Mohr U, Dungworth DL, Capen CC (Eds.) (1992)
Pathobiology of the Aging Rat
ILSI, Washington, DC.

Provides information on age-associated changes which influence the interpretation of pathologic data derived from experiments in laboratory rats. The information is presented by system, and emphasis is on the prevalence and nature of the lesions and the current state of knowledge concerning pathogenesis.

Mohr U, Dungworth DL, Ward J, Capen CC, Carlton W, Sundberg J (Eds.) (1996)
Pathobiology of the Aging Mouse, Vols. 1 and 2
ILSI, Washington, DC.

Provides up-to-date information on pathological data from major strains of laboratory mice used throughout the world. Emphasis is placed on the prevalence and nature of naturally occurring and artificially induced lesions and on what is known about their pathogenesis.

Neal MJ (2002)
Medical Pharmacology at a Glance
Blackwell Publishing Group, Oxford, UK.

An excellent summary of pharmacological processes explained clearly and succinctly.

Percy DH, Barthold SW (1993)
Pathology of Laboratory Rodents and Rabbits
Iowa State University Press, Ames, IO.

Designed to serve as a general reference for veterinary pathologists requiring general information on diagnostic features of the diseases of commonly used laboratory animals. The six species covered in this useful volume are the rat, mouse, hamster, gerbil, guinea pig, and rabbit.

Salisbury J (Ed.) (1997)
Molecular Pathology
Taylor & Francis, Washington, DC.

Provides a simple description of how specific aspects of molecular pathology are important to the understanding of disease processes. Each chapter focuses on a common disease and explains how such aspects as histopathology, genetic polymorphism, and molecular techniques construct comprehension of the onset and development of disease.

Scarpelli DG, Craighead JE, Kaufman N (Eds.) (1985)
The Pathologist and the Environment (Monographs in Pathology, No. 26)
Williams & Wilkins, Baltimore, MD.

Covers the role of the anatomical pathologist in the detection of environmental effects. Considers toxicity of drugs and heavy metals and the biochemical epidemiology of cancer.

Slauson DO, Cooper BJ (2002)
Mechanisms of Disease: A Textbook of Comparative General Pathology, 3rd Edition
Mosby Inc., St Louis, MO.

Extensive and well-illustrated. Providing substantial explanation and information regarding disease processes.

Smith CA, Andrews CM, Collard JK, Hall DE, Walker AK (1994)

Colour Atlas of Comparative Diagnostic and Experimental Haematology
Wolfe Publishing, London.

An excellent atlas of interspecies differences in hematology.

Sternberg SS (Ed.) (1992)
Histology for Pathologists
Raven Press, New York.

Attempts to bridge the gap between histologists and pathologists. To this end, each of the 48 chapters considers the significance and function of many histological structures in terms of pathological interpretation. This text is useful to those interpreting structural deviations from the norm to assess biological significance.

Stevens AS, Lowe JS (2005)
Human Histology, 3rd Edition
Mosby-Elsevier Inc.

Excellent basic text for the student and non-specialist. User-friendly, color layout revised to include molecular biology and advances in histological techniques.

Stevens AS, Lowe JS, Young BJS (2003)
Wheater's Basic Histopathology, A Colour Atlas and Text, 4th Edition
Churchill Livingstone, London.

Similar to the basic histology text but featuring illustrations of general and systemic pathological lesions. This updated version focuses more on human clinical pathology.

Timbrell J (2000)
Principles of Biochemical Toxicology
Taylor and Francis, Oxford, UK.

An excellent book making chemical toxicology, including pathways and metabolism understandable for the pathologist.

Turton JA, Hooson J (Eds.) (1997)
Target Organ Pathology
Taylor & Francis, London.

Describes the major organs of the body as targets for chemically induced effects. This text reviews the mechanisms of these toxic effects and the structural and functional changes which occur in the target organ as a result of exposure to toxicants (including drugs, agrochemicals, industrial chemicals, radiation, and heat).

Pathology of the Fischer Rat
Academic Press, San Diego, CA.

Provides a readable text useful not only to pathologists but also to investigators from a variety of disciplines that use the rat as an experimental model. The data used in this book derive from the NTP program covering hundreds of specific studies. A total of 35 chapters, each devoted to a single organ constitute this work.

International Agency for Research on Cancer (IARC)
Pathology of Tumours in Laboratory Animals
IARC, Lyon.

Part of the monographic series IARC Scientific Publications. Vol. 1, Tumours of the Rat (No. 99, 1990); Vol. 2, Tumours of the Mouse (No. 111, 1994); Vol. 3, Tumours of the Hamster, 2nd ed. (No. 126, 1996).

An essential reference to the pathology associated with these species. Recommended.

Journals

Experimental and Toxicologic Pathology (1967)
Elsevier, London
Web: http://www.eurotoxpath.org/organization/index.php?id=journal

Official journal of the European Society of Toxicologic Pathology. The international multidisciplinary journal is devoted to the publication of multidisciplinary studies covering the whole range of research on disease processes and toxicology including cell biological investigations. Its aim is to support the interdisciplinary co-operation of researchers working in pathobiology, toxicology, and cell biology independent of the methods used.

International Journal of Experimental Pathology
Blackwell Publishing Ltd., Oxford, UK
PO Box 1354
9600 Garsington Road
Oxford OX4 2XG
UK
Phone: +44 (0)1865 778315
Fax: +44 (0)1865 471775

The journal encompasses the use of multidisciplinary scientific techniques to investigate the pathogenesis and progression of pathologic processes. Subject areas are in in vitro investigations, animal models, and in clinical research. The key objective is to report on work that addresses the common theme of mechanism at a cellular and molecular level.

For further information on subscription and article submissions go to website.

Toxicologic Pathology (1971)
Web: http://mc.manuscriptcentral.com/toxpath
www.toxpath.org

The journal will publish all subject areas that are relevant to toxicological pathology. Relevant subjects include safety assessment of pharmaceuticals, chemicals, food additives, pesticides, environmentally

relevant chemicals and medical devices; risk characterization of xenobiotics; investigative studies that contribute to refinement of the safety assessment process; mechanistic studies that provide a basis for interpreting and predicting toxicologic outcome; emerging approaches and methods in toxicological pathology; spontaneous diseases that may influence toxicity studies, and animal and alternative models relevant to toxicologic pathology.

Journal Articles

Bertram TA (1996) Role of toxicologic pathology in advancing understanding of previously identified hazards, current safety assessments, and mechanism of action for therapeutic xenobiotics. Toxicol. Pathol. 24: 151–152.

Bertram TA (1996) Validation of in vitro methods: Societies' expectations require the involvement of toxicological pathologists. Toxicol. Pathol. 24: 509–510.

Boorman G (2003) Assessment of hyperplastic lesions in rodent carcinogenicity studies. Toxicol. Pathol. 31: 709–710.

Clayson DB (1989) The potential for the use of cell proliferation studies in carcinogen risk assessment. Reg. Toxicol. Pharmacol. 9: 284–295.

Colombo P (2001) Toxicological testing of cytotoxic drugs (Review). Intern. J. Oncol. 19: 1021–1028.

Copley MP (1997) Environmental Protection Agency risk assessment—Process and toxicologic pathology. Toxicol. Pathol. 25: 68–71.

Delnomdedieu M, et al (1996) Magnetic resonance microscopy—A new tool for the toxicologic pathologist. Toxicol. Pathol. 24: 36–44.

Documentation of pathology peer review. Position of the Society of Toxicologic Pathologists (1997) Toxicol. Pathol. 25(6): 655.

Ettlin RA (1994) Causes of death in rodent toxicity and carcinogenicity studies. Toxicol. Pathol. 22(2): 165–178.

Ettlin RA (2002) Unexpected tumour findings in lifetime rodent bioassay studies – what to do? Toxicol. Lett. 128: 17–33.

Foster JR (2005) Spontaneous and drug-induced hepatic pathology of the laboratory Beagle dog, the *Cynomolgus macaque* and the marmoset. Toxicol. Pathol. 33: 63–74.

Gopinath C (1996) Pathology of toxic effects on the immune system. Inflammation Res. 45(Suppl. 2): PS74–PS78.

Greaves P (2004) First dose of potential new medicines to humans: How animals help. Nature Rev. 3: 226–236.

Haley P (2005) STP Position paper: Best practice guideline for the routine pathology evaluation of the immune system. Toxicol. Pathol. 33: 404–407.

Hottendorf GH (1974) Lesions of spontaneous subclinical disease in Beagle dogs. Vet. Pathol. 11: 240–258.

Iatropoulos MJ (1994) Endocrine considerations in toxicologic pathology. Exp. Toxicol. Pathol. 45: 391–410.

Kleinjans JCS (2003) Principles in toxicological risk assessment. Toxicol. Lett. 140–141: 311–315.

Lowenstein LJ (2003) A primer of primate pathology: lesions and non-lesions. Toxicol. Pathol. 31(Suppl): 92–102.

Maita K (1988) Mortality, major cause of moribundity, and spontaneous tumours in CD-1 mice. Toxicol. Pathol. 16(3): 340–349.

Maronpot RR (1996) Laboratory animal pathology—Emphasis on an area of relevance to the toxicologic pathologist. Toxicol. Pathol. 24: 506.

Moch RW, et al (1997) Food and Drug Administration risk assessment—Process and toxicologic pathology. Toxicol. Pathol. 25: 61–67.

Morishima H (1990) Spontaneous lesions in Beagle dogs used in toxicity studies. Exp. Anim. 39(2): 239–248.

Olsen H (2000) Concordance of the toxicity of pharmaceuticals in humans and in animals. Reg. Toxicol. Pharmacol. 32: 56–67.

Rousseaux CG (1997) Symposium Introduction: Risk Assessment and the Toxicologic Pathologist. Toxicol. Pathol. 25(1): 22–35.

Rozman K (1988) Disposition of xenobiotics: Species differences. Toxicol. Pathol. 16(2): 123.

Tokayasu ITO (1992) Spontaneous lesions in Cynomolgus monkeys used in toxicity studies. Exp. Anim. 41(4): 455–469.

Tibbitts J (2003) Issues related to the canines in toxicologic pathology – Issues with pharmacokinetics and metabolism. Toxicol. Pathol. 31(Suppl): 17–24.

Wagner BM (1996) The future of environmental and toxicologic pathology. Hum. Pathol. 27: 1003–1004.

Ward JM (1995) Peer review in toxicologic pathology. Toxicol. Pathol. 23(2): 226–234.

Weigand K, et al (1996) Harmonization of animal clinical pathology testing in toxicity and safety studies. The Joint Scientific Committee for International Harmonization of Clinical Pathology Testing. Fundam. Appl. Toxicol. 29(2): 198–201.

Zbinden G (1991) Predictive value of animal studies in toxicology. Reg. Toxicol. Pharmacol. 14: 167–177.

Zbinden G (1993) The concept of multispecies testing in industrial toxicology. Reg. Toxicol. Pharmacol. 17: 85–94.

Zuhlke U (2003) The common Marmoset (*Callithrix jacchus*) as a model in toxicology. Toxicol. Pathol. 31(Suppl): 123–127.

Organizations

American College of Veterinary Pathologists
2810 Crossroads Drive
Suite 3800
Madison
WI 53718
USA
Phone: (608) 443 2466 x 149
Web: http://www.acvp.org/

Armed Forces Institute of Pathology (AFIP)
625 16th Street NW
Washington, DC 20306-6000
USA
Phone: (202) 782 2100
Web: http://www.afip.org/vetpath/polatab.html

Dutch Toxicologic Pathology Society
Web: http://www.toxicologie.nl/uk/ToxPath.html

Contact via website.

European College of Veterinary Pathologists
Web: http://www.ecvpath.org/

Contact via website.

European Society of Toxicological Pathology
Web: http://www.eurotoxpath.org/

Contact via website.

European Society of Veterinary Pathology
Dr Seamus Kennedy
Department of Agriculture for Northern Ireland
Stoney Road
Stormont
Belfast BT4 3SD
E-mail: Seamus.kennedy@afbini.gov.uk

International Federation of Societies of Toxicologic Pathology (IFSTP)
Web: http://www.ifstp.org/

Contact via website.

Royal Microscopical Society
Web: http://www.rms.org.uk/
The Royal Microscopical Society
37/38 St Clements
Oxford OX4 1AJ
UK
Phone: +44 (0)1865 248 768 or (0) 1865 254760
Fax: +44 (0)1865 791 237

Society of Toxicological Pathologists
Web: http://www.toxpath.org/
Contact via website.

Websites

Animal models
http://www.criver.com/research_models_and_services/research_models/RM_literature.html

Current Issues
http://www.pharmafocus.com/cda/focusH
http://www.pharmafile.com/cda/pfileH

Electron microscopy
http://cimesg1.epfl.ch/EMYP/search.html
http://sup.ultrakohl.com
http://www.bu.edu/histology/m/t_electr.htm
http://www.acem.org.uk

General Pathology
http://www.pathologyoutlines.com/

Histological stains
http://home.primus.com.au/royellis/stains.html
http://www.visualhistology.com
http://stainsfile.info/StainsFile/jindex.html
http://www.ibms.org
http://reni.item.fraunhofer.de/reni/trimming/index.php

Human Tissues
http://www.hta.gov.uk/

Image analysis
http://www.cyto.purdue.edu/flowcyt/educate/pptslide.htm
http://www.stereologysociety.org

Immunohistochemistry
http://www.ihcworld.com/introduction.htm
http://www.biocompare.com/jumppage.asp?scid=2&start=a&page=
http://www.antibodyresource.com/onlinecomp.html
http://www.hprd.org
http://www.proteinatlas.org/search.php

Microscopy
http://www.micro.magnet.fsu.edu/

Toxicological Pathology
http://ntp.niehs.nih.gov/
http://www.bstp.org.uk/

CHAPTER

41

Pharmacokinetics and Metabolism

KARL K. ROZMAN

INTRODUCTION

The study of the kinetics of chemicals was first initiated for drugs and consequently termed pharmacokinetics. However, toxicology is not limited to the study of adverse drug effects but entails investigation of deleterious effects of all chemicals. Therefore, the study of kinetics of xenobiotics is more properly called *toxicokinetics*. In contrast, toxicodynamics deals with modeling the manifestation of a toxic effect either driven by the kinetics of a compound or the dynamics of the effect, whichever provides the rate-determining (or -limiting) step(s) for the causative process.

Toxicokinetics is the modeling and mathematical description of the time course of disposition (absorption, distribution, biotransformation, and excretion) of xenobiotics in the whole organism. It is also possible to model the individual steps of disposition (e.g., elimination alone) separately or even to describe the kinetics of xenobiotics in isolated organs (e.g., hepatic clearance). The most common way to characterize the kinetics of drugs in the past has been to represent the body as consisting of a number of compartments, even though these compartments have no apparent physiological or anatomical reality. More recently, physiologically based pharmacokinetic models have been advanced, where mass balance equations allow the modeling of each organ or tissue based on physiological considerations. It should be emphasized that there is no inherent contradiction between the classical and the physiologically based approach. Classical pharmacokinetics requires certain assumptions that the physiologically based models do not need. Under ideal conditions, physiological pharmacokinetic models are able to predict tissue concentrations, which classical models cannot do. However, the appropriate physiological (e.g., blood flow rate, tissue volume, etc.) and biochemical (e.g., rate of biotransformation in a particular tissue) parameters are often unknown or inexact, hampering a meaningful physiologically based pharmacokinetic modeling.

Metabolism or biotransformation is the most important process contributing to the kinetic profile of compounds because it represents more often than not the origin of the rate-determining (-limiting) step(s) in the kinetics of drugs and/or other chemicals.

RESOURCES

Books

Brunton L, Lazo J, Parker K (2005)
Goodman & Gilman's The Pharmacological Basis of Therapeutics (Goodman and Gilman's the Pharmacological Basis of Therapeutics)
McGraw Hill Companies, USA

Covers medical pharmacology, updated to reflect all critical new developments in drug action and drug–disease interaction. It provides detailed discussion of metabolism of drugs in humans as well as in animals. Includes an in-depth treatment of the principles of pharmacokinetics as well as information on the kinetics and metabolism of each drug discussed.

Caira MR, Ionescu C (Eds) (2006)
Drug Metabolism: Current Concepts
Springer, Netherlands

This book provides a comprehensive explanation of the processes taking place after ingestion of a medicinal agent or other xenobiotics, with particular emphasis on the crucial role of metabolism (biotransformation). The necessity of knowledge about these phenomena and how they are incorporated into the design of new drug candidates is also outlined. The user-friendly text focuses on concepts rather than excessive details and is supported by many examples of biotransformations.

Coleman M (2005)
Human Drug Metabolism: An Introduction
John Wiley & Sons, Ltd., West Sussex, UK

This new text provides a concise introduction to drug metabolism that is ideal for undergraduates. Focusing on a conceptual understanding of drug metabolizing systems, the book deals with the methods of xenobiotics detection, of their modification by biotransformation and elimination from the human body.

Crosby DG (1998)
Environmental Toxicology and Chemistry (Topics in Environmental Chemistry)
Oxford University Press, New York

They are two aspects of the same subject, environmental toxicology and environmental chemistry, although they are usually presented as if they were entirely different subjects; even their practitioners often seem unaware of the connectedness. This book is the first text to tie these subjects together, demonstrating the immediate relevance of each subject to the other while also providing basic, easily understandable introductions to both areas. Ideal for advanced undergraduate and graduate students in environmental toxicology courses, the book offers a timely, comprehensive introduction to the principles of toxicology which includes metabolism and the kinetics of chemicals as they apply to our environment. It is also useful for professionals and practitioners in a wide range of environmentally related fields and businesses.

Ette EI, Williams PJ (Eds.) (2007)
Pharmacometrics: The Science of Quantitative Pharmacology
John Wiley & Sons, New Jersey

Pharmacometrics is the science of interpreting and describing pharmacology quantitatively. The pharmaceutical industry is integrating pharmacometrics into its drug development program. This book outlines the science of pharmacometrics and its application to drug development, evaluation, and pharmacotherapy, providing a comprehensive treatise suitable for the training of pharmacometricians.

Evans G (Ed.) (2004)
A Handbook of Bioanalysis and Drug Metabolism
CRC Press, LLC, Boca Raton, FL

This book examines the techniques, methodology, and theory of bioanalysis, pharmacokinetics, and metabolism from the perspective of scientists with extensive professional experience in drug discovery and development. These three areas of research help drug developers to identify the most active component within a class of compounds and to provide safety and efficacy information required by regulators. It covers topics such as high performance liquid chromatography, protein binding, pharmacokinetics and drug–drug interactions. A unique industrial perspective helps to reinforce theory and develop valuable analytical and interpretational skills.

Gad SC (Ed.) (2006)
Animal Models in Toxicology, Second Edition
CRC Press, Boca Raton, FL

This is a practical guide to the common statistical problems encountered in toxicology and the methodologies that are available to solve them. The book presents a historical review of the use of animal models and an overview of broad considerations of metabolism and its relevance for toxicology.

Gibaldi M, Perrier D (1982)
Pharmacokinetics, Second Edition, Revised and Expanded
Marcel Dekker, Inc., New York

This revised and expanded edition of the first edition from 1975 is a must for anybody aiming at understanding classical pharmacokinetics at the conceptual level.

Ioannides C (2002)
Enzyme Systems that Metabolise Drugs and Other Xenobiotics (Current Toxicology)
John Wiley & Sons, West Sussex, UK

This reference work describes the enzyme systems that participate in the metabolism of drugs and other chemicals. Each chapter deals with a specific enzyme system, emphasizing its role in the activation or detoxication of chemicals. Critically discussed aspects include: enzyme function in the metabolism and bioactivation of xenobiotics, substrate specificity, tissue distribution, species differences (to include laboratory animals and humans), hormonal regulation, sex differences, modulation by prior exposure to other chemicals, age-dependent expression, pharmacogenetics, and modulation by disease.

Klaassen C (2007)
Casarett & Doull's Toxicology: The Basic Science of Poisons
McGraw Hill, USA

This book provides an unsurpassed understanding of modern toxicology, including the principles, concepts, mechanisms, and modes of thought that are the foundation of the discipline. The book consists of seven units looking at toxicology from different points of view. Unit 2 deals in depth with disposition of toxicants including toxicokinetics.

Krüse J, Verhaar H, de Raat WK, (Eds) (2002)
The Practical Applicability of Toxicokinetic Models in the Risk Assessment of Chemicals
Kluwer Academic Publishers, Netherlands

In 2000 OpdenKamp Registration & Notification organized a two-day symposium in The Hague, The Netherlands, on `The Practical Applicability of Toxicokinetic Models in the Risk Assessment of Chemicals'. Many speakers from Europe and the United States were invited to present different aspects of this topic, and they prepared comprehensive papers for this symposium book, reflecting the state of the art of modeling and toxicological risk assessment.

Lee J, Obach RS, Fisher MB (Eds) (2003)
Drug Metabolism Enzymes
FontisMedia S.A. and Marcel Dekker, Inc., Netherlands

Cytochrome P450 has a strong bearing on the scientific assessments of genetic polymorphism in metabolism, which is critical in the elimination of drugs and other xenobiotics from the body. The possibility of drug–drug interactions and bioavailability is also discussed. This text systematizes findings on P450 and similar enzymes – as well as related issues affecting the pharmaceutical industry – to promote the next generation of safer, more effective drugs.

Mahmood I (2005)
Interspecies Pharmacokinetic Scaling: Principles And Application of Allometric Scaling
Pine House Publishers, Rockville, MD

Pharmacokinetic allometric scaling is a very useful tool for the selection of first-in-human dose in drug development. This is the first book ever written on the interspecies pharmacokinetic scaling and is an ideal resource for pharmaceutical scientists, preclinical and clinical pharmacologists, physiologists, biochemists, toxicologists, environmental health scientists, veterinarians, and biologists in academia and industry.

Ng R (2004)
Drugs – From Discovery to Approval
John Wiley & Sons, New Jersey

This book presents a clear, step-by-step overview of the drug development and approval process. It introduces basic concepts, then moves on to discuss disease target selection and the discovery processes for both small- and large-molecule drugs. Subsequent chapters explain preclinical studies, clinical trials, regulatory issues, good manufacturing practices (GMPs), and perspectives on the future of drug development. Coverage also includes: a helpful listing of current FDA and European guidelines, a special section on regulatory authorities and processes in Japan and China, appendices on the history of drug discovery and development, and representative examples of drug mechanisms of action as shown.

Reddy M, Yang RS, Andersen ME, Clewell III HJ (2005)
Physiologically Based Pharmacokinetic Modeling: Science and Applications
John Wiley & Sons, New Jersey

This book is a comprehensive reference organized by classes of compounds and modeling purposes so users can quickly access information. It presents an overview of the underlying principles of PBPK model development, and provides a compendium of PBPK modeling information, including historical development, specific modeling challenges, and current practices for: halogenated alkanes, halogenated alkenes, alkenes and aromatic compounds, reactive vapors, alkanes, oxyhydrocarbons and related compounds, pesticides and persistent organic pollutants, dioxins and related compounds, metals and inorganic compounds, drugs; antineoplastic agents, perinatal transfer, mixtures, and dermal exposure models. In addition to pinpointing specific information, readers can explore diverse modeling techniques and applications.

Uetrecht JP, Trager W (2007)
Drug Metabolism: Chemical and Enzymatic Aspects: Textbook Edition
Informa Healthcare USA, Inc., New York

This is a comprehensive textbook which will provide students with a good understanding of drug metabolism, and links chemical and biological terminology together in a clear and concise fashion. The book explains how a drug is metabolized, the effects of the metabolites if present, extensive material to help understand drug metabolism as well as practical problems and solutions.

Woolf T (Ed.) (1999)
Handbook of Drug Metabolism
Marcel Dekker, New York

This reference book provides an overview of the subject from a historical, kinetic, and chemical context. It contains tables, drawings, photographs, and equations, highlights the importance of pharmacokinetics and cytochrome P450, explains clearance, volume of distribution, non-linear kinetics, and sequential metabolism. Phase 1 and 2 metabolism is conceptualized as well as formation of reactive metabolites and more.

Journals

Biochemical Pharmacology

British Journal of Pharmacology

Chemical Research in Toxicology

Chemotherapy

Clinical Pharmacokinetics

Clinical Pharmacology and Therapeutics

Drug Metabolism and Diposition

Drug Metabolism and Drug Interactions

Drug Metabolism Reviews

European Journal of Clinical Pharmacology

Journal of Anesthesiology

Journal of Pharmacokinetics and Biopharmacology

Journal of Pharmacology and Experimental Therapeutics

Journal of Pharmacological Sciences

Journal of Toxicology and Clinical Toxicology

Pharmacology and Toxicology

Toxicological Sciences

Toxicology and Applied Pharmacology

Xenobiotica

Review Articles

Guengerich FP (2001) Common and uncommon cytochrome P450 reactions related to metabolism and chemical toxicity. Chem. Res. Toxicol. 14(6): 611–650.

Proudfoot AT, Krenzelok EP, Vale JA (2004) Position paper on urine alkalinization. J. Toxicol. Clin. Toxicol. 42(1): 1–26.

Roberts MS, Magnusson BM, Burczynski FJ, Weiss M (2002) Enterohepatic circulation: physiological, pharmacokinetics and clinical implications. Clin. Pharmacokinet. 41(10): 751–790.

Slikker W, Jr, Andersen ME, Bogdanffy MS, et al (2004) Dose-dependent transitions in mechanisms of toxicity: case studies. Toxicol. Appl. Pharmacol. 201(3): 226–294.

Slikker W, Jr, Andersen ME, Bogdanffy MS, et al (2004) Dose-dependent transitions in mechanisms of toxicity. Toxicol. Appl. Pharmacol. 201(3): 203–225.

Journal Articles

Models of Lymphatic System Transport

Melder RJ, Munn LL, Stoll BR, et al (2002) Systemic distribution and tumor localization of adoptively transferred lymphocytes in mice: comparision with physiologically based pharmacokinetic model. Neoplasia 4(1): 3–8.

Meno-tang GM, Li H, Mis S, et al (2006) Physiologically based pharmacokinetic modeling of FTY720 (2-amino-2[2-(-4-octylphenyl)ethyl]propane-1,3-diol hydrochloride) in rats after oral and intravenous doses. Drug Metab. Disp. 34: 1480–1487.

Zhu H, Melder RJ, Baxter LT, et al (1996) Physiologically based kinetic model of effector cell biodistribution in mammals: implications for adoptive immunotherapy. Cancer Res. 56: 3771–3781.

Models of Repeat/Chronic Dose Studies

Lu Y, Lohitnavy M, Reddy MB, et al (2006) An updated physiologically based pharmacokinetic model for hexachlorobenzene: incorporation of pathophysiological states following partial hepatectomy and hexachlorobenzene treatment. Tox. Sci. 91(1): 29–41.

Willems BA, Melnick RL, Kohn MC, et al (2001) A physiologically based pharmacokinetic model for inhalation and intravenous administration of naphthalene in rats and mice. Toxicol. Appl. Pharmacol. 176: 81–91.

Yu X, Johanson G, Ichihara G, et al (1998) Physiologically based pharmacokinetic modeling of metabolic interactions between n-hexane and toluene in humans. J. Occup. Health 40: 293–301.

Models of Dissolution/Oral Absorption

Galia E, Nicolaides E, Hörter D, et al (1998) Evaluation of various dissolution media for predicting in vivo performance of class I and II drugs. Pharm. Res. 15(5): 698–705.

Nicolaides E, Galia E, Efthymiopoulos C, et al (1999) Forecasting the in vivo performance of four low solubility drugs from their in vitro dissolution data. Pharm. Res. 16(12): 1876–1882.

Yu L (1999) An integrated model for determining causes of poor oral drug absorption. Pharm. Res. 16(12): 1883–1887.

Organizations

American Association of Colleges of Pharmacy

American Association of Pharmaceutical Scientists

American Chemical Society

Canadian Society for Pharmaceutical Sciences

Federation of American Societies for Experimental Biology

Society of Toxicology

The Royal Pharmaceutical Society of Great Britain

Classes

A First Course in Pharmacokinetics and Biopharmaceutics
David W. A. Bourne
Web: http://www.boomer.org/c/p1/

Basic Pharmacokinetics
Michael Makoid, Phillip Vuchetich, and Umesh Banakar. Creighton University.
Web: http://pharmacyonline.creighton.edu/pha443/pdf/default.htm

Basic Principles of Pharmacokinetics and Pharmacodynamics
Online PDF Resources published by PJ Online (The Pharmaceutical Journal).
Web: http://www.pharmj.com/noticeboard/series/pharmacokinetics.html

Biopharmaceuticals and Pharmacokinetics
F. Jamali, University of Alberta web-based course.
Web: http://www.pharmacy.ualberta.ca/pharm415/

Websites

Pharmacokinetic software from PK Solutions
Web: www.summitpk.com

PBPK website
Contains announcements of new publications and meetings, and a forum for sharing information and asking questions.
Web: www.PBPK.org

CHAPTER

42

Physical Hazards

GENE RIDER

Toxicologists have traditionally been called upon to assess the chemical and biological hazards of products. However they are increasingly required to take a more holistic approach to product hazard evaluation and consider all potential hazards – physical as well as chemical. Increasing emphasis on physical hazards can be seen, for example, in the adoption of the Physical Agents directive by the European Union in 2004, recent changes in ASTM International's Toy Safety Standard addressing magnets, strangulation, and noise, and increasing awareness that injuries are the leading cause of death to children in all developed nations[1].

The following text addresses the wide range of physical hazards associated with products. Emphasis is placed on consumer products rather than industrial or military products, although references from the latter are cited when they have clear relevance to consumer products. References have been chosen with an eye toward eliminating hazards from products. Emphasis was placed on understanding the etiology and susceptible population groups for each hazard. This review begins with an introduction to resources and organizations concerned with physical hazards of consumer products in general. Following this, specific classes of hazard are addressed individually. A hazard definition is provided for each of the specific hazard areas followed by a brief description of the scope of the hazard.

PHYSICAL HAZARDS IN GENERAL

Numerous organizations around the world are concerned with the epidemiology and reduction of physical hazards associated with consumer products. These include governmental organizations at the national, multinational, and sub-national levels as well as non-governmental groups. In some cases regulatory bodies provide valuable information on the identification and elimination of hazards.

When referesncing any of the data sources, caution must be taken and the scope and limitations of the data source considered. For instance, the U.S. Consumer Product Safety Commission (CPSC) has a good data collection of consumer-product-related injuries and fatalities. However, since food is not under CPSC's jurisdiction, a search of the CPSC data with no findings should not be interpreted mistakenly that no incidents have occurred with food. Food is a major source of choking, aspiration, and related injuries, but these injuries fall outside the jurisdiction of the CPSC. Perhaps of even greater significance, it must be kept in mind that injury data typically rely upon hospital registry and its frequency of occurrence does not necessarily correlate with that of fatality. Due to the obvious reason that dead persons are not sent to hospitals for treatment, mortality is often underrepresented by hospital data and any extrapolation should be made with caution. Similarly coroners' records provide a great deal of information on fatalities but should not be used for inferences regarding injuries.

In the United States, the Consumer Product Safety Commission (www.cpsc.gov) provides valuable information on hazards associated with products. In general this information is organized by product rather than hazard. The National Electronic Injury Surveillance System (NEISS, www.cpsc.gov/LIBRARY/neiss.html) operated by the CPSC monitors emergency rooms for incidents of consumer product

[1] www.unicef-icdc.org/publications/pdf/repcard2e.pdf

related injuries. The U.S. Centers for Disease Control and Prevention (CDC) also operate a National Center for Injury Prevention and Control (NCIPC, www.cdc.gov/ncipc/) which provides information on a wide variety of physical hazards including many associated with consumer products. Health Canada (www.hc-sc.gc.ca/cps-spc/index_e.html) serves a similar function in Canada, offering information on general safety and physical hazards of consumer products. The Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP, www.childsafetylink.ca/research-chirpp.asp) collects reports of incidents involving consumer products.

Numerous organizations throughout Europe similarly collect and disseminate information relevant to consumer product safety and accident prevention. The following is a representative sample:

- The United Kingdom (UK) Royal Society for the Prevention of Accidents (RoSPA, www.rospa.com/). The UK Department of Trade and Industry commissioned research in consumer product safety until 2003 and still provides a number of useful publications (www.dti.gov.uk/consumers/Safety/awareness/research/index.html).
- The Dutch Consument En Veiligheid (Consumer Safety Institute, www.veiligheid.nl/csi/websiteveiligheid.nsf/wwwVwContent/homepage.htm).
- The Center for Research and Prevention of Injuries (Greece, www.euroipn.org/cerepri/).
- The Instituto Nacional del Consumo (Spain, www.consumo-inc.es/home/home.htm).
- The Kuratorium für Verkehrssicherheit (Austria, www.kfv.at/index.php?id = 488). In particular the Department of Home, Liesure & Sports.
- Grosse schützen Kleine (Austria, www.grosse-schuetzen-kleine.at/).
- The Norwegian National Institute for Consumer Research (SIFO, www.sifo.nl).
- The Bundesarbeitsgemeinschaft (BAG) Mehr Sicherheit für Kinder (Germany, www.kindersicherheit.de/).
- The Commission de la Sécurité des Consommateurs (France, www.securiteconso.org/).
- Konsument verket (Sweden, www.konsumentverket.se/).

Pan European organizations and projects include:

- Eurosafe (formerly ECOSA), the European Association for Injury Prevention and Safety Promotion, www.actiononinjuries.org/csi/eurosafe2006.nsf/).
- The EU Injury Database (https://webgate.cec.eu.int/idb) which allows public searches of injury data.
- Susy Safe (www.susysafe.org/), the Surveillance System on Suffocation Injuries due to Foreign Bodies in European Children, and
- RAPEX, the EU rapid alert system for dangerous consumer products (http://ec.europa.eu/consumers/dyna/rapex/rapex_archives_en.cfm).

Links to other European organizations can be found through the European Commission Health and Consumer Protection Directorate (http://ec.europa.eu/dgs/health_consumer/index_en.htm). Organizations active in identifying and reducing physical hazards associated with consumer products in Asia and Australia include:

- National Institute of Technology and Evaluation (Japan, www.nite.go.jp/index.html).
- Hong Kong Childhood Injury Prevention and Research Association (www.childinjury.org.hk/).
- Research Centre for Injury Studies incorporating Australian Institute of Health and Welfare National Injury Surveillance Unit (www.nisu.flinders.edu.au/)
- University of Otago Injury Prevention Research Unit (New Zealand, www.otago.ac.nz/ipru/).

Worldwide organizations concerned in part with physical hazards and injuries resulting from consumer products include the World Health Organization (www.who.int/en/) and Unicef (http://www.unicef.org). A great deal of information is also available from the San Diego State University Injury Prevention Literature Update (www.safetylit.org/).

Even though toxicology information resources are the main focus of this book, it is vital to emphasize that an assessment depending solely upon toxicity or hazard can be insufficient or even misleading. A product at a certain hazard level can have dramatically different risk impact on society based upon its exposure level. In consequence, it is suggested that risk assessments be performed in order to holistically evaluate the likelihood and severity of any adverse event happening. By taking into consideration both hazard and exposure, risk assessment can be practically applied in any decision-making process and enable decision makers to act upon their risk appetite or tolerance level. For more information on risk assessment of consumer products, see:

- Rider G. Framework Model of Product Risk Assessment. (2009). J. Injury Prevention Safety Promotion (accepted).
- Rider G, Milkovich S, Stool D, Wiseman T, Doran C, Chen X. Quantitative Risk Analysis, Injury Control and Safety Promotion, Volume 7, Number 2, June 2000, pp. 115–133 (19).

RESOURCES

Key References (General)

Due to the extraordinarily wide range of physical hazards associated with consumer products, few books or articles are able to provide comprehensive or even general discussions of this field. However there are journals whose scopes include a wide range of physical hazards. Suggested references include:

- Rider G (2005) Physical Hazards. In: Wexler P (ed) Encyclopedia of Toxicology, 2nd Edition, vol. 3, pp 424–436.
- American Academy of Pediatrics Committee on Injury and Poison Prevention and Widome MD (1997) Injury Prevention and Control for Children and Youth, Third Edition.
- Baker SP, O'Neill B, Ginsburg MJ, Li G (1991) The Injury Fact Book, 2nd Ed. Oxford University Press, 368 pp.
- Injury Prevention (http://injuryprevention.bmj.com/).
- International Journal of Injury Control and Safety Promotion (www.tandf.co.uk/journals/titles/17457300.asp).
- Robertson L (2007) Injury Epidemiology: Research and Control Strategies, Oxford University Press, 264 pp.

A large number of papers on a wide range of hazards are available from the Intertek Risk Assessment & Management website (www.intertek.com/ram). This site also includes an online gateway to the most comprehensive and up-to-date data sources as well as a number of hazard and risk assessment tools.

Physical Hazard Resources Grouped by Topic

In this section information resources are provided for a wide range of physical hazards associated with consumer products. The information resources are grouped according to the nature of the hazard rather than the nature of the product. A definition is provided for each hazard, followed by a short description of the scope of the hazard that briefly introduces issues such as epidemiology, etiology, and severity of the hazard. Links are provided to organizations, associations, and societies that routinely deal with the subject hazard. Resources are listed in approximate reverse chronological order of publication.

Hazards are ordered roughly into groups. The first group consists primarily of hazards involving entry of foreign material into, blockage of, or closure of body orifices or cavities and subsequent disturbance of bodily functions. These include foreign body injuries, suffocation, drowning/submersion, asphyxia, and strangulation. Resulting injuries are often characterized by a lack of external trauma. Entanglement or tourniquet hazards, where the primary mechanism of injury is restriction of blood flow, is included at the end of this group.

The second group of hazards includes those in which the primary agent is external mechanical force transmitted to or from an object and in which primary trauma is to contacted and/or underlying tissues. Included in this group are impact, laceration, puncture, abrasion, vibration, and explosions. Noise-induced hearing loss is included at the end of this group as it involves damage transmitted from an object to the ear through an intervening layer of air.

The third group of hazards includes strain/sprain and repetitive motion. Again caused by mechanical energy, these hazards result primarily in internal trauma.

The fourth group of hazards includes those in which the agent is thermal energy (or removal thereof).

The final group of hazards includes those in which the principal agent is electrical or electromagnetic energy. Electricity is included first in this group as its effects often include the creation of and subsequent injury due to thermal energy.

Foreign Body Injuries

Airway (Choking, Insertion, Ingestion, and Aspiration Including Magnets and Batteries)

Hazard Definitions

Acute or chronic injuries caused by objects which enter and lodge in the oral airway, lungs, nasal passages, or gastro-intestinal tract.

Scope

Foreign object injuries to the airway are among the most common and potentially life-threatening of physical hazards. Food products, coins, toys, hardware, jewelry, and dental appliances are among the most common airway foreign bodies. Children, the elderly, and the neurologically impaired are the most susceptible subpopulations. Penetration of the airway by foreign objects is possible due to the combined oral airway functions of the oral cavity and pharynx. Humans must interrupt respiration during the pharyngeal phase of the swallow cycle. Asphyxiation hazard for foreign objects is a function of the degree of difficulty in processing the foreign objects into a bolus suitable for successful swallowing. Foreign objects that are difficult to process create a condition where the hazard of asphyxiation is present. Oral airway penetration is the hazard created by swallowing objects that have not

been conditioned into a bolus fit for a successful swallow. This hazard may manifest in asphyxia.

Organizations/Associations/Societies

American Society of Pediatric Otolaryngology (ASPO, www.aspo.us/)

European Society of Pediatric Otorhinolaryngology (ESPO, www.espo.eu.com/)

Society for Ear, Nose, and Throat Advances in Children (SENTAC, www.sentac.org/)

Susy Safe (www.susysafe.org)

Key References

Cauchi JA, Shawis RN (2002) Multiple magnet ingestion and gastrointestinal morbidity. Arch. Dis. Child. 87(6): 539–540. http://adc.bmj.com/cgi/content/full/87/6/539.

Corradetti R, Gregori D, Morra B, Passali D, Snidero S (Eds) (2005) The ESFBI Study Final Report, FrancoAngeli, Milan, 510 pp.

Gastrointestinal injuries from magnet ingestion in children – United States, 2003–2006 (2006). MMWR Morb. Mortal Wkly. Rep. 55(48): 1296–1300. www.cdc.gov/mmwr/preview/mmwrhtml/mm5548a3.htm.

Harris CS, Baker SP, Smith GA, Harris RM (1984) Childhood asphyxiation by food. A national analysis and overview. JAMA 251: 2231–2235.

Kalan A, Tariq M (2000) Foreign bodies in the nasal cavities: a comprehensive review of the aetiology, diagnostic pointers, and therapeutic measures. Postgrad. Med. J. 76(898): 484–487.

Litovitz T, Schmitz BF (1992) Ingestion of cylindrical and button batteries: An analysis of 2382 cases. Pediatrics 89: 747–757.

Milkovich SM, Rider G, Greaves D, Stool D, Chen X (2003) Application of data for prevention of foreign body injury in children. Int. J. Pediatr. Otorhinolaryngol. 67(Suppl 1): S179–S182.

Reilly BK, Stool D, Chen X, Rider G, Stool SE, Reilly JS (2003) Foreign body injury in children in the twentieth century: a modern comparison to the Jackson collection Int. J. Pediatr. Otorhinolaryngol. 67(Suppl 1): S171–S174.

Reilly JS, Cook SP, Stool D, Rider G (1996) Prevention and management of aerodigestive foreign body injuries in childhood. Pediatr. Clin. North Am. 43(6): 1403–1411.

Rider G (2005) Physical Hazards. In: Wexler P (ed) Encyclopedia of Toxicology 2nd Edition, vol. 3, pp. 424–436.

Rider G, Wilson CL (1996) Small parts aspiration, ingestion, and choking in small children: findings of the small parts research project. Risk Anal. 16(3): 321–330.

Rimell FL, Thome A, Jr, Stool S, Reilly JS, Rider G, Stool D, Wilson CL (1995) Characteristics of objects that cause choking in children. JAMA 274: 1763–1766.

Uyemura MC (2005) Foreign body ingestion in children. Am. Fam. Physician 72(2): 287–291. and 2006 73(8): 1332. www.aafp.org/afp/20050715/287.html.

Yardeni D, Yardeni H, Coran AG, Golladay ES (2004) Severe esophageal damage due to button battery ingestion: can it be prevented?. Pediatr. Surg. Int. 20(7): 496–501.

Other Body Cavity (Ear, Urogenital, Rectal)

Hazard Definition

Objects lodged in ears or other non-airway body cavities.

Scope

Foreign objects inserted into non-airway body cavities, while rarely life threatening, may pose a significant risk for serious injury. Children place objects in their ears which may cause tympanic membrane perforation and may require medical intervention. In addition, objects may be inserted into the urogenital or rectal openings. If these objects cannot then be removed, medical intervention is required.

Organizations/Associations/Societies

American Academy of Pediatrics (www.aap.org/)

American College of Emergency Room Physicians (www.acep.org/webportal)

Key References

Clarke DL, Buccimazza L, Anderson FA, Thomson SR (2005 Jan) Colorectal foreign bodies. Colorectal Dis. 7(1): 98–103.

Gomes CC, Sakano E, Lucchezi MC, Porto PR (1994 June) Button battery as a foreign body in the nasal cavities. Special aspects. Rhinology 32(2): 98–100. Review.

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Rider G, Stool D, Milkovich S (2002 Sep) Development of a criterion to prevent tympanic membrane

perforation caused by children's products. Injury Control Safety Promotion 9(3): 169–173.

Schulze SL, Kerschner J, Beste D (2002 July) Pediatric external auditory canal foreign bodies: a review of 698 cases. Otolaryngol Head Neck Surg. 127(1): 73–78.

Stricker T, Navratil F, Sennhauser FH (2004 Apr) Vaginal Foreign Bodies. Pediatric Child Health. 40(4): 205–207.

Suffocation

Mechanical (films, air-impermeable flexible materials, rigid and semi-rigid containers covering nose and mouth, confinement in enclosed spaces)

Hazard Definition

Anoxia caused by obstructing the passage of air by sealing the mouth and nose with an external object (example: plastic films, containers).

Scope

Suffocation is one of the leading causes of death to children. Suffocation usually results in death or severe brain injury.

Organizations/Associations/Societies

American College of Emergency Room Physicians (www.acep.org/webportal)
American Society of Pediatric Otolaryngology (ASPO, www.aspo.us/)
European Society of Pediatric Otorhinolaryngology (ESPO, www.espo.eu.com/)
Society for Ear, Nose, and Throat Advances in Children (SENTAC, www.sentac.org/)

Key references

Byard RW, Wick R, Simpson E, Gilbert JD (2006, 2 June) The pathological features and circumstances of death of lethal crush/traumatic asphyxia in adults – a 25-year study. Forensic Sci. Int. 159(2–3): 200–205. Epub 2005 Sep 23.

Drago DA, Dannenberg AL (1999 May) Infant Mechanical Suffocation Deaths in the United States. Pediatrics 1980–1997 103(5): e59.

Kraus JF (1985 Mar–Apr) Effectiveness of measures to prevent unintentional deaths of infants and children from suffocation and strangulation. Public Health Rep. 100(2): 231–240. www.pubmedcentral.nih.gov/picrender.fcgi?artid=1424727&blobtype=pdf.

Nakamura SW, Pollack-Nelson C, Chidekel AS (2003 Jan) Suction-type suffocation incidents in infants and toddlers. Pediatrics 111(1): e12–e16. http://pediatrics.aappublications.org/cgi/reprint/111/1/e12.

Rider G, Physical Hazards. Encyclopedia of Toxicology 2nd Edition., P. Wexler, Ed., vol. 3, pp 424–436, 2005

Weiss RL, Goldstein MN, Dharia A, Zahtz G, Abramson AL, Patel M (1996, 1 Nov) Clear plastic cups: a childhood choking hazard. Int. J. Pediatr Otorhinolaryngol. 37(3): 243–251.

Drowning/submersion

Hazard Definition

Anoxia caused by obstructing the passage of air by submersion of mouth and nose in a fluid.

Scope

Drowning is the single most common cause of death involving consumer products and young people. By definition drowning is fatal. Near drowning generally results in extremely severe injuries.

Organizations/Associations/Societies

American Academy of Pediatrics (www.aap.org)
World Congress on Drowning (www.drowning.nl/)

Key references

Bernard SJ, Paulozzi LJ, Wallace DL (2007, 18 May) Centers for Disease Control and Prevention (CDC). Fatal injuries among children by race and ethnicity – United States, 1999–2002. MMWR Surveill. Summ. 56(5): 1–16.

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Brenner RA American Academy of Pediatrics Committee on Injury, Violence, and Poison Prevention (2003 Aug) Prevention of Drowning in Infants, Children, and Adolescents. Pediatrics. 112: 440–445. http://pediatrics.aappublications.org/cgi/reprint/112/2/440.

Brenner RA, Trumble AC, Smith GS, Kessler EP, Overpeck MD (2001 Jul) Where children drown, United States. Pediatrics 108(1): 85–89. 1995 http://pediatrics.aappublications.org/cgi/reprint/108/1/85.

Cummings P, Quan L (2003 Jun) Characteristics of drowning by different age groups. Inj Prev. 9(2): 163–168. http://injuryprevention.bmj.com/cgi/reprint/9/2/163.

http://pediatrics.aappublications.org/cgi/reprint/112/2/440.

McGee K, Peden MM (2003 Dec) The epidemiology of drowning worldwide. Inj Control Saf Promot. 10(4): 195–199.

Salomez F, Vincent JL (2004 Dec) Drowning: a review of epidemiology, pathophysiology, treatment and prevention. Resuscitation 63(3): 261–268.

Asphyxia

Positional Asphyria, Chest Compression

Hazard Definition

Positional asphyxia: Anoxia caused by obstructing the passage of air through posture or chest compression.

Scope

Infants are susceptible to airway obstruction caused by changes in head and jaw position in relationship to the thorax due to compression of the trachea. This same population group is also susceptible to anoxia resulting from compression of the chest resulting in difficulty in breathing. Older children and adults suffer similar injuries when crushed by products such as garage doors.

Organizations/Associations/Societies

American Academy of Pediatrics (www.aap.org)
Forensic Medicine for Medical Students (www.forensicmed.co.uk/index.htm)

Key References

Bell MD, Rao VJ, Rodriguez RN, Wetli CV (1992 June) Positional asphyxiation in adults. A series of 30 cases from the Dade and Broward County Florida Medical. Examiner Offices from 1982 to 1990. Am. J. Forensic Med. Pathol. 13(2): 101.

Byard RW, Gilbert JD, Simpson E, Wick R (2006, 2 June) The pathological features and circumstances of death of lethal crush/traumatic asphyxia in adults– a 25-year study. Forensic Sci. Int. 159(2–3): 200–205. Epub 2005 Sep 23.

Hunt CE, Hauck FR (2006, 20 June) Sudden infant death syndrome. CMAJ 174(13): 1861–1869. www.cmaj.ca/cgi/reprint/174/13/1861.

Kanetake J, Aoki Y, Funayama M (2003 June) Evaluation of rebreathing potential on bedding for infant use. Pediatr. Int. 45(3): 284–289.

Patel AL, Paluszynska D, Harris KA, Bradley T (2001 Dec) Inspired CO_2 and O_2 in sleeping infants rebreathing from bedding: relevance for sudden infant death syndrome. Thach J. Appl. Physiol. 91: 2537. http://jap.physiology.org/cgi/reprint/91/6/2537.

Patel AL, Paluszynska D, Harris KA, Bradley T (2003 Apr) Occurrence and Mechanisms of Sudden Oxygen Desaturation in Infants Who Sleep Face Down. Thach Pediatrics 111: e328–e332. http://pediatrics.aappublications.org/cgi/reprint/111/4/e328.

Rider, G (2005) Physical Hazards. Encyclopedia of Toxicology 2nd Edition., P. Wexler, Ed., vol. 3, pp 424–436.

Strangulation (Respiratory, Cardiovascular, and Vagus Nerve Stimulation)

Strangulation

Hazard Definition

Anoxia caused by external pressure obstructing the passage of air through the airway or by preventing the flow of oxygenated blood to the brain. The vagus nerve controls heart rate and respiration. Stimulation of this nerve by external pressure may result in asphyxiation.

Scope

Strangulation is one of the most common causes of fatal injury, particularly to children. Injuries, when they occur, are usually extremely serious.

Organizations/Associations/Societies

American College of Emergency Room Physicians (www.acep.org/webportal)
American Society of Pediatric Otolaryngology (ASPO, www.aspo.us/)
European Society of Pediatric Otorhinolaryngology (ESPO, www.espo.eu.com/)
Society for Ear, Nose, and Throat Advances in Children (SENTAC, www.sentac.org/)

Key references

Drago DA, Dannenberg AL (1999 May) Infant Mechanical Suffocation Deaths in the United States. Pediatrics 103(5): e59. 1980–1997.

Feldman KW, Simms RJ (Jun 1980) Strangulation in Childhood: Epidemiology and Clinical Course. Pediatrics 65: 1079–1085.

Hunsaker DM, Hunsaker JC, 3rd, Shields LB (2005, 1 March) Autoerotic asphyxia: part I. Am. J Forensic. Med. Pathol. 26(1): 45–52.

Nixon JW, Kemp AM, Levene S, Sibert JR (1995) Suffocation, choking, and strangulation in children

in England and Wales: epidemiology and prevention. Arch Dis Child. 72: 6–10.

Racette S, Sauvageau A (2006 Jan) Autoerotic deaths in the literature from 1954 to 2004: a review. J. Forensic Sci. 51(1): 140–146.

Rider, G (2005) Physical Hazards. Encyclopedia of Toxicology 2nd Edition., P. Wexler, Ed., vol. 3, pp 424–436.

Stevens RR, Stool D, Lane GA, Rider G, Milkovich SM, Stool SE (2000) Prevention of Accidental Childhood Strangulation: A Clinical Study. Ann Otol Rhinol Laryngol. 109: 797–802.

Stevens RR, Stool D, Lane GA, Rider G, Milkovich SM, Stool SE (1999, 5 Oct) Prevention of accidental childhood strangulation: where is the site of obstruction?. Int. J. Pediatr. Otorhinolaryngol. 49(Suppl 1): S321–S322.

Thies KC, Sep D (2007, 14 Mar) Strangulation Injuries in Children. Resuscitation. [Epub ahead of print].

Entanglement (Finger, Toe, Tourniquet Appendage Strangulation)

Hazard Definition

Hazardous condition in which a limb or digit enters a space from which it cannot be removed. Loops acting as tourniquets, and moving rigid components which may pinch or amputate are included.

Scope

Entanglement injuries are often associated with hair. However string and similar consumer products can cause similar injuries. Children are often victims of entanglement injuries.

Key References

Alverson B (2007 Mar) A genital hair tourniquet in a 9-year-old girl. Pediatr. Emerg. Care 23(3): 169–170.

Bacon JL, Burgis JT (2005 June) Hair thread tourniquet syndrome in adolescents: a presentation and review of the literature. J. Pediatr. Adolesc. Gynecol. 18(3): 155–156.

Barton DJ, Nichter LS, Reinisch JF, Sloan GM (1988 Dec) Hair-Thread Tourniquet Syndrome. Pediatrics 82: 925–928.

Strahlman RS (2003 Mar) Toe tourniquet syndrome in association with maternal hair loss. Pediatrics 111(3): 685–687. http://pediatrics.aappublications.org/cgi/reprint/111/3/685.

Impact (Eye Impact, Chest Trauma, Falls, Cardiac Contusion)

Hazard Definition

Fall: Injury caused by dropping down freely under the influence of gravity. The force or impetus transmitted to the body by a collision with an immobile person/ object. May result in fracture or bruising. The force or impetus transmitted to the body by a collision from a moving person/object. May result in fracture or bruising.

Scope

Impact can result in a wide range of injury to all regions of the body. Impact injuries are often associated with traffic accidents and falls. The latter can be severe, particularly in the elderly. Many impact injuries are related to sports and play activities.

Organizations/Associations/Societies

American Academy of Ophthalmology (www.aao.org/)
Duke University Injury and Orthopaedic Biomechanics Laboratory (http://biomechanics.bme.duke.edu/index.htm)
International Brain Injury Association (http://internationalbrain.org/index.php)
World Eye Injury Registry (www.weironline.org/Index2.html)

Key References

King AI (2001, 1 Jan) Fundamentals of impact biomechanics: Part 2–Biomechanics of the abdomen, pelvis, and lower extremities. Annu. Rev. Biomed. Eng. 3: 27–55.

Boden BP (2005 Nov) Direct Catastrophic Injury in Sports. J. Am. Acad. Ortho. Surg. 13: 445–454.

Bradley, C., Harrison, J.E. Fall Related Hospitalizations among Older People, Injury Research and Statistics Series No. 33, Australian Institute of Health and Welfare, May 2007 www.nisu.flinders.edu.au/pubs/reports/2007/injcat97.pdf

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Currie LM (2006) Fall and injury prevention. Annu. Rev. Nurs. Res. 24: 39–74.

Duma SM, Kennedy EA, Ng TP, et al (2005 Oct) Determination of significant parameters for eye injury risk from projectiles. J. Trauma. 59(4): 960–964.

Gardner TN, Simpson AH, Booth C, Sprukkelhorst P, Evans M, Kenwright J, Evans JG (1988, 1 Jan)

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Hampson D (1995 Jan) Facial injury: a review of biomechanical studies and test procedures for facial injury assessment. J. Biomech. 28(1): 1–7.

Holanda MS, Dominguez MJ, Lopez-Espadas F, Lopez M, Diaz-Reganon J, Rodreiguez-Borregan JC (2006 Dec) Cardiac contusion following blunt chest trauma. Eur. J. Emerg. Med. 13(6): 373–376.

Johnson M, Peng Z, Rogena S, Sadler D, Thakore E (2000 Nov) Non-penetrating chest blows and sudden death in the young. Emerg. Med. J. 17: 421.

Josephson KR, Rubenstein LZ (2006 Sep) Falls and their prevention in elderly people: what does the evidence show?. Med. Clin. North Am. 90(5): 807–824.

Peate WF (2007, 1 Apr) Work-related eye injuries and illnesses. American Family Physician 75(7): 1017–1022.

Woodcock MG, Scott RA, Huntbach J, Kirkby GR (2006 Dec) Mass and shape as factors in intraocular foreign body injuries. Ophthalmology 113(12): 2262–2269.

Laceration

Hazard Definition

Penetration injury of the skin caused by contact with a sharp edge.

Scope

Laceration is a common injury associated with both knives and unintended sharp edges on consumer products. The severity of laceration injuries can range from very minor to fatal.

Organizations/Associations/Societies

American College of Emergency Physicians (www.acep.org/webportal)

Key References

Chadwick EK, Nicol AC, Lane JV, Gray TG (1999, 25 Oct) Biomechanics of knife stab attacks. Forensic Sci. Int. 105(1): 35–44.

Hollander JE, Singer AJ (1999 Sep) Laceration management. Ann Emerg Med. 34(3): 356–367.

Knight S, Junkins EP, Jr, Lightfoot AC, Cazier CF, Olson LM (2000 Jul) Injuries Sustained by Students in Shop Class. Pediatrics 106: 10–13. http://pediatrics.aappublications.org/cgi/reprint/106/1/10.

McGuire BJ, Moore JD, Sorrells JR (1973, 10 Feb) Resistance of human skin to puncture and laceration. NBSIR 73–123.

O'Callaghan PT, Jones MD, James DS, Leadbeatter S, Holt CA, Nokes LD (1999, 11 Oct) Dynamics of stab wounds: force required for penetration of various cadaveric human tissues. Forensic Sci Int. 104(2–3): 173–178.

Rittichier KK, Bassett KE (2001 Feb) Metal lawn and garden edging: the hidden knife?. Pediatr Emerg Care 17(1): 28–31.

Sorrells JR, Berger RI. Some cutting experiments on human skin and synthetic materials, NBSIR 73–262.

Puncture

Hazard Definition

Penetration injury of the skin caused by contact with a sharp point.

Scope

Puncture injuries often result from interaction with tools having sharp points or consumer products with intended (e.g. pins and needles) or unintended sharp points. Tetanus subsequent to puncture wounds remains a problem in much of the world.

Organizations/Associations/Societies

American College of Emergency Physicians (www.acep.org/webportal)

Key References

Baldwin G, Colbourne M (1999 Jan) Puncture wounds. Pediatr Rev. 20(1): 21–23.

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Moore, J.D. (1972) A method for evaluating and testing the sharpness of points, National Bureau of Standards Report No. 10–673.

Niall DM, Murphy PG, Fogarty EE, Dowling FE, Moore DP (1997 Apr–Jun) Puncture wound related pseudomonas infections of the foot in children. J Med Sci. 166(2): 98–101.

Pennycook A, Makower R, O'Donnell AM (1994 Oct) Puncture wounds of the foot: can infective complications be avoided?. J R Soc Med. 87(10): 581–583.

Abrasion

Hazard Definition

Penetration injury of the skin caused by contact with a rough surface.

Scope

Abrasions are very common childhood injuries often resulting from falling or sliding. Corneal abrasion is another common injury often associated with contact lenses or other ocular foreign bodies. In most cases abrasion injuries are minor although infection is a possible complication. Tetanus subsequent to abrasion wounds remains a problem in much of the world.

Organizations/Associations/Societies

American Academy of Pediatrics (www.aap.org/)
American College of Emergency Physicians (www.acep.org/webportal)

Key References

Abbas MI, Bamberger HB, Gebhart RW (2004 Sep) Home Treadmill Injuries in Infants and Children Aged to 5 Years: A Review of Consumer Product Safety Commission Data and an Illustrative Report of Case. J Am Osteopath Assoc. 104: 372–376.

Barnett PL, Oakley EA, Young SJ (2005 Jun) Bruising, abrasions and lacerations: minor injuries in children I. Med. J. Aust. 182(11): 588–592.

Bergfeld WF, Taylor JS (1985) Trauma, sports, and the skin. Am J Ind Med. 8(4–5): 403–413.

Chao CH, Yu KW, Liu CY, Cheng DL, Wang LS, Wong WW (1991 Aug) Tetanus: 20 years of clinical experience. Zhonghua Yi Xue Za Zhi (Taipei) 48(2): 110–115.

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Leininger RE, Knox CL, Comstock RD (2007 Feb) Epidemiology of 1.6 million pediatric soccer-related injuries presenting to US emergency departments from 1990 to 2003. Am J Sports Med. 35(2): 288–293. Epub 2006 Nov 7.

Vibration

Hazard Definition

Handarm vibration (HAV) (usually associated with the use of vibrating hand tools), and whole-body vibration (WBV) which is experienced when the operator or driver sits on or in a vibrating machine, usually a vehicle such as a forklift, or one of the numerous kinds of vehicles used in agriculture, transport, materials handling, mining and forestry.

Scope

Injuries from limb or whole-body vibration are generally associated with industrial workers rather than consumer products. However recreational vehicles and professional-grade power tools used increasingly by consumers can be sources of signifi cant mechanical vibration.

Organizations/Associations/Societies

Human Vibration (www.humanvibration.com/human_vibration.htm)

Key References

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Explosions

Hazard Definition

A release of chemical energy in a sudden and often violent manner, usually with the generation of high temperature and release of gases. A release of mechanical energy in a sudden and often violent manner.

Scope

Explosion injuries are most often associated with warfare, where they result in loss of life, limb, and

function on a large scale. Among consumer products, fireworks are most often associated with explosion injuries. However explosion injuries also result from pressurized vessels and malfunctioning gas appliances.

Organizations/Associations/Societies

American Academy of Pediatrics (www.aap.org/)
American College of Emergency Physicians (www.acep.org/webportal)

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Sound and Noise

Hazard Definition

Permanent or temporary hearing damage caused by short- or long-term exposure to loud sound.

Scope

Hearing loss is caused primarily by damage to hair cells in the inner ear. Traditionally associated with the elderly, hearing loss among younger population groups is of increasing concern. Exposure to loud noise and music is one of the most common causes of hearing loss in children and young adults.

Organizations/Associations/Societies

American Academy of Audiology (www.audiology.org/)
Better Hearing Institute (www.betterhearing.org/)
British Academy of Audiology (www.baaudiology.org/)

Key References

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Strain/sprain

Hazard Definition

Damage to connective tissues caused by exceeding movement limitations of joints.

Scope

Strain/sprain injuries are commonly associated with sports. They often occur in the home environment when performing new and strenuous tasks with inadequate preparation.

Organizations/Associations/Societies

American College of Sports Medicine (www.acsm.org/)

Key References

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Repetitive Motion

Hazard Definition

Frequently repeated tasks can cause strains and fatigue in muscles, joints, and tendons.

Scope

Repetitive motion injuries are most commonly associated with performing repetitive tasks in the workplace. However recreational computer use and video games may also cause these injuries.

Organizations/Associations/Societies

Human Factors and Ergonomics Society (http://www.hfes.org/web/Default.aspx)
Repetitive strain injury association (www.rsi.org.uk/)

Key References

Bernard BP, (Ed) Musculoskeletal Disorders and Workplace Factors. A Critical Review of Epidemiologic Evidence for Work-Related Musculoskeletal Disorders of the Neck, Upper Extremity, and Low Back NIOSH Publication No. 97–141, July 1997 www.cdc.gov/niosh/docs/97-141/

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Thermal burns

Scalds (Liquid or Gas)

Hazard Definition

Chemical changes to the skin resulting from contact with liquids and gases of elevated temperatures. Severity of these injuries is related to dose, which is a function of time and temperature.

Scope

Scalds are of particular concern in young children and the elderly due to factors such as thinner skin, slower response time, and inability to escape from hazardous environment.

Organizations/Associations/Societies

American Burn Association (www.ameriburn.org/)
European Burns Association (www.euroburn.nl/)
Mediterranean Council for Burns and Fire Disasters (www.medbc.com/)

Key References

Ahmed J, Evans J, Stone M (2000 Jun) The continuing risk of domestic hot water scalds to the elderly. Burns 26(4): 347–350.

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Contact Burns (Contact with Hot Solid Surface or Open Flames)

Hazard Definition

Chemical changes to the skin resulting from contact with solids of elevated temperatures or open flames. Severity of these injuries is related to dose, which is a function of time and temperature.

Scope

Consumer products commonly associated with contact burns include kitchen appliances. Flame injuries are associated with numerous products, including candles, fireworks, mattresses, upholstered furniture, sleepwear, and other clothing.

Organizations/Associations/Societies

American Burn Association (www.ameriburn.org/)
European Burns Association (www.euroburn.nl/)
Mediterranean Council for Burns and Fire Disasters (http://www.medbc.com/)
(U.S.) National Fire Protection Association (www.nfpa.org/)

Key References

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Witsaman RJ, Comstock RD, Smith GA (2006 Jul) Pediatric Fireworks-Related Injuries in the United States: 1990–2003. Pediatrics 118: 296–303.

Burns

Cryogenic Burns

Hazard Definition

Chemical changes to the skin resulting from contact with solids, liquids, or gases at reduced temperatures.

Scope

Injuries due to contact with cold materials or environments are commonly associated with outdoor workers.

However some consumer products including aerosol cans are capable of producing very low temperatures.

Organizations/Associations/Societies

American Burn Association (www.ameriburn.org/)
European Burns Association (www.euroburn.nl/)

Key References

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Electricity

Electric Shock, Electrical Burn, and Electrocution

Hazard Definition

Injuries caused by passage of electric current through tissue. Serious injury may occur if current passes through the central nervous system or heart.

Electrical burns may occur and severity is dependent on voltage, amperage, and duration of contact.

Scope

Exposure to electricity can cause a variety of injuries including burns, injuries to the cardiovascular and nervous system, and impact injuries resulting from falls secondary to electric shock.

Organizations/Associations/Societies

Electrical Safety Foundation International (www.esfi.org/)
University of Chicago Electrical Trauma Program (http://etrp.bsd.uchicago.edu/)

Key References

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Static and Low-frequency Electromagnetic Fields

Hazard Definition

Adverse biological and health effects of electromagnetic fields ranging from static fields to approximately AM radio frequencies (approximately 0 to 100 kHz).

Scope

The primary biological concern regarding low-frequency electromagnetic fields generated by consumer products is a potential link to cancer. There is a

definite risk of interference with implanted medical devices from high-strength fields.

Organizations/Associations/Societies

International Commission on Non-Ionizing Radiation Protection (ICNIRP, www.icnirp.de)

Key References

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Wood AW (2006 Apr) How dangerous are mobile phones, transmission masts, and electricity pylons?. Arch. Dis. Child. 91: 361–366.

Radio Frequency and Microwave Radiation

Hazard Definition

Adverse biological and health effects of electromagnetic fields in the radiofrequency and/or microwave range (100 kHz to 1 terahertz).

Scope

The primary biological concern regarding radiofrequency and microwave fields generated by consumer products is a potential link to cancer. Intense fields can also interfere with implanted medical devices.

Organizations/Associations/Societies

International Commission on Non-Ionizing Radiation Protection (ICNIRP, www.icnirp.de)

Key References

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What effects do mobile phones have on people's health? WHO Regional Office for Europe's Health Evidence Network (HEN) November 2006 www.euro.who.int/document/E89486.pdf

Visible Light and Near-infrared Radiation

Ocular Injury

Hazard Definition

Damage to ocular media caused by light in the wavelength range 380 nm to 1400 nm.

Scope

Acute ocular injury from visible light and near-infrared radiation generally takes the form of retinal

damage. Two mechanisms can be involved: a photochemical mechanism associated with blue light can be characterized by a dose that depends on wavelength, intensity, and time, and a thermal mechanism that is related to local temperature increase on the retina. Historically the sun has been the source of most light-induced ocular injuries. However artificial light sources including both lasers and incoherent light sources (lamps and light-emitting diodes) are capable of causing retinal damage.

Organizations/Associations/Societies

Berufsgenossenschaft der Feinmechanik und Elektrotechnik (BGF, www.bgfe.de/start/index.html)
International Commission on Illumination (CIE, www.cie.co.at/cie/)
International Commission on Non-Ionizing Radiation Protection (ICNIRP, www.icnirp.de)
Laser Institute of America www.laserinstitute.org/

Key References

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West T, Wolfe M (2005) Applied Optics 44(11): 2162–2176. www.icnirp.de/documents/OcularInstruments0405.pdf.

Distraction and Interference with Safe Activity

Hazard Definition

Injury occurring from an accident secondary to distraction, impaired vision, or temporary blinding by bright light.

Scope

Injuries resulting from accidents secondary to visual impairment or distraction by a bright light are traditionally associated with automobile and air traffic. However as brighter lights becoming integrated into automobiles and consumer products possibilities of accidents involving bicycle riders and persons engaged in other activities increase.

Organizations/Associations/Societies

International Commission on Illumination (CIE, www.cie.co.at/cie/)
U.S. Department of Transportation National Highway Traffic Safety Administration (www.nhtsa.dot.gov/)
U.S. Federal Aviation Administration (www.faa.gov/)

Key References

Bullough JD, Van Derlofske J, Dee P, Chen J, Akashi Y. An Investigation of Headlamp Glare: Intensity, Spectrum and Size. DOT HS 809 672 October 2003, www.unece.org/trans/doc/2004/wp29gre/TRANS-WP29-GRE-52-34e.pdf

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Johannes JV (2003). Reflections on Glare Lighting Research and Technology 35(2): 163–176.

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Rider G (2005) Physical Hazards. Encyclopedia of Toxicology 2nd Edition., P. Wexler, Ed., vol. 3, pp 424–436.

Flashing-light-induced Seizure

Hazard Definition

Seizure induced by viewing flashing lights, rapidly alternating images of differing colors, or certain patterns.

Scope

A relatively small fraction of the general population is susceptible to seizures induced by flashing lights, rapidly alternating images of different colors (particularly alternating red and cyan), and certain patterns. Induction of seizures has been most often associated with viewing certain television programs, music videos, and strobe lights.

Organizations/Associations/Societies

Epilepsy Foundation of America (www.epilepsyfoundation.org/)

Key References

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Ultraviolet Light

Skin and Ocular Injury

Hazard Definition

Damage to skin and ocular tissues from ultraviolet light.

Scope

Ultraviolet light is associated with acute skin damage such as sunburn and blistering and chronic diseases such as skin cancer. Ocular exposure to UV light has been linked to cataracts. The eyes of young children are more transparent to UV than those of older children and adults.

Organizations/Associations/Societies

British Health Protection Agency, Radiation Protection Division (formerly National Radiological Protection Board, www.hpa.org.uk/radiation/)

International Commission on Non-Ionizing Radiation Protection (ICNIRP, www.icnirp.de)

Strahlenschutzkommission (Commission on Radiological Protection, www.ssk.de/)

Key References

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Vecchia P, Hietanen M, Stuck BE, Van Deventer E, Niu S. (eds.) ICNIRP/WHO/ILO Joint Guide on Protecting Workers from Ultraviolet Radiation 2007 www.icnirp.de/documents/UVWorkers.pdf

CHAPTER

43

Precautionary Principle

STEVEN G. GILBERT, KEES VAN LEEUWEN AND PERTTI HAKKINEN

Precautionary Principle

'When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically. In this context the proponent of an activity, rather than the public, should bear the burden of proof. The process of applying the precautionary principle must be open, informed and democratic and must include potentially affected parties. It must also involve an examination of the full range of alternatives, including no action.' Wingspread Statement on the Precautionary Principle, Jan. 1998.

INTRODUCTION

John Muir once wrote about the interconnectedness of the world, 'When we try to pick out anything by itself, we find it hitched to everything else in the Universe.' Since human society does not understand every intricacy of the web of life, we must make decisions based on our imperfect knowledge of the world. We must use what we do know to prevent harming the ecological systems we depend on for health and wellbeing: thus the precautionary principle.

The precautionary principle originates from the German principle of foresight or *Vorsorge*. Germany further developed this principle in the 1970s as a foundation for its environmental law and policies on global warming and acid rain. Embracing the principle has also led to a strong and innovative environmental industry in Germany. The European Union has continued to advance a precautionary approach through its new legislation on chemicals, i.e. Registration, Evaluation, Authorization and Restriction of Chemicals (REACH), first introduced as a proposal in 2003 and finally adopted in 2006.

The United States first endorsed the precautionary principle when the U.S. federal government signed and ratified the Rio Declaration following the 1992 United Nations Conference on Environment and Development in Rio de Janeiro. The Rio Declaration definition, also referred to as Agenda 21, states:

> In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

This definition focuses primarily on environmental impacts and has been expanded to include public health concerns. In 1998, scholars, scientists, advocates, and lawyers gathered to discuss methods for implementing the precautionary principle at Wingspread, the home of the Johnson Foundation in Racine, Wisconsin. The goal was to determine how the precautionary principle could be used in daily environmental and public health policy decisions at the state and federal level. The conference produced the following definition, known as the 1998 Wingspread Statement on the Precautionary Principle (see above).

The precautionary principle includes the following key components:

1. Taking anticipatory action to prevent harm in the face of scientific uncertainty.
2. Exploring alternatives, including the alternative of 'no action.'

3. Considering the full cost of environmental and health impacts over time.
4. Increasing public participation in decision-making.
5. Shifting responsibility for providing evidence of safety to proponents of an activity.

An essential component is the need to evaluate the full range of alternatives when pursuing an activity, new technology or product and to ensure meaningful public participation in the alternatives analysis and decision-making.

The precautionary principle has since been articulated widely in international statements and laws that apply to high-stakes environmental or health concerns. The underlying idea behind each statement is that action should be taken to prevent harm to the environment and human health, even if scientific evidence is inconclusive.

The precautionary principle often functions as a statement of values, to be used as a guideline in the decision-making process. However, it should be pointed out that the precautionary principle is also being enforced more directly in the context of international agreements, including:

- **The Cartagena Protocol on Biosafety of 2003** (http://www.biodiv.org/biosafety/default.aspx), which allows countries to apply the precautionary principle in decisions on importing genetically modified organisms; and
- **The Stockholm Convention on Persistent Organic Pollutants of 2001** (http://www.pops.int/), which uses the precautionary principle as a standard for adding to its original list of 12 banned chemicals.

In the U.S., the principle is not expressly referred to in the federal law. However, the idea of taking precautionary action to prevent harm is at the foundation of several important pieces of national legislation. These include:

- **The National Environmental Policy Act of 1970**, which requires any federally funded project that could potentially harm the environment to undergo an environmental impact study to evaluate whether safer alternatives are possible;
- **The Clean Water Act of 1972**, which established clear water safety goals and standards, in order to protect the 'chemical, physical, and biological integrity of the Nation's waters;'
- **The Occupational Safety and Health Act of 1970**, which aims to ensure safe and health working conditions for U.S. men and women;
- **The Pollution Prevention Act of 1990**, which was enacted following the tragic Exxon-Valdez oil spill to set prevention as the highest priority of U.S. environmental programs; and
- **The Food Quality Protection Act of 1996**, which calls for several uses of organophosphate pesticides to be phased out and requires pesticides to be proven safe for children or else not used.

At a more local level several cities and counties have moved to adopt the precautionary principles as basis for decision making about issues affecting human health and the environment.

In Europe the Precautionary Principle is a cornerstone of the REACH legislation. REACH is the European Unions approach to managing health and environmental issues for future generations. The precaution principle is rapidly becoming the scientific and philosophical backbone for regulation to ensure human and environmental health.

The precautionary principle according to the European Commission (2000) is described below.

Where action is deemed necessary, measures based on the precautionary principle should be, inter alia:

1. Proportional to the chosen level of protection.
2. Non-discriminatory in their application.
3. Consistent with similar measures already taken.
4. Based on an examination of the potential benefits and costs of action or lack of action (including, where appropriate and feasible, an economic cost/benefit analysis).
5. Subject to review, in the light of new scientific data.
6. Capable of assigning responsibility for producing the scientific evidence necessary for a more comprehensive risk assessment.

Proportionality means tailoring measures to the chosen level of protection. Risk can rarely be reduced to zero, but incomplete risk assessments may greatly reduce the range of options to risk managers. A total ban may not be a proportional response to a potential risk in all cases. However, in certain cases, it is the sole response to a given risk.

Non-discrimination means that comparable situations should not be treated differently, and that different situations should not be treated in the same way, unless there are objective grounds for doing so.

Consistency means that measures should be of comparable scope and nature to those already taken in equivalent areas in which all scientific data are available.

Examining costs and benefits entails comparing the overall cost to the community of action and lack of action, in both the short and long term. This is not simply an economic cost–benefit analysis: its scope is much broader, and includes non-economic

considerations, such as the efficacy of possible options and their acceptability to the public. In the conduct of such an examination, account should be taken of the general principle and the case of law of the Court that the protection of health takes precedence over economic considerations.

Subject to review in the light of new scientific data, means measures based on the precautionary principle should be maintained so long as scientific information is incomplete or inconclusive, and the risk is still considered too high to be imposed on society, in view of chosen level of protection. Measures should be periodically reviewed in the light of scientific progress, and amended as necessary.

Assigning responsibility for producing scientific evidence is already a common consequence of these measures. Countries that impose a prior approval (marketing authorization) requirement on products that they deem dangerous a priori reverse the burden of proving injury, by treating them as dangerous unless and until businesses do the scientific work necessary to demonstrate that they are safe.

Where there is no prior authorization procedure, it may be up to the user or to public authorities to demonstrate the nature of a danger and the level of risk of a product or process. In such cases, a specific precautionary measure might be taken to place the burden of proof upon the producer, manufacturer or importer, but this cannot be made a general rule.

RESOURCES

Books

Goklany IM (2001)
The Precautionary Principle: A Critical Appraisal
Cato Institute, Washington, DC

The author addresses concerns that the precautionary principle can be used to delay or stop advances in technology. The book has chapters addressing global warming, DDT, and bioengineered crops.

Harremoës P, Gee D, MacGarvin M, Stirling A, Keys JB, Vaz JG (2001)
Late Lessons from Early Warnings: The Precautionary Principle 1986–2000
European Environmental Agency, Copenhagen, pp. 210.
Web: http://reports.eea.europa.eu/environmental_issue_report_2001_22/en/Issue_Report_No_22.pdf

This excellent book documents the health and environmental consequences of not addressing early indications of potential for harm. Each chapter addresses a different agent or situation by examining the early indications of potential harm and then documenting the consequences of not acting on this information.

Jones JS, Von Schomberg R (Eds) (2006)
Implementing the Precautionary Principle: Perspectives And Prospects
Edward Elgar Publishing, Northampton, Massachusetts

Address the challenges of implementing the precautionary principle in public policy that directs decision-making. Several chapter address specific topics that might incorporate the precautionary principle.

Marchant GE, Mossman KL (2004)
Arbitrary and Capricious: The Precautionary Principle in the European Union Courts
American Enterprise Institute Press.
Web: http://www.aei.org/books/bookID.787/book_detail.asp

Concerns that the precautionary principle is legally undefined are examined, along with the general view that the precautionary principle is unworkable.

Marco M, Tickner JA (Eds.) (2004)
The Precautionary Principle: Protecting Public Health, the Environment and the Future of our Children
World Health Organization Regional Office for Europe. Copenhagen.
Web: http://www.euro.who.int/document/e83079.pdf

Myers NJ, Raffensperger C (2006)
Precautionary Tools for Reshaping Environmental Policy
MIT Press, Cambridge, MA

One of the challenges of the precautionary principle is applying it to the local situation. Meyers and Raffensperger discuss community-based tools that can be used to develop and implement precautionary approaches.

O'Brien M (2001)
Making Better Environmental Decisions: An Alternative to Risk Assessment
MIT Press, Cambridge MA

While risk assessment is easy to criticize, addressing alternatives is more difficult. O'Brien describes and illustrates some of the weakness of risk assessment and then explores different approaches to making human health and environmental decisions.

Peel J (2005)
The Precautionary Principle in Practice: Environmental Decision-Making and Scientific Uncertainty

Federation Press, Australia
Web: http://www.federationpress.com.au/bookstore/book.asp?isbn=9781862875197

This book focuses on legal issues related to the environment and scientific uncertainty and how to apply the precautionary principle.

Raffensperger C, Tickner J (Eds) (1999)
Protecting Public Health & the Environment: Implementing the Precautionary Principle
Island Press, Washington, DC, pp. 385.

This book developed out of the proceedings of the 1998 Wingspread conference in Racine, Wisconsin. Book chapters are by leaders in the U.S. and internationally covering a range of issues related to applying the precautionary principle.

Smart RC, Hodgson E (Eds) (2008)
Molecular and Biochemical Toxicology, 4th edn
John Wiley and Sons Inc., Hoboken, New Jersey, USA

The fourth edition has been newly revised and covers the underlying biochemical, molecular, and cellular mechanisms through which toxicants produce their adverse effects. Toxicological issues are covered from the molecule to the cell to the organ level including complex methods used in toxicology. Additional topics emphasize the interrelationship between toxicology and genomic sciences (e.g., bioinformatics, proteomics, metabolomics, and toxicogenomics). Further, structure, mechanism, and regulation of xenobiotic metabolizing enzymes, toxicogenetics, and xenobiotic transporters have been emphasized. Other new topics and chapters include molecular epidemiology and genetic susceptibility, DNA damage and mutagenesis, DNA repair, mechanisms of cell death, mitochondrial dysfunction, metals, reproductive toxicology, developmental toxicology, and reactive oxygen/metabolites and toxicity.

Tickner JA (Eds) (2003)
Precaution – Environmental Science and Preventive Public Policy
Island Press, Washington, DC.

This book covers national and international issues on the science and philosophy of applying the precautionary principle to improving public health by preventing harm.

Trouwborst A (2002)
Evolution and Status of the Precautionary Principle in International Law
Kluwer Law International, Cambridge, MA

Starting with a history of the precautionary principle, this book then addresses international applications of the precautionary principle from a legal perspective.

Whiteside KH (2006)
Precautionary Politics: Principle and Practice in Confronting Environmental Risk
The MIT Press, Cambridge, MA.

Environmental ethics and the precautionary principle are examined in light of difference between the United States and Europe.

Journals

The Precautionary Principle
Multinational Monitor, Sept 2004, Vol 25, No 9
Web:http://multinationalmonitor.org/mm2004/09012004/index.html

Includes articles by Nancy Myers, Peter Montague, Joe DiGangi, and an interview with Carolyn Raffensperger

The Precautionary Principle and Environmental Policy: Science, Uncertainty, and Sustainability
International Journal of Occupational Environmental Health, Vol. 6, No. 3, Oct/Dec 2000
Web: http://www.sehn.org/pdf/ppep.pdf
Special Series Guest Editor: Carl Smith
Contributors: Andrea Ahrens, Clifton Curtis, Gwynne Lyons, Susan Mayer, Nancy Myers, Carolyn Raffensperger, Claudia Saladia, Elizabeth Salter, Ted Schettler, Carl Smith, Andy Stirling, Joe Thorton, Joel Tickner.
Special Issue on Precaution and Public Health. Tickner, J. 2002. ed Public Health Reports, Nov/Dec, 117: 493–497

Precaution, Precaution Everywhere: Developing a 'common understanding' of the precautionary principle in the European Community
Fisher E (2002) Maastricht Journal of European and Comparative Law 9(1): 7–28.

Journal Articles

Abouchar J (2002) The Precautionary Principle in Canada: The first decade. Environmental Law Reporter 32(12): 11407–11420.

Ashford NA (2004) Implementing the Precautionary Principle: incorporating science, technology, fairness, and accountability in environmental, health, and safety decisions. Int. J. Occup. Med. Environ. Health 17: 59–67.

Biocca M (2004) Risk communication and the Precautionary Principle. Int. J. Occup. Med. Environ. Health 17: 197–201.

Bodar CW, Berthault F, de Bruijn JH, van Leeuwen CJ, Pronk ME, Vermeire TG (2003) Evaluation of EU risk assessments existing chemicals (EC Regulation 793/93). Chemosphere 53: 1039–1047.

Cairns J, Jr (2003) Interrelationships between the precautionary principle, prediction strategies, and sustainable use of the planet. Environ. Health Perspect. 111: 877–880.

Cranor CF (2004) Some legal implications of the Precautionary Principle: improving information-generation and legal protections. Int. J. Occup. Med. Environ. Health, 17: 17–34.

Cranor CF (2004) Toward understanding aspects of the precautionary principle. J. Med. Philos. 29: 259–279.

de Bruijn J, Hansen B, Munn S (2003) Role of the precautionary principle in the EU risk assessment process on industrial chemicals. Pure Appl. Chem. 75: 2535–2541.

Dowie J (2004) Research implications of science-informed, value-based decision making. Int. J. Occup. Med. Environ. Health 17: 83–90.

Engelhardt HT, Jotterand F (2004) The precautionary principle: a dialectical reconsideration. J. Med. Philos. 29: 301–312.

Gilbert SG (2005) Public Health and the Precautionary Principle. Northwest Public Health. Spring/Summer 2005, p. 4. http://healthlinks.washington.edu/nwcphp/nph/s2005/

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Goldstein BD (2004) The precautionary principle, toxicological science, and European–U.S. scientific cooperation. Drug Metab. Rev. 36: 487–495.

Goldstein B, Carruth RS (2004) The precautionary principle and/or risk assessment in World Trade Organization decisions: a possible role for risk perception. Risk Anal. 24: 491–499.

Goldstein BD, Carruth RS (2004) Implications of the Precautionary Principle: is it a threat to science?. Int. J. Occup. Med. Environ. Health 17: 153–161.

Grandjean P (2004) Implications of the precautionary principle for primary prevention and research. Annu. Rev. Public Health 25: 199–223.

Grandjean P (2004b) Implications of the Precautionary Principle for public health practice and research. Int. J. Occup. Med. Environ. Health 17: 5–7.

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Harari R, Freire Morales R, Harari H (2004) Major concerns in developing countries: applications of the Precautionary Principle in Ecuador. Int. J. Occup. Med. Environ. Health 17: 187–191.

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Kopelman LM, Resnick D, Weed DL (2004) What is the role of the precautionary principle in the philosophy of medicine and bioethics? J. Med. Philos. 29: 255–258.

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Lambert TW, Soskolne CL, Bergum V, Howell J, Dossetor JB (2003) Ethical perspectives for public and environmental health: fostering autonomy and the right to know. Environ. Health Perspect. 111: 133–137.

Marchant GE (2003) From general policy to legal rule: aspirations and limitations of the precautionary principle. Environ. Health Perspect. 111: 1799–1803.

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Raffensperger C (2002) The precautionary principle: bearing witness to and alleviating suffering. Altern. Ther. Health Med. 8: 111–115.

Raffensperger C, Schettler T, Myers N (2000) Precaution: belief, regulatory system, and overarching principle. Int. J. Occup. Environ. Health 6: 266–269.

Raffensperger C, Barrett K (2001) In defense of the precautionary principle. Nat. Biotechnol. 19: 811–812.

Resnik DB (2004) The precautionary principle and medical decision making. J. Med. Philos. 29: 281–299.

Ricci PF, Rice D, Ziagos J, Cox LA, Jr (2003) Precaution, uncertainty and causation in environmental decisions. Environ. Int. 29: 1–19.

Richter ED, Laster R (2004) The Precautionary Principle, epidemiology and the ethics of delay. Int. J. Occup. Med. Environ. Health 17: 9–16.

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U.N. (June 1992) Rio Declaration on Environment and Development. U.N. Doc./CONF.151/5/Rev.1.

Weed DL (2004) Precaution, prevention, and public health ethics. J. Med. Philos. 29: 313–332.

Wiedemann PM, Schutz H (2005) The precautionary principle and risk perception: experimental studies in the EMF area. Environ. Health Perspect. 113: 402–405.

Organizations

Bay Area Working Group on the Precautionary Principle
c/o Clean Water Fund
111 New Montgomery Street, Suite 600
San Francisco, CA 94105
Web: http://www.takingprecaution.org/

This group has worked to establish the precautionary principle as a basic decision-making tool in the San Francisco area to protect health and the environment.

Center for Health, Environment and Justice – Be Safe
P.O. Box 6806
Falls Church, VA 22040-6806
Phone: 703-237-2249
Email: chej@chej.org
Web: http://www.besafenet.com/

Be Safe coordinates information on the precautionary principle including the precautionary principle clearing house (http://www.besafenet.com/ppc/). Be Safe is sponsored by Center for Health, Environment and Justice, which was founded in 1981, by Lois Gibbs, the community leader at Love Canal. CHEJ seeks to help local citizens and organizations come together and take an organized, unified stand in order to hold industry and government accountable and work toward a healthy, sustainable future.

Science and Environmental Health Network – Precautionary Principle
PMB 282
217 Welch Ave. Ste 101
Ames Iowa 50014
Phone: (515) 268-0600
Fax: (515) 268-0604
Email: info@sehn.org
Web: http://www.sehn.org/precaution.html

The mission of Science and Environmental Health Network is to engage communities and governments in the effective application of science to protect and restore public and ecosystem health. They have an extensive section on the precautionary principle.

Seattle Precautionary Principle Working Group
Collaborative on Health and the Environment – Washington (CHE-WA)
Institute for Children's Environmental Health (ICEH)
1646 Dow Road
Freeland, WA 98249
Phone: 360-331-7904
Fax: 360-331-7908
Email: iceh@iceh.org
Web: http://washington.chenw.org/PPgroup.html

Working with the Collaborative on Health in the Environment Washington (CHE-WA), this group developed a white paper and other documents related to establishing the precautionary principle as a decision making tool in Washington State.

Database

BE SAFE Precautionary Policy Clearinghouse
Web: www.besafenet.com

Other Resources

Commission of the European Communities (2000)
Communication from the Commission on the precautionary principle
COM (2000) 1 final. Brussels, Belgium.

Commission of the European Communities (2001)
White Paper on the Strategy for a future Chemicals Policy
Brussels, 27,2,2001. COM(2001) 88.

Commission of the European Communities (2006)
Directive 2006/121/EC of the European Parliament and of the Council of 18 December 2006 amending Council Directive 67/548/EEC
Web: http://eur-lex.europa.eu/LexUriServ/site/en/oj/2006/l_396/l_39620061230en08500856.pdf

European Commission. Environment Directorate General

REACH
Web: http://ec.europa.eu/environment/chemicals/reach/reach_intro.htm

Rachel's Precaution Reporter
Peter Montague (ed.)
Web: http://precaution.org/ First issue – September 1, 2005

Precautionary Principle
Wikipedia
Web: http://en.wikipedia.org/wiki/Precautionary_principle

The Role of Precaution in Chemicals Policy
In Freytag, E., Jakl, T., Loibl, G., Wittman, M. Vienna: Diplomatische Akademie Wien, Favorita Papers 01/2002.
Web: http://www.chemicalspolicy.org/downloads/Austria%20chem%20prec.pdf

The Precautionary Principle Project: Sustainable Development, Natural Resource Management and Biodiversity Conservation
Web: http://www.pprinciple.net/

The Precautionary Principle – A Primer
Web: http://www.ntktrainings.com/open.htm
An interactive web-based training on the precautionary principle.

Health Council of the Netherlands

Prudent Precaution
The Hague: Health Council of the Netherlands (2008)
Web: http://gezondheidsraad.nl/referentie.php?ID=1751

CHAPTER

44

Radiation

BRUCE BUSBY

INTRODUCTION

For many, certain images come to mind when they hear the word 'radiation,' such as mushroom clouds, smoke rising from Chernobyl, Three Mile Island cooling towers and those famous radiation mutants – the Incredible Hulk, Spiderman, and the Fantastic Four. Mass media has played a role in creating erroneous ideas and myths about radiation. The Internet and World Wide Web provide information resources for the public and professionals. Indeed, there might be too much information available, some good and some bad. This article is meant to provide a reference to what the author considers to be useful sources of books, articles, and online information about radiation.

The general public is leery of and understands little of what radiation is or what it is not. In the simplest terms, radiation is energy in transit in the form of high-speed particles or electromagnetic waves. In typical usage, the word radiation means the ionizing radiation, i.e. radiation with enough energy to release electrons in the material it interacts with, such as gamma rays and beta particles. Non-ionizing radiation sources such as microwaves or radio waves can also be a hazard though.

Radioactive materials, substances that give off radiation, are found naturally in everything we touch, eat, and inhale. The Earth's atmosphere is continually bombarded with cosmic radiation, some of which reaches the surface. Radiation is a known carcinogen and mutagen to which every human on the planet is exposed to every second of every day. Radiation is a natural part of our environment and it plays important roles in medicine, industry, and academic research.

Far from being an unknown force that is hard to detect, radiation characteristics are well known and radiation is easy to detect down to small quantities.

RESOURCES

Books

ANSI Z136 Working group (2007)
ANSI Z136.1 Safe Use of Lasers
Laser Institute of America.

The technical safety standard for lasers is the Z136 series and the revised ANSI Z136.1 (2007) provides guidance for the safe use of lasers and laser systems by defining control measures for each of the four laser classes.

BEIR VI Committee (1999)
Health Effects of Exposure to Radon: BEIR VI
National Academies Press.

The report is from the Committee on Health Risks of Exposure to Radon (BEIR VI), part of the National Research Council and National Academy of Sciences to estimate the risk from radon. It contains a very comprehensive listing of sources and references.

BEIR VII Committee (2005)
Health Risks from Exposure to Low Levels of Ionizing Radiations: BEIR VII Phase 2
National Academies Press.

The report is from the Committee to Assess Health Risks from Exposure to Low Levels of Ionizing Radiation (BEIR VII), part of the National Research Council and National Academy of Sciences, to estimate

the risk from low-level radiation. It contains a very comprehensive listing of sources and references.

Herman Cember (1996)
Introduction to Health Physic, 3rd Edition
McGraw-Hill Medical.

Textbook and reference on radiation physics, interactions and protection, with chapters also on non-ionizing radiation. Good overall review of radiation safety, nuclear processes, internal and external dosimetry, detection, and monitoring.

Merril Eisenbud and Thomas Gesell (1997)
Environmental Radioactivity, 4th Edition
Academic Press.

Textbook and reference for radioactivity in the environment from natural and human-produced sources including accidents. Comprehensive look at all aspects of environmental radioactivity, from source to detection to impact on humans.

Eric Hall and Amato J Giaccia (2005)
Radiobiology for the Radiologist, 6th Edition
Lippincott Williams & Wilkins.

Textbook and reference for radiation biology. This book is used often as a textbook for medical schools, health physics graduate programs, and as a reference for anyone interested in radiation biology and medical use of radiation.

IARC and WHO (2002)
Non-Ionizing Radiation, Part 1: Static and Extremely Low-Frequency (ELF) Electric and Magnetic Fields (IARC Monographs on the Evaluation of Carcinogenic Risks to Humans)
World Health Organization.

This IARC/WHO document evaluates possible carcinogenic hazards from exposures to static and extremely low-frequency (ELF) electric and magnetic fields.

Glenn F Knoll (2000)
Radiation Detection and Measurement, 3rd Edition
Wiley.

Textbook and reference for radiation-detection instrumentation. This work covers topics of instrument electronics, detector design, as well as information on typical detectors used in the field and laboratory.

James Martin (2000)
Physics for Radiation Protection: A Handbook
Wiley-VCH.

Textbook and reference for radiation physics. A very comprehensive publication with a historical perspective of radiation physics. Covers early discoveries in radiation use to modern-day applications. Designed to be used as a textbook for health physicist students, can also be used in all fields needing a basis in radiation physics.

Mike Stabin (2007)
Radiation Protection and Dosimetry: An Introduction to Health Physics
Springer Science.

Textbook and reference for the field of radiation protection (health physics). This new text is organized to introduce the reader to basic principles of radiation emission and propagation, to review current knowledge and historical aspects of the biological effects of radiation, and to cover important operational topics such as radiation shielding and dosimetry.

James E Turner (2007)
Atoms, Radiation, and Radiation Protection, 3rd Edition
Wiley-Interscience.

Introductory textbook and reference on radiation physics, interactions, and protection. Covers diverse topics of decay, matter interactions, detection, and risk. Often used by health physicists as a reference.

Andrew W Wood, Colin Roy (Eds) (2005)
Non-Ionizing Radiation Protection
Wiley-Interscience.

A work based on an Australian expert group's work and covers radio frequencies, ELF, UV, lasers, and ultrasound.

Journals

The Health Physics Journal (1958–)
Lippincott Williams & Wilkins.
Web: http://www.health-physics.com/
Official journal of the Health Physics Society

Health Physics provides peer-reviewed articles on radiation, radiation safety, and health effects.

Journal of Radiological Protection (1981–)
Institute of Physics Publishing.
Official journal of the Society for Radiological Protection (UK)
Web: http://www.iop.org/EJ/journal/0952-4746

Journal of Radiological Protection provides peer-reviewed articles on radiation protection including non-ionizing radiations as well as ionizing radiations.

Medical Physics (1997–)
American Association of Physicists in Medicine

Web: http://www.medphys.org/

Medical Physics provides peer-reviewed articles on radiation use in medical applications.

Operational Radiation Safety (1999–)
Lippincott Williams & Wilkins.
Web: http://www.health-physics.com/

Published by the Health Physics Society quarterly with peer-reviewed articles on operational radiation safety topics.

Radiation Research (2000–)
Allen Press, Inc.
Official journal of the Radiation Research Society
Web: http://www.rrjournal.org

Radiation Research provides peer-reviewed articles on basic research on radiation, including health effects.

Journal Articles

American Academy of Pediatrics Committee on Environmental Health (1998) Risk of ionizing radiation exposure to children: A subject review. Pediatrics 101(4, Pt. 1): 717–719.

Anonymous (1997) Ionizing radiation. An overview for the occupational health nurse. Agency for Toxic Substances and Disease Registry. AAOHN J. 45(4): 170–183.

Bender MA (1995) Cytogenetics research in radiation biology. Stem Cells 13(Suppl. 1): 172–182.

Cardis E (1996) Epidemiology of accidental radiation exposures. Environ. Health Perspect. 104(Suppl. 3): 643–649.

Christmann M, et al (2003) Mechanisms of human DNA repair: An update. Toxicology 193: 3–34.

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Organizations

American Academy of Health Physics (AAHP)
1313 Dolley Madison Blvd Ste 402
McLean, VA 22101
Phone: 703-790-1745 X25
Fax: 703-790-2672
E-mail: aahp@BurkInc.com
Web: http://www.hps1.org/aahp/

The AAHP provides information on Certified Health Physicists and the process of certification. Forms, deadlines, exams are all available.

American Association of Physicists in Medicine (AAPM)
One Physics Ellipse
College Park, MD 20740
2007.aapm@aapm.org
Phone: (301) 209-3350
Fax: (301) 209-0862

Web: http://www.aapm.org

The AAPM mission is to advance the practice of physics in medicine and biology (i.e., Medical Physics) by encouraging innovative research and development, disseminating scientific and technical information, fostering the education and professional development of medical physicists, and promoting the highest quality medical services for patients.

Food and Drug Administration (FDA)
U.S. Food and Drug Administration
5600 Fishers Lane, Rockville MD 20857-0001
Phone: 1-888-INFO-FDA (1-888-463-6332)
Web: http://www.fda.gov

The FDA is part of the U.S. Department of Health and Human Services. FDA's Center for Devices and Radiological Health oversees radiation safety of medical imaging systems, security systems (i.e., screening systems for airline security), and industrial and electronic consumer products that emit radiation (i.e., microwave ovens, lasers, and tanning booths). For these products, FDA establishes performance standards and recommends good practices. The FDA is responsible for review and approval of radioactive drugs and mammography.

Health Physics Society (HPS)
1313 Dolley Madison Boulevard
Suite 402
McLean, Virginia 22101
Phone: 703-790-1745
Fax: 703-790-2672
Email: hps@BurkInc.com
Web: http://www.hps.org/

The HPS is a professional organization whose mission is excellence in the science, education and practice of radiation safety. Publishes the peer-reviewed journal *Health Physics*.

International Atomic Energy Agency (IAEA)
P.O. Box 100
Wagramer Strasse 5
A-1400 Vienna, Austria
Phone: (+431) 2600-0
Fax: (+431) 2600-7
Email: Official.Mail@iaea.org
Web: http://www.iaea.org

IAEA, often called the nuclear watchdog agency of the United Nations, has a much broader perspective, providing information on worldwide use of nuclear power and radiation, nuclear safeguards and safety, nuclear law and conventions, nuclear fusion, and Chernobyl.

International Commission on Non-Ionizing Radiation Protection (ICNIRP)
ICNIRP c/o BfS
Ingolstaedter Landstr. 1
85764 Oberschleissheim
Germany
Phone: +49 1888 333 2156
Fax: +49 1888 333 2155
Email: G.ziegelberger@icnirp.org
Web: http://www.icnirp.de/index.html

ICNIRP provides information on the protection against the adverse health effects of non-ionizing radiation.

International Commission on Radiation Protection (ICRP)
SE-171 16 Stockholm
Sweden
Telefax: +46 8 729 729 8
Email: scient.secretary@icrp.org
Web: http://www.icrp.org/

ICRP reviews the fundamental principles and quantitative bases upon which appropriate radiation protection measures can be established. ICRP offers its recommendations to regulatory and advisory agencies on radiological protection. While ICRP has no formal power to impose its proposals on anyone, in fact legislation in most countries adheres closely to ICRP recommendations.

International Commission on Radiation Units and Measurements (ICRU)
7910 Woodmont Avenue, Suite 400
Bethesda, MD 20814-3095
Phone: (301) 657-2652
Email: icru@icru.org
Web: http://www.icru.org

ICRU's principal objective is the development of recommendations regarding quantities and units of radiation and radioactivity and procedures suitable for the measurement.

International Radiation Protection Association (IRPA)
Web: http://www2000.irpa.net/

IRPA provides association and communications for radiation protection activities in all countries and is dedicated to advancing radiation protection all over the world. The IRPA is made up of associate radiation protection societies from around the world.

National Council on Radiation Protection & Measurements (NCRP)
7910 Woodmont Avenue, Suite 400,
Bethesda, Maryland 20814-3095

Phone: (301) 657-2652
Email: schauer@NCRPonline.org
Web: http://www.ncrponline.org

Chartered by U.S. Congress in 1964 as the National Council on Radiation Protection and Measurements. Their goal is to collect, analyze, develop, and disseminate, in the public interest, information and recommendations about protection against radiation and radiation measurements, quantities and units, particularly those concerned with radiation protection. The NCRP publishes recommendation in reports, commentaries, proceedings and lectures.

Occupational Safety and Health Administration (OSHA)
Occupational Safety & Health Administration
200 Constitution Avenue, NW
Washington, DC 20210
Phone: 1-800-321-OSHA
Web: http://www.osha.gov

The OSHA is part of the U.S. Department of Labor. They are responsible for regulation of radiation sources not covered by other government agencies, and in addition, non-ionizing radiation sources for workers.

Radiation Effects Research Foundation
5-2 Hijiyama Park,
Minami-ku, Hiroshima, 732-0815
Phone: 082-261-3131
Web: http://www.rerf.jp/

The objective of the Radiation Effects Research Foundation (RERF) is to conduct research, for peaceful purposes, on the medical effects of radiation on man, with a view to contributing to the health and welfare of the atomic-bomb survivors and to the enhancement of the health of mankind.

Radiation Research Society
PO Box 7050
Lawrence, KS 66044-8897
Phone: 1-800-627-0326
Fax: 1-785-843-1234
Email: sstarr@allenpress.com
Web: http://www.radres.org/

The Radiation Research Society's objectives are to encourage the advancement of radiation research and to promote dissemination of knowledge in the field. Publishes peer-reviewed journal *Radiation Research*.

Society of Nuclear Medicine (SNM)
1850 Samuel Morse Drive
Reston, Virginia 20190
Phone: (703) 708.9000
Web: http://www.snm.org

SNM is an international scientific and professional organization dedicated to promoting the science, technology and practical applications of nuclear medicine to diagnose, manage, and treat diseases.

U.S. Department of Energy (DOE)
1000 Independence Ave., SW
Washington, DC 20585
Phone: (202) 586-4403
Email: The.Secretary@hq.doe.gov
Web: http://www.energy.gov

The DOE as a cabinet-level agency has multiple missions, with cleaning up prior nuclear-related sites (e.g. Hanford, INEL, Oakridge) being a priority, as well as maintaining the country's nuclear weapon complexes.

U.S. Environmental Protection Agency (EPA)
Ariel Rios Building
1200 Pennsylvania Avenue, N.W.
Washington, DC 20460
Phone: (202) 272-0167
Email: radiation.questions@epa.gov
Web: http://www.epa.gov

The EPA regulates radioactive air and water emissions and provides guidance on radon. Also on the EPA web site are full text versions of more than a dozen major statutes and laws, such as National Environmental Policy Act, that form the legal basis for the programs of the EPA.

U.S. Nuclear Regulatory Commission (NRC)
U.S. Nuclear Regulatory Commission, Office of Public Affairs (OPA)
Washington, D.C. 20555
Phone: 800-368-5642
Email: opa@nrc.gov
Web: http://www.nrc.gov

NRC has the responsibility for regulating much of the use of radiation and nuclear power in the United States.

Databases

Exploring the Table of Isotopes
Ernest O. Lawrence Berkeley National Laboratory
Web: http://ie.lbl.gov/education/isotopes.htm

Provides nuclear data in an easy-to-retrieve format.

The National Nuclear Data Center (NNDC)
Sponsored by the Brookhaven National Laboratory and the Department of Energy's Offices of Nuclear Physics and Science.
Web: http://www.nndc.bnl.gov/

The NNDC provides nuclear- and radiation-related databases. For example, NuDat is the database for evaluated nuclear structure and decay data, with a good web interface for data retrieval. The NNDC also provides evaluated atomic masses, graphic displays of nuclear structure, radiation interaction data, and chart of the nuclides, datasheets, and references.

XCOM: Photon Cross Sections Database
Supported in part by the Department of Energy, Office of Health and Environmental Research; National Institute of Standards and Technology
Web: http://physics.nist.gov/PhysRefData/Xcom/Text/XCOM.html

Used to calculate photon cross-sections for scattering, photoelectric absorption, and pair production, as well as total attenuation coefficients, for any element, compound, or mixture.

Other Resources

ABC's of Nuclear Science
Web: http://www.lbl.gov/nsd/education/ABC/index.html

The ABC's of Nuclear Science is a brief introduction to nuclear science.

Radiation Information Network (RIN)
Idaho State University
Web: http://www.physics.isu.edu/radinf/

RIN provides information of basics of radiation.

The Regulation and Use of Radioisotopes in Today's World
US Nuclear Regulatory Commission
Web: http://www.nrc.gov/reading-rm/doc-collections/nuregs/brochures/br0217/

Good reference describing the many uses in industry, medicine, and research for radioactive material.

What You Need To Know About Radiation, 1996
Lauriston S. Taylor
Student Chapter of the Health Physics Society of the Idaho State University
Web: http://www.physics.isu.edu/radinf/lst.htm

Paper published by an icon in radiation protection, meant to provide an easy to understand description of radiation and its associated risks.

CHAPTER

45

Regulatory Toxicology

AMANDA S. PERSAD

INTRODUCTION

Interdependence exists between toxicology and regulatory development. Many government programs use the results of toxicology studies to support regulation of chemicals and other toxic substances. Some government programs impose regulations on the conduct of toxicology studies, while other programs have more informal methods of encouraging and promoting high-quality toxicology studies. This interplay between regulation and toxicology defines the construct of regulatory toxicology. For chemical regulation, the potential for human hazard from exposure, the magnitude of risk, the cost and consequence of regulation may be taken into account. In the U.S., regulatory bodies like the Environmental Protection Agency (EPA), the Food and Drug Administration (FDA), the Occupational Safety and Health Administration (OSHA), and the Consumer Product Safety Commission (CSPC) are responsible for regulating chemical hazards. Many agencies have prescribed testing standards for the conduct of toxicology research. For example, the FDA has established that investigational drugs must be evaluated in preclinical studies in order to protect human subjects in subsequent clinical trials (21 C.F.R. § 312.22, 2006).

In addition to imposing regulations on the conduct of toxicology studies, the regulatory process has promoted research in previously uncharted areas through the establishment of programs like the High Production Volume Challenge Program and the National Toxicology Program, and the passing of Acts like the 1976 Toxic Substances Control Act and the 1996 Food Quality Protection Act. In return, advances in toxicological research have offered cutting-edge tools to the regulatory community such as toxicogenomics, physiologically based pharmacokinetics, and alternatives to animal testing (Green 2006). With the ever-broadening knowledge base of toxicology, some regulatory decisions have been revisited and amended. For example, in 1996 the provision of the Food, Drug and Cosmetic Act applicable to pesticide residues on food was amended to allow pesticide residues that have a carcinogenic potential of less than 1 in a million. This decision was fueled by the understanding that carcinogenic potential is dependent on the dose and potency, and there is an exposure level below which the risk may be considered 'de minimus' or negligible (Merrill 2003).

This chapter provides an overview of resources in regulatory toxicology from the last 10 years.

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Merrill RA (2003) Regulatory Toxicology. In: Casarett & Doull's Essentials of Toxicology. New York: McGraw-Hill.

RESOURCES

Books

Ashford NA, Caldart CC (Eds.) (1996)
Technology, Law, and the Working Environment
Island Press, Washington, DC

Designed to provide an understanding of the roles of the agencies, courts, and industry and how technical, scientific, and economic considerations interface within the legal framework.

Benson BW, Lang PL (1998)
Handbook of Good Laboratory Practice
Taylor & Francis, Washington, DC

Provides a detailed analysis for the clear understanding of and compliance with GLP regulations for field and laboratory studies. Using key examples, the book details what each regulation means and why it is important to the process of safety evaluation. The book also offers practical means of implementation.

Candolfi, M. P. (2003)
Guidance Document on Regulatory Testing and Risk Assessment Procedures for Plant Protection Products with Non-Target Arthropods: From the Escort 2 Workshop (European Standard Characteristics of Non-Target Arthropod Regulatory Testing): BART , EPPO/CoE , OECD , and IOBC Workshop organized in conjunction with SETAC-Europe and EC
Society of Environmental Toxicology and Chemistry, Pensacola
Web: http://www.versailles.inra.fr/ssm/documents/doceval/eu/ecotox/ESCORT2.doc

Chengelis CP, Holson JF, Gad SC (Eds.) (2001)
Regulatory Toxicology, 2nd Edition
Taylor and Francis, New York

Presents a clear and practical guide to the government regulations that govern why and how toxicology/safety testing is done and how the results of such testing are reported and used in regulating the entry and use of products in the marketplace.

Cranor CF (1993)
Regulating Toxic Substances: A Philosophy of Science and the Law
Oxford University Press, New York

Addresses the role of science in the control of toxic substances through ethics, philosophy of law, epidemiology, tort law, regulatory law, and risk assessment.

Fisher LJ, Holmstead CR, Hayes DJ, Holmstead JR, Slater GS, Rawson WK, Winik PL (1995)
Toxic Substances and Pesticides Regulation Deskbook
Environmental Law Institute, Washington, DC

Provides full text for the currently existing 19 environmental laws. The book is designed to benefit anyone in the field by providing access to the text in an orderly and understandable fashion.

Geltman EG (1998)
Environmental Law Library
Lewis, Boca Raton, FL

In three volumes, this book presents a library of explanations of environmental regulations. Includes permit procedures and provides case law references.

Green S (Ed.) (2006)
Toxicology and Regulatory Process
Taylor and Francis Group, New York

Through the use of detailed examples, this book illustrates the relationship between toxicology and the regulation of chemicals, pharmaceuticals, herbal and nutritional supplements, and other food substances.

Hubbert WT, Hagstad HV, Hughes KL, Spangler E, Hinton MH (1996)
Food Safety and Quality Assurance: Foods of Animal Origin, 2nd Edition
Iowa State Press, Ames, IA

Basic reference for veterinarians, extension specialists, and others who help food-animal producers throughout the food chain to provide a safe product to consumers. This book covers both microbial and non-microbial agents, modern food-processing techniques, and social and political concerns in food safety and quality assurance.

Levine B (2003)
Principles of Forensic Toxicology, 2nd Edition
AACC Press, Washington, DC

Provides an introduction to postmortem forensic toxicology, analytical principles, including both theory and applications, methodologies, and commonly encountered analytes, including alcohol, benzodiazepines, γ-hydroxybutyrate, miscellaneous central nervous system depressants, opioids, cocaine, marijuana, amfetamines/sympathomimetic amines, hallucinogens, anticonvulsants, antiarrhythmics, antidepressants, neuroleptics, carbon monoxide/cyanide, inhalants, and metals.

Marcus PA, Willig JT (Eds.) (1997)
Improving Environmental Management and Advancing Sustainable Development
Wiley, New York

Focuses on the implementation of the ISO 14,000 program by the industrial community. The book contains five sections dealing with the global challenge of voluntary management standards; gaining support within a company; registration, certification, and implementation issues; implementation impact and tools; and advancing sustainable development as a competitive tool.

Marrs TC, Ballantyne B (Eds.) (2003)
Pesticide Toxicology and International Regulation
Wiley, John & Sons, West Sussex, UK

Provides a global prospective of how major classes of insecticides, fungicides, and herbicides are regulated. The book also discusses occupational risk to pesticides as well as poisoning through contaminated foodstuffs.

Montgomery L (1995)
Health and Safety Guidelines for the Laboratory
ASCP Press, Chicago, IL

Describes the essentials of the standards, interpreting the basic requirements for compliance and the scope and terminology of the hazard communication standard, the formaldehyde standard, the occupational exposures to hazardous chemicals in laboratories standard, and the bloodborne pathogen standard.

O'Neil MJ (2006)
The Merck Index: An Encyclopedia of Chemicals, Drugs, and Biologicals, 14th Edition
John Wiley & Sons, Hoboken, NJ

Provides an index of chemicals, drugs, and biologicals that contains more than 10 000 monographs with each monograph providing a concise description of a single substance or a small group of closely related compounds.

Pisano DJ, Mantus D (Eds.) (2003)
FDA Regulatory Affairs: A Guide for Prescription Drugs, Medical Devices, and Biologics
CRC Press, Boca Raton, FL

Examines the key aspects of the drug approval process taking into account the Federal Food, Drug and Cosmetic Act, Current Good Manufacturing Practices, Good Clinical Practices, Quality System Compliance, and FDA inspection processes and enforcement options.

van Leeuwen CJ, Vermeire TG (Eds.) (2007)
Risk Assessment of Chemicals: An Introduction, 2nd Edition
Springer, Netherlands

A concise guide that provides background and training material on five major areas, including: (1) risk management of industrial chemicals, (2) exposure assessment, (3) human health and ecological effects assessment and risk characterization, (4) data and data estimation, and (5) risk assessment and management of chemicals in the EU (REACH), U.S.A., Japan, and Canada.

Zeiger E, Auletta A, Cavagnaro J (1997)
Validation and Regulatory Acceptance of Toxicological Test Methods
DIANE Publishing Company, Darby

Review of methods being developed and implemented to better understand biologic mechanisms behind toxicological processes.

Journals

Clinical Research and Regulatory Affairs (1983–)
Taylor and Francis, Philadelphia

Rapid communication, peer-reviewed journal that publishes original, scientific articles that pertain to advancements in clinical research and regulatory affairs in the area of drug, device, and biological development.

Food and Drug Law Journal (1945–)
Food and Drug Law Institute, United States
Web: http://www.fdli.org/pubs/Journal%20Online/

Publishes in-depth, analytical articles, providing insight into the actions of the U.S. Food and Drug Administration, the U.S. Federal Trade Commission, and the U.S. Department of Agriculture, how the courts interpret these actions, and the reaction of industry.

Regulatory Toxicology and Pharmacology (1981–)
Academic Press, Danvers

Includes peer-reviewed articles on issues that surround the generation, evaluation, and interpretation of experimental animal and human data as well as the interpretation of scientific knowledge as it influences regulatory decision-making.

Journal Articles

American College of Toxicology (2004) American College of Toxicology: policy statement on the use of animals in toxicology. Int. J. Toxicol. 23(1): 2. p following 1.

Anonymous (2003) Report of the IFSTP Professional Standards Subcommittee (PSSC). Toxicol. Pathol. 31: 562–565.

Basketter DA, et al (2002) Factors affecting thresholds in allergic contact dermatitis: safety and regulatory considerations. Contact Derm. 47: 1–6.

Berend K (2002) Good laboratory practice in the European Community. Role of the commission and the member states: external aspects. Ann. Ist. Super. Sanita. 38: 9–13.

Botham PA (2002) ECVAM, ECETOC and the EU chemicals policy. Altern. Lab. Anim. 30: 185–187.

Chan VS, Theilade MD (2005) The use of toxicogenomic data in risk assessment: a regulatory perspective. Clin. Toxicol. 43: 121–126.

Cimino MC (2006) Comparative overview of current international strategies and guidelines for genetic toxicology testing for regulatory purposes. Environ. Mol. Mutagen. 47: 362–390.

Collins TF (2006) History and evolution of reproductive and developmental toxicology guidelines. Curr. Pharm. Des. 12: 1449–1465.

Dykstra MJ, Mann PC, Elwell MR, et al (2002) Suggested Standard Operating Procedures (SOPs) for the preparation of electron microscopy samples for toxicology/pathology studies in a GLP environment. Toxicol. Pathol. 30: 735–743.

Gerner I, Spielmann H, Hoefer T, et al (2004) Regulatory use of (Q)SARs in toxicological hazard assessment strategies. SAR QSAR Environ. Res. 15: 359–366.

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Handy RD, Galloway TS, Depledge MH, et al (2003) A proposal for the use of biomarkers for the assessment of chronic pollution and in regulatory toxicology. Ecotoxicology 12: 331–343.

Huggins J (2003) Alternatives to animal testing: research, trends, validation, regulatory acceptance. ALTEX 20: 3–61.

Kimmel CA, Makris SL (2001) Recent developments in regulatory requirements for developmental toxicology. Toxicol. Lett. 120: 73–82.

Kramer CB, Cullen AC, Faustman EM, et al (2006) Policy implications of genetic information on regulation under the Clean Air Act: the case of particulate matter and asthmatics. Environ. Health Perspect. 114: 313–319.

Leighton JK (2005) Application of emerging technologies in toxicology and safety assessment: regulatory perspectives. Int. J. Toxicol. 24: 153–155.

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MacGregor JT (2003) The future of regulatory toxicology: impact of the biotechnology revolution. Toxicol. Sci. 75: 236–248.

Malmfors T, Di Marco P, Savolainen K (2004) Good Evaluation Practice: a proposal of guidelines. Toxicol. Lett. 151: 19–23.

Morris T, Goulet S, Morton D, et al (2002) The international symposium on regulatory testing and animal welfare: recommendations on best scientific practices for animal care in regulatory toxicology. ILAR J. 43: S123–S125.

Neil A (2004) Regulatory implication – the EU perspective. Ernst. Schering Res. Found. Workshop, 48: 135–150.

Pratt IS, Barron T (2003) Regulatory recognition of indirect genotoxicity mechanisms in the European Union. Toxicol. Lett. 140–141: 53–62.

Pugh DM (1997) The precautionary principle and scientific base limits in regulatory toxicology. Arch. Toxicol. Suppl. 19: 147–154.

Purchase IF (1999) Ethicial review of regulatory toxicology guidelines involving experiments on animals: the example of endocrine disrupters. Toxicol. Sci. 52: 141–147.

Schwenk M, Werner M, Younes M (2002) Regulatory toxicology: objectives and tasks defined by the working group of the German society of experimental and clinical pharmacology and toxicology. Toxicol. Lett. 126: 145–153.

Schwenk M, Gundert-Remy U, Heinemeyer G, et al (2003) Children as a sensitive subgroup and their role in regulatory toxicology: DGPT workshop report. Arch. Toxicol. 77: 2–6.

Smith RL, Cohen SM, Doull J, et al (2005) Criteria for the safety evaluation of flavoring substances. The Expert Panel of the Flavor and Extract Manufacturers Association. Food Chem. Toxicol. 43: 1141–1177.

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Stokes WS, Schechtman LM, Hill RN, et al (2002) The Interagency Coordinating Committee on the Validation of Alternative Methods (ICCVAM): a review of the ICCVAM test method evaluation process and current international collaborations with the European Centre for the Validation of Alternative Methods (ECVAM). Altern. Lab. Anim. 30: 23–32.

Travis KZ, Pate I, Welsh ZK, et al (2005) The role of the benchmark dose in a regulatory context. Regul. Toxicol. Pharmacol. 43: 280–291.

Watson A, Opresko D, Young R, et al (2006) Development and application of acute exposure guideline levels (AEGLs) for chemical warfare nerve and sulfur mustard agents. J. Toxicol. Environ. Health B. Crit. Rev. 9: 173–263.

Weinberg WC, Frazier-Jessen MR, Wu WJ, et al (2005) Development and regulation of monoclonal antibody

products: challenges and opportunities. Cancer Metastasis Rev. 24: 569–584.

Weinstein M, Widenor M, Hecker S (2005) Health and employment practices: ethical, legal, and social implications of advances in toxicogenomics. AAOHN J. 53: 529–533.

Wu KM, Farrelly J, Birnkrant D, et al (2004) Regulatory toxicology perspectives on the development of botanical drug products in the United States. Am. J. Ther. 11: 213–217.

Organizations

Environmental Law Institute
2000 L Street, NW, Suite 620
Washington, DC 20036
Phone: 202-939-3800
Fax: 202-939-3868
Email: law@eli.org
Web: http://www.eli.org

A non-profit, tax-exempt organization that provides information in the form of publications (*Environmental Law Reporter* and *The Environmental Forum*), training courses, seminars, and research programs on environmental issues. The organization also offers advice and policy recommendations regarding these issues.

The Food Drug and Law Institute
1155 15th Street, NW, Suite 800
Phone: 800-956-6293, 202-371-1420
Fax: 202-371-0649
Email: Comments@fdli.org
Web: http://www.fdli.org

A non-profit organization that provides education and training in the practice of food and drug law and regulation. FDLI also publishes the peer-reviewed *Food and Drug Law Journal*, among other publications.

Government Institutes
Scarecrow Press, Inc.
15200 NBN Way, Building B
Blue Ridge Summit, PA 17214
Phone: 800-462-6420, 717-794-3800
Fax: 800-338-4550, 717-794-3803
Email: custserv@rowman.com
Web: http://www.govinstpress.com

The institute provides information and training on a host of topics relevant to environmental, health, and safety professionals.

International Life Sciences Institute
One Thomas Circle, NW, 9th Floor
Washington, DC 20005
Phone: 202-659-0074
Fax: 202-659-3859
E-mail: ilsi@ilsi.org
Web: http://www.ilsi.org

An international non-profit foundation that is committed to furthering the understanding of scientific issues such as environmental concerns, food safety, toxicology, and risk assessment.

ILSI is affiliated with the World Health Organization and is involved in projects with the International Agency for Research on Cancer and the International Programme on Chemical Safety.

International Society for Regulatory Toxicology and Pharmacology
6546 Belleview Drive
Columbia, MD 21046
Phone: 410-992-9083
Fax: 410-740-9181
Web: http://www.isrtp.org

An organization that provides an open public forum for both scientists and policy makers to discuss and promote toxicology and pharmacology. The Society sponsors the peer-reviewed journal *Regulatory Toxicology and Pharmacology.*

Regulatory and Safety Evaluation Specialty Section (RSESS)
Society of Toxicology
1821 Michael Faraday Drive, Suite 300
Reston, Virginia 20190
Phone: 703-438-3115
Fax: 703-438-3113
Email: sothq@toxicology.org
Web: http://www.toxicology.org/ISOT/SS/regulatorysafety/

A specialty section within the Society of Toxicology that promotes the development of sound governmental policies and regulations based on contemporary scientific knowledge arising from the disciplines encompassed by the field of toxicology.

Society for Risk Analysis
1313 Dolley Madison Blvd, Suite 402
McLean, VA 22101
Phone: 703-790-1745
Email: sra@burkinc.com
Web: http://www.sra.org

Society that provides an open forum for scientists interested in all related aspects of risk analysis. The Society promotes dialogue and discussion of risk assessment through annual meetings and the publication of the peer-reviewed journal *Risk Analysis.*

Other Resources

Brown F, Peden K, Lewis AM (Eds.) (2001)
Evolving Scientific and Regulatory Perspectives on Cell Substrates for Vaccine Development, Vol. 106
Karger, S. Inc., Rockville

International Society for Regulatory Toxicology and Pharmacology

International Society for Regulatory Toxicology and Pharmacology Newsletter

U.S. Food and Drug Administration (2007)
Orange Book (electronic) – Approved Drug Products with Therapeutic Equivalence Evaluations
Web: http://www.fda.gov/cder/ob/default.htm

The Electronic Orange Book Query enables searching of the approved drug list by active ingredient, proprietary name, applicant holder, or applicant number. The data are updated concurrently with the publication of the annual edition or cumulative supplements.

Daughton CG, Jones-Lepp, T.L. (Eds.) (2001)
Pharmaceuticals and Personal Care Products in the Environment: Scientific and Regulatory Issues (ACS Symposium Series)
American Chemical Society, Washington, DC

U.S Food and Drug Administration (2006)
Redbook 2000: Toxicological Principles for the Safety Assessment of Food Ingredients
Web: http://www.cfsan.fda.gov/~redbook/red-toca.html

CHAPTER

46

Risk Assessment

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INTRODUCTION

The concept of weighing risks and benefits dates back to antiquity. Over the last 50 years, with the escalating number of chemicals in the environment, regulatory agencies have been forced to address the issue of the adverse health risks from potential exposure. Nurtured by regulatory decision-making, the discipline of science-based risk assessment emerged in the 1950s, and gained momentum in the 1970s with the advent of human health risk assessment. Though science-based risk assessment includes both human health risk assessment and ecological risk assessment, the term 'risk assessment' in toxicology generally refers to the former.

Within the scope of toxicology, human health risk assessment is defined as the 'systematic scientific characterization of potential adverse health effects resulting from human exposures to hazardous agents or situations' (Faustman & Omenn 2003). It is a process by which toxicology, epidemiology, and environmental research are meshed to provide an overall understanding of risk. Risk assessments are used (1) as input to cost–benefit analyses (e.g., in terms of balancing drug and pesticide safety and efficacy), (2) to set target levels of risk, (3) to set priorities for program activities, and (4) to estimate residual risks and extent of risk reduction upon implementation of risk-reduction efforts (Faustman & Omenn 2003).

Human health risk assessment does not exist in a vacuum, but rather is part of a larger framework that includes synthesizing information from basic research and providing scientific support to risk management decision making and risk communication. Globally, one of the most accepted risk assessment/risk management frameworks is the paradigm put forth by the National Research Council (NRC) of the U.S. National Academy of Sciences (NRC 1983). According to this paradigm, risk assessment is comprised of four steps or components: hazard identification, dose–response assessment, exposure assessment, and risk characterization. The last step combines information from the first three steps to provide an estimate of the risk. This approach can be tiered and iterative, depending on the goals and needs of the risk assessment, and the available data and possible ways to manage the risks.

Hazard identification, the first in the four-step risk assessment paradigm, is the process used to determine whether exposure to a chemical or other agent may result in an adverse human health effect. Hazard identification relies on information from animal and epidemiology studies and, to a lesser extent, in vitro assays and structure/activity relationships. Decisions or conclusions from this step are often synthesized and described in terms of a weight or level of evidence. Once a hazard has been identified, a dose–response assessment, the second step in the risk assessment paradigm, is performed to describe the relationship between the dose or concentration of the chemical and the incidence of disease or adverse health effect in exposed groups. The resulting data are plotted to produce a dose–response curve, which is an integral part of determining quantitative estimates for risk characterization. In constructing and interpreting a dose–response curve, a number of factors are considered including intensity and pattern of exposure, individual differences in susceptibility, and the relevance of the risk to humans if results from animal bioassays were utilized. The underlying goal of exposure

assessment, the third step in the risk assessment process, is to determine the amount of the chemical or agent that is reaching the target tissues. Here the focus is on the exposure itself and involves gathering information on the intensity, frequency, and duration of human exposure or estimating exposures from the release of chemicals into the environment and calculating the level of total exposure. Risk characterization is the culminating step in which information from the hazard identification, dose–response assessment, and the exposure assessment are synthesized in an effort to characterize risk for a particular chemical or agent. Risk characterization is dependent on the preceding steps in the risk assessment process.

Though this risk assessment paradigm has been incorporated by public health and regulatory agencies worldwide, many organizations have developed guidance for evaluating and quantifying risk. To help implement the Registration, Evaluation, Authorisation, and Restriction of CHemicals (REACH) legislation, the European Commission and the European Chemicals Agency has developed technical guidance documents and associated databases for industry to conduct chemical safety assessments (EC 2006, ECHA 2008). These assessments will need to demonstrate that the intended uses and reasonably foreseeable exposures associated with the lifecycle of a REACH-impacted chemical are safe for the people and the environment in all EU member states. In addition, as a possible tool for use in REACH, the European Centre for Ecotoxicology and Toxicology of Chemicals (ECETOC) has developed a framework to perform efficient risk assessments on the large volume of assigned chemicals (ECETOC 2004). This risk assessment process, known as targeted risk assessment, entails a three-tiered or step-wise approach for identifying and prioritizing the assessment of risk based on the characteristics of potential exposure. The first tier, Tier 0, is designed to screen chemicals and conditions with general exposure or low hazard potential out of the process. Chemicals and conditions that survive through Tier 0 are evaluated in Tier 1, a process that distinguishes chemicals or conditions that require 'no further risk assessment' from those that require more detailed investigation. Tier 1 uses key exposure scenarios, predicted exposures, and a generic hazard evaluation. This tier relies on the cooperation between producers and the downstream users to identify the potential hazards of these chemicals. Chemicals not eliminated from further review in Tier 1 undergo detailed risk assessment in Tier 2, using a framework similar to the NRC's four-step risk assessment process.

Similar in principle to human health risk assessment, ecological risk assessment is the process that evaluates the likelihood that an adverse effect may occur as a result of exposure to a stressor (EPA 1998). These assessments are used to (1) predict future adverse effects, (2) evaluate a resource and factors that might impact or affect that resource, and (3) determine causative factors for an observed effect (Sergeant 2002). The ecological risk assessment paradigm is comprised of three major steps or components: problem formulation, analysis, and risk characterization. The problem formulation step involves the collaboration of risk assessors, risk managers, and interested parties. This step structures the analysis, which entails characterizing exposure and ecological effects. Analogous to NRC's risk assessment paradigm, risk characterization in ecological risk assessment integrates exposure and ecological effects as it describes the risk. Unlike human hazard risk assessment, ecological risk assessment often does not follow a sequential format but involves interaction of the different components (Sergeant 2002).

The development of sophisticated tools and methodologies in toxicology, epidemiology, and statistics has fuelled refinement of risk assessment estimates. With the advent of physiologically based pharmacokinetics (PBPK) modeling, chemical-specific adjustment factors (CSAF), and body weight scaling, more precise risk estimates can be derived. Additionally, the use of biomarkers has aided in better exposure assessment.

Today, risk assessment research has widespread applications and influences fields that may seem far removed from its regulatory toxicology roots. For example, in the field of international trade law, under the Sanitary and Phytosanitary (SPS) Agreement, countries wishing to implement food safety or pest control measures that impact trade must provide scientific evidence in the form of a risk assessment to establish and maintain such measures (Lugard & Smart 2006).

This chapter provides resources for both human health and ecological risk assessment. The information resources provided are presented in the following order: 'Books', 'Journals', 'Journal articles', 'Organizations', 'Databases', and 'Other resources'. Since government agencies are a continual source of guidelines and information on different aspects of risk assessment, a compilation of each agency's general risk assessment documents is provided in the 'Other resources' section.

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No 793/93 and Commission Regulation (EC) No 1488/94 as well as Council Directive 76/769/EEC and Commission Directives 91/155/EEC. 93/67/EEC, 93/105/EC and 2000/21/EC.

ECETOC (2004) Targeted Risk Assessment. Technical Report No. 93, European Centre for Ecotoxicology and Toxicology of Chemicals, Brussels.

ECHA (2008) Guidance on information requirements and chemical safety assessment. Part A: Introduction to the Guidance Document. Guidance for the implementation of REACH, 1–44.

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Faustman EM, Omenn GS (2003) Risk Assessment. In: Casarett & Doull's Essentials of Toxicology. McGraw-Hill, New York.

Lugard A, Smart M (2006) The role of science in international trade law. Reg. Toxicol. Pharmacol. 44: 69–74.

NRC (1983) Risk Assessment in the Federal Government: Managing the Process. National Academy Press, Washington, DC.

Sergeant A (2002) Ecological Risk Assessment: History and Fundamentals. In: Human and Ecological Risk Assessment. Wiley-Interscience, New York.

RESOURCES

Books

Asante-Duah, D.K. (2002)
Public Health Risk Assessment for Human Exposure to Chemicals
Kluwer Academic Publishers, Norwell

Geared towards both students and professionals in health-related and environmental disciplines. This book presents important tools and methodologies for assessing risk from exposure to chemicals both within the workplace and in the general environment.

Bahr NJ (1997)
System Safety Engineering and Risk Assessment: A Practical Approach
Taylor & Francis Group, New York

A comprehensive, practical guide on how to build safety into products and industrial processes. Includes how to implement a cost-effective safety management program, how to set up data management systems, how to set up an accident investigation board, and how to carry out risk assessment and risk evaluation.

Bateman M (2006)
Tolley's Practical Risk Assessment Handbook, 5th Edition
Butterworth-Heinemann, Oxford, UK

Comprehensive overview of risk assessment as it relates to legislation in the United Kingdom. In addition to risk assessment principles, this book covers key aspects of Control of Substances Hazardous to Health (COSHH) regulations and Dangerous Substances and Explosive Atmospheres Regulations (DSEAR).

Colditz G, Stein CJ (2003)
Handbook of Cancer Risk Assessment and Prevention
Jones and Bartlett Publishers, Boston, MA

Designed as a practical guide for healthcare providers. This handbook presents in depth information on over a dozen of the most common cancers in the U.S. and key lifestyle behaviors that can impact cancer risks.

Chyczewski L, Pluygers E, Niklinski J (2002)
Endocrine Disrupters and Carcinogenic Risk Assessment
IOS Press, Amsterdam

Focuses on biologically based risk assessment and the development of biologically based models of carcinogenesis.

Edler L, Kitsos CP (Eds.) (2005)
Quantitative Methods for Cancer and Human Health Risk Assessment
J. Wiley, New York

Comprehensive text covering biological, toxicological, and medical approaches in the risk assessment of both cancer and non-cancer endpoints.

Eisler R (2000)
Handbook of Chemical Risk Assessment: Health Hazards to Humans, Plants, and Animals, Three Volume Set
CRC Press, Boca Raton, FL

Compilation of chemicals introduced into the environment from human activity. For each chemical, information regarding physical, chemical, and metabolic properties as well as uses, adverse effects, and proposed regulatory criteria for the protection of human health and the environment are presented.

European Monitoring Centre for Drugs and Drug Addiction (1999)
Guidelines for the Risk Assessment of New Synthetic Drugs
Office for Official Publications of the European Communities, Luxembourg

Provides a history to the European Union's Joint Action concerning the information exchange, risk assessment and control of new synthetic drugs, with discussion on how it operates, along with an outline of the basic principles, a conceptual framework, and quality information for future risk assessments.

Flaherty DK (1999)
Immunotoxicology and Risk Assessment
Kluwer Academic Publishers, New York

Describes basic immunological principles, in terms of toxicology and risk assessment, at the cellular and molecular level.

Forsythe S (2002)
The Microbiological Risk Assessment of Food
Blackwell Science, Danvers

Presents basic tenets of microbial risk assessment (MRA) as well as practical information on how to implement such programs. This user-friendly book illustrates MRA implementation through case studies.

Frantzen KA (Ed.) (2001)
Risk-Based Analysis for Environmental Managers
CRC Press, Danvers

Practical guide on how to integrate the risk assessment process into impact decision making.

Goehl TJ (Ed.) (2004)
Genomics And Risk Assessment: A Reprint from the Journal, Environmental Health Perspectives
Diane Publishing Company, Darby

A mini-monograph containing over a dozen articles on the application of genomics in risk assessment.

Greenberg BM, Hull RN, Roberts Jr, MH, Gensemer RW (Eds.) (2001)
Environmental Toxicology and Risk Assessment: Science, Policy, and Standardization – Implications for Environmental Decisions, 10th Volume
ASTM International, West Conshohocken

Tenth volume in a series of books on environmental toxicology and risk assessment. Other books in this series include *Recent Achievements in Environmental Fate and Transport, Modeling in Risk Assessment, Standardization of Biomarkers for Endocrine Disrupters*.

Jayjock MA, Lynch J, Nelson DI (Eds.) (2000)
Risk Assessment Principles for the Industrial Hygienist
American Industrial Hygiene Association, Fairfax

Presents risk assessment principles as it applies to industrial hygienists and environmental scientists. In addition to the basic tenets, the book discusses the integration of risk assessment and industrial hygiene.

Kruse J, Verhaar H, De Raat WK (Eds.) (2002)
The Practical Applicability of Toxicokinetic Models in the Risk Assessment of Chemicals
Kluwer Academic Publishers, Dordrecht

Based on the two-day symposium by the OpdenKamp Registration and Notification in 2000. Some of the topics include occupational toxicology and monitoring, exposure to organic solvents, dose–response relationship in carcinogenicity, and species to species extrapolation.

Lalloo F, Kerr B, Friedman JM, Evans DG (Eds.) (2005)
Risk Assessment And Management in Cancer Genetics
Oxford University Press, Oxford

Practical guide designed for healthcare professionals. This book outlines risk assessment and risk management through common familial cancers.

Lerche I, Glaesser W (2006)
Environmental Risk Assessment – Quantitative Measures, Anthropogenic Influences, Human Impact
Springer-Verlag, Berlin

Focuses on environmental and health risk problems related to contamination. The book includes discussion on sparse datasets and political, social and economical issues with regard to environmental contamination and human health.

Lipscomb JC, Ohanian GW (Eds.) (2006)
Toxicokinetics And Risk Assessment
Informa Healthcare, Richmond

Describes the non-cancer risk assessment process and the application of physiologically based pharmacokinetic (PBPK) modeling in human health risk assessment. Through examples, this text demonstrates the use of toxicokinetics as a means of better informing values for uncertainty factors.

National Research Council (NRC) (1983)
Risk Assessment in the Federal Government: Managing the Process
National Academy Press, Washington, DC.

Provides case studies on formaldehyde, nitrite, and asbestos and an in-depth discussion of a four-step risk assessment paradigm, consisting of hazard identification, dose–response assessment, exposure assessment, and risk characterization.

National Research Council (2000)
Scientific Frontiers in Developmental Toxicology and Risk Assessment

National Academy Press, Washington, DC

Presents the current approaches used in developmental defects risk assessment. This book identifies key areas of uncertainty and evaluates the current understanding of the mechanisms of action of chemicals in terms of developmental defects.

Ostergaard G, Larsen JC, Nielsen E (2007)
Principles of Toxicologic Risk Assessment
Taylor & Francis, Boca Raton

Presents key aspects of conducting toxicological risk assessments. In addition to providing an in-depth perspective of the risk assessment paradigm, this book discusses different approaches to regarding the evaluation of chemical mixtures.

Pastorok RA, Bartell SM, Ferson S, Ginzburg LR (Eds.) (2001)
Ecological Modeling in Risk Assessment: Chemical Effects on Populations, Ecosystems and Landscapes
CRC Press, Danvers

Comprehensive text that describes ecological models and their potential use in risk assessment.

Paustenbach DJ (Ed.) (2002)
Human and Ecological Risk Assessment: Theory and Practice
Wiley-Interscience, New York

Comprehensive resources on different aspects of risk assessment. This book serves as a textbook for understanding the basic tenets of risk assessment and as a 'how-to' guide in conducting and interpreting risk assessments.

Pellston Workshop on Multiple Stressors in Ecological Risk Management, Jeffery Allen Foran, Susan A Ferenc, SETAC (Society), SETAC Foundation for Environmental Education (1999)
Multiple Stressors in Ecological Risk and Impact Assessment
SETAC Foundation, Pensacola

Based on a 1997 workshop by the ILSI Risk Science Institute and the Society of Environmental Toxicology and Chemistry (SETAC). The workshop was aimed at developing a framework to assess, compare, and manage the impacts of multiple stressors on biological systems.

Reddy MB, Yang RSH, Clewell III HJ, Andersen ME (2005)
Physiologically Based Pharmacokinetic Modeling: Science and Applications
John Wily & Sons, Hoboken

Describes the development and application of physiologically based pharmacokinetic modeling to an array of chemicals and mixtures.

Ricci PF (2005)
Environmental and Health Risk Assessment and Management: Principles and Practices
Springer, Dordrecht

Discusses the legal, economic, and practical assessment and management surrounding risk via exposure to environmental and occupational hazards. The book addresses issues such as environmental and health law, environmental economics, and risk-based methodologies.

Sadhra SS, Rampal KG (Eds.) (1999)
Occupational Health: Risk Assessment and Management
Blackwell Science, Malden

Covers risk assessment and management as it pertains to occupational health. Geared towards health and safety managers, industrial hygienists, and healthcare professionals, this book provides both a theoretical and practical approach to occupational health issues.

Salem H, Olajos E (Eds.) (1999)
Toxicology in Risk Assessment
Taylor & Francis, Philadelphia

A broad-based practical guide to risk assessment. This book provides detailed insight into risk assessment, risk management, and risk communication and discussion on ethical, legal, and economic implications.

Scheringer M (2002)
Persistence and Spatial Range of Environmental Chemicals – New Ethical and Scientific Concepts for Risk Assessment
Wiley-VCH, Weinheim

Introduces the concept of persistence and spatial range as measures of environmental threats.

Shields PG (Ed.) (2005)
Cancer Risk Assessment
Marcel Dekker Incorporated, New York

Presents cancer risk assessment by taking into account the evaluation of etiological agents, real-world environments, and individual rates of exposure.

Shields PG (2005)
Methods for Cancer Risk Assessment
Taylor & Francis, Boca Raton

Provides a practical approach to conducting risk assessment utilizing biomarkers and taking into account genetic susceptibilities.

Sonnemann G, Castells F, Schuhmacher M (2003)
Integrated Life-Cycle and Risk Assessment for Industrial Processes
CRC Press, Boca Raton

Describes the combined use of life-cycle assessment and risk assessment in estimating environmental damage. This book serves as a practical resource for environmental analysis and decision making.

Suter GW, Efroymson R, Sample BE, Jones DS (2000)
Ecological Risk Assessment for Contaminated Sites
CRC Press, Boca Raton

Focuses on how to perform ecological risk assessments for Superfund sites and locations contaminated by improper waste disposal or chemical spills.

Tweeddale M (2003)
Managing Risk and Reliability of Process Plants
Elsevier, Burlington

Provides a systematic and integrated approach to risk assessment, risk analysis, and risk management. The text uses case studies and worked examples to illustrate concepts throughout the book.

United Nations Environment Programme, International Labour Organisation, World Health Organisation (2004)
IPCS Risk Assessment Terminology
World Health Organisation, Geneva

Compilation of internationally harmonized generic and technical terms used in risk assessment.

United Nations Environment Programme, International Labour Organisation, World Health Organization, Inter-Organization Programme for the Sound Management of Chemicals, International Program on Chemical Safety, WHO Task Group on Environmental Health Criteria for Human Health: Principles and Approaches (2001)
Neurotoxicity Risk Assessment for Human Health
World Health Organization, Geneva

Summarizes the scientific knowledge base on which principles and methods involved in neurotoxicity risk assessment are based. Provides a framework for public health officials, research and regulatory scientists, and risk managers on the use and interpretation of neurotoxicity data from human and animal studies.

U.S. Environmental Protection Agency (1995)
Risk Assessment Methodologies for Toxic Air Pollutants
Government Institutes, Rockville

Handbook describing methods for estimating risks from toxic air pollutants.

van Leeuwen CJ, Vermeire TG (2007)
Risk Assessment of Chemicals: An Introduction, 2nd Edition
Springer, The Netherlands

A concise guide that provides background and training material on five major areas, including: (1) risk management of industrial chemicals, (2) exposure assessment, (3) human health and ecological effects assessment and risk characterization, (4) data and data estimation, and (5) risk assessment and management of chemicals in the EU (REACH), U.S., Japan, and Canada.

World Health Organisation (2005)
Chemical Safety of Drinking-water Assessing Priorities for Risk Assessment
Renouf Publishing Company, Ottawa

Provides guidance of the chemical safety of drinking water. This book is designed to assist users at both a local and national level establish which chemicals should be given priority in developing strategies for risk management and monitoring.

Journals

Human and Ecological Risk Assessment (1995–)
Web: http://www.aehs.com/journals/humanandecojournal/

Aimed at providing a framework for professionals researching and assessing developments in both human and ecological risk assessments.

Journal of Risk Research (1998–)
Taylor and Francis, London

Publishes theoretical and empirical research articles relating to risk analysis from a broad spectrum of disciplines.

Regulatory Toxicology and Pharmacology (1981–)
Academic Press, Danvers

Includes peer-reviewed articles on issues that surround the generation, evaluation, and interpretation of experimental animal and human data as well as the interpretation of scientific knowledge as it influences regulatory decision-making.

Risk Analysis (1981–)
Blackwell Publishing

Publishes empirical research and commentaries dealing with risk issues as well as conference proceedings from the Society for Risk Analysis annual meetings.

Risk: Health, Safety, and Environment (1990–2002)
Web: http://www.piercelaw.edu/risk/profRisk.htm

Publication of the Franklin Pierce Law Center; journal currently inactive.

Stochastic Environmental Research and Risk Assessment (1987–)
Springer, Berlin

Publishes research papers, reviews and technical notes on stochastic and probabilistic approaches to environmental sciences and engineering.

Journal Articles

Albertini RJ, Anderson D, Douglas GR, et al (2000) IPCS guidelines for the monitoring of genotoxic effects of carcinogens in humans. Mutat. Res. 463: 111–172.

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Organizations

California EPA – Office of Environmental Health Hazard Assessment
1001 I Street
Post Office Box 4010
Sacramento, CA 95812
Phone: (916) 324-7572
Web: http://www.oehha.ca.gov/

Develops health-protective exposure standards for air, water, and land to recommend to regulatory agencies. The office also maintains its publicly available *Toxicity Criteria Database* and provides toxicological information to aide in the risk assessment process.

CIIT Centers for Health Research
6 Davis Drive
P.O. Box 12137
Research Triangle Park, NC 27709-2137
Phone: 919-558-1200
Web: http://www.ciit.org/

Private, not-for-profit research organization created to promote the use of the best possible science for human health risk assessments and to enhances public health by conducting leading-edge, interdisciplinary research that elucidates the mechanisms of action of chemicals in biological systems.

European Centre for Ecotoxicology and Toxicology of Chemicals (ECETOC)
Avenue Edmond Van Nieuwenhuyse 4 Bte 6
B-1160 Brussels, Belgium
Phone: 32-2-675-3600
Fax: 32-2-675-3625
Email: info@ecetoc.org
Web: http://www.ecetoc.org

European center that promotes the use of sound science in the assessment of human health effects and environmental impact of chemicals. ECETOC provides a forum for regulators and scientists to evaluate the safe use of chemicals.

European Chemicals Agency (ECHA)
Annankatu 18
00120 Helsinki, Finland
Phone: 358-9-686180
Email: http://echa.europa.eu/about/contact.asp
Web: http://echa.europa.eu/

Manages and carries out the technical, scientific, and administrative aspects of REACH. Provides the Member States and the institutions of the Community with the best possible scientific and technical advice on questions relating to chemicals, which fall under REACH. Manages IT-based guidance documents, tools, and databases, and ensures that information on chemicals is publicly accessible.

Consumer Products Safety & Quality Unit, Formerly Known as the European Chemicals Bureau (ECB)
TP582
Institute for Health and Consumer Protection
Joint Research Centre, Ispra Site

European Commission
Via fermi 1
I-21020 Ispra (VA), Italy
Web: http://ecb.jrc.it

Provides scientific and technical support for the implementation of EU legislation regarding the safe use of chemicals. The ECB coordinates risk assessment programs, drafts technical guidance on risk assessment, and provides information on legal classification and labeling, QSAR and REACH.

Harvard Center for Risk Analysis
Landmark Center
P.O. Box 15677
401 Park Dr.
Boston MA 02215
Phone: 617-998-1039
Fax: 617-384-8859
Email: hcra@hsph.harvard.edu
Web: http://www.hcra.harvard.edu

Focuses on research and education on risk analysis and other related disciplines. Additionally, the Center strives to further public discourse on risk through the publication of their newsletter *Risk in Perspective*.

Health Canada – Environmental & Workplace Health
Environmental Health Assessment Services
Health Canada
269 Laurier Ave. 5th Floor, A.L. 4905B
Ottawa, Ontario K1A 0K9 Canada
Phone: (613) 948-2875
Web: http://www.hc-sc.gc.ca/ewh-semt/index_e.html

Provides information on human health and environmental risk assessments by establishing tools and guidance and conducting training to aide in the risk assessment process.

Institute of Environment and Health
Interdepartmental Group on Health Risks from Chemicals (IGHRC)
Cranfield University
Silsoe, Bedfordshire MK45 4DT, UK
Phone: +44 (0) 1525 863002
Web: http://www.silsoe.cranfield.ac.uk/ieh/

The IGHRC comprises representatives of UK government departments, research councils, and agencies, and aims to stimulate the development of new improved approaches to the assessment of risks to human health from chemicals.

International Agency for Research on Cancer (IARC)
150 Cours Albert Thomas
69372 Lyon CEDEX 08, France
Phone: +33 (0)4 72 73 84 85
Fax: +33 (0)4 72 73 85 75
Email: www@iarc.fr
Web: http://www.iarc.fr

Part of the World Health Organization, responsible for the coordinating and conducting research on human cancer etiology. Publications are an integral part of the IARC's mission producing monographs on over 900 substances evaluating carcinogenic risk as well as other handbooks and manuals that aide in the risk assessment process.

International Programme on Chemical Safety (IPCS)
International Labor Organisation, United Nations Environmental Program, World Health Organisation
20 Avenue Appia
CH-1211 Geneva 27, Switzerland
Phone: +41 22 791 3590
Fax: +41 22 791 4848
Web: http://www.who.int/ipcs

Repository of information on chemical risks to human health, methods for chemical assessment, chemicals in food and poison information. IPCS houses a number of publications, databases and tools for risk assessment including the Concise International Chemical Assessment Documents (CICADs) listing, Environmental Health Criteria (EHC) documents, INCHEM search tool, INTOX databank, Pesticide Safety Data Sheets, and International Chemical Safety Cards.

International Life Sciences Institute (ILSI)
One Thomas Circle, NW, 9th Floor
Washington, DC 20005
Phone: 202-659-0074
Fax: 202-659-3859
Email: ilsi@ilsi.org
Web: http://www.ilsi.org

An international non-profit foundation that is committed to furthering the understanding of scientific issues such as environmental concerns, food safety, toxicology, and risk assessment.

ILSI is affiliated with the World Health Organization and is involved in projects with the International Agency for Research on Cancer and the International Programme on Chemical Safety.

International Society of Exposure Science (ISES, formerly International Society of Expossure Analysis, ISEA)
c/o JSI Research and Training Institute
44 Farnsworth Street
Boston, MA 02210

Phone: 617-482-9485
Fax: 617-482-0617
Web: http://www.iseaweb.org

Founded to foster and advance the field of exposure analysis in both human populations and the environment. This Society encourages scientific discussion on exposure analysis through annual meetings and is also responsible for the publication of the recently renamed *Journal of Exposure Science and Environmental Epidemiology*.

National Center for Environmental Assessment (NCEA)
U.S. Environmental Protection Agency
Email: ncea.webmaster@epa.gov
Web: http://www.epa.gov/ncea

Repository of guidance documents, tools, and databases on human health and ecological risk assessment. The Center houses the Integrated Risk Information System (IRIS), and Causal Analysis/Diagnosis Decision Information System (CADDIS) as well as tools such as benchmark dose software and Flowthru data reader and other modeling documentation.

Risk Assessment Forum
U.S. Environmental Protection Agency
Email: risk.forum@epa.gov
Web: http://cfpub.epa.gov/ncea/raf/index.cfm

Formally part of the National Center of Environmental Assessment, this forum, now under direct supervision of the U.S. EPA's Office of the Assistant Administrator, serves as a standing committee of senior EPA scientists promoting Agency-wide consensus on difficult and controversial risk assessment issues.

Society for Risk Analysis
1313 Dolley Madison Blvd, Suite 402
McLean, VA 22101
Phone: 703-790-1745
Email: sra@burkinc.com
Web: http://www.sra.org

Society that provides an open forum for scientists interested in all related aspects of risk analysis. The Society promotes dialogue and discussion of risk assessment through annual meetings and the publication of the peer-reviewed journal *Risk Analysis.*

Toxicology Excellence for Risk Assessment (TERA)
2300 Montana Avenue, Suite 409
Cincinnati OH 45211
Phone: 513-542-7475
Fax: 513-542-7487
Email: tera@tera.org
Web: http://www.tera.org

A non-profit, 501(c)(3) corporation that is focused on developing and communicating risk assessment information. TERA maintains the International Toxicity Estimates for Risk (ITER) database, provides risk assessment values for chemicals through their Verifiable Estimates for Risk Assessment (VERA), and facilitates research and education activities relating to risk assessment.

Databases

Agency for Toxic Substances and Disease Registry (ATSDR)
U.S. Department of Health and Human Services
Web: http://www.atsdr.cdc.gov

Repository of public health assessments on chemicals found at hazardous waste sites. Registry includes minimal risk levels (MRLs), TOX Faqs, and toxicological profiles on almost 300 substances.

Concise International Chemical Assessment Documents
International Programme on Chemical Safety (IPCS)
Web: http://www.who.int/ipcs/index.html

Series of risk assessment documents that review the effects of chemicals or chemical mixtures on human health or the environment.

Environmental Information Management System (EIMS)
U.S. Environmental Protection Agency
Web: http://www.epa.gov/eims/eims.html

A data warehouse storing, managing, and delivering descriptive information for datasets, databases, documents, models, and other scientific documentation that might aide in environmental research.

IARC Monographs Database on Carcinogenic Risks to Humans
International Agency for Research on Cancer (IARC)
http://monographs.iarc.fr

A monograph series in which over 900 biological, chemical, and physical agents have been assessed for potential human carcinogenicity.

Integrated Risk Information System (IRIS)
U.S. Environmental Protection Agency
Web: http://www.epa.gov/iris

Searchable database of over 500 chemical assessments, providing qualitative and quantitative chronic health information as part of the hazard identification and dose–response components of the risk assessment process.

International Toxicity Estimates for Risk (ITER) Database
Toxicology Excellence for Risk Assessment

Web: http://www.tera.org/iter

Searchable database of human health risk values and cancer classifications for over 600 chemicals from multiple organizations worldwide.

Risk Assessment Information System (RAIS)
U.S. Department of Energy, Office of Environmental Management, Oak Ridge Operations Office
Web: http://rais.ornl.gov

Searchable, web-based database that provides toxicity values and profiles of chemicals from multiple sources including U.S. EPA and ATSDR. The website also provides guidance documents and tools for human and ecological risk assessment.

Toxicity Criteria Database
California EPA – Office of Environmental Health Hazard Assessment
Web: http://www.oehha.ca.gov/risk/ChemicalDB/index.asp

Provides chemical-specific cancer potency information and California public health goals for hundreds of chemicals.

Other Resources

Capen CC, Dybing E, Rice JM, Wilbourn JD (Eds.) (1999)
Species Differences in Thyroid, Kidney and Urinary Bladder Carcinogenesis
IARC Scientific Publication No. 147
Web: http://monographs.iarc.fr/ENG/Publications/pub147/IARCpub147.pdf

EC (2003)
2nd edition of the Technical Guidance Document in support of Commission Directive 93/67/EEC on Risk Assessment for new notified substances, Commission Regulation (EC) No1488/94 on Risk Assessment for existing substances and Directive 98/8/EC of the European Parliament and of the Council concerning the placing of biocidal products on the market
Office for Official Publications of the European Communities, Luxembourg.

ECETOC (2004)
Targeted Risk Assessment. Technical Report No. 93
European Centre for Ecotoxicology and Toxicology of Chemicals, Brussels.

ECHA (2007)
REACH Guidance
A compilation of new and existing guidance documents produced by the ECHA that aid with facilitating the implementation of REACH.
Web: http://reach.jrc.it/guidance_en.htm

FoodRisk.org
Joint Institute for Food Safety and Applied Nutrition
Web: http://www.foodrisk.org/

Global Information Network on Chemicals (GINC)
International Labour Organisation, National Institute of Health Sciences, Organization for Economic Co-operation and Development, United Nations Environmental Program, World Health Organisation
Web: http://www.nihs.go.jp/GINC/index.html

IEH (2006)
Guidelines on route-to-route extrapolation of toxicity data when assessing health risks to chemicals
Web: http://www.silsoe.cranfield.ac.uk/ieh/pdf/cr12.pdf

IEH (2003)
Uncertainty factors: Their use in human health risk assessment by UK Government
Web: http://www.silsoe.cranfield.ac.uk/ieh/pdf/cr9.pdf

IEH (2002)
Assessment of Chemical Carcinogens: Background to general principles of a weight of evidence approach
Web: http://www.silsoe.cranfield.ac.uk/ieh/pdf/cr8.pdf

IEH (2002)
Priority research topics for improving chemical risk assessments
Web: http://www.silsoe.cranfield.ac.uk/ieh/pdf/prioritychems.pdf

IEH (1999)
Developing new approaches to assessing risk to human health from chemicals
Web: http://www.silsoe.cranfield.ac.uk/ieh/pdf/cr1.pdf

IEH (1999)
Risk assessment approaches used by UK government for evaluating human health effects of chemicals
Web: http://www.silsoe.cranfield.ac.uk/ieh/pdf/cr2.pdf

IEH (1999)
Physiologically based pharmacokinetic modelling: A potential tool for use in risk assessment
Web: http://www.silsoe.cranfield.ac.uk/ieh/pdf/cr4.pdf

IEH (1999)
Exposure assessment in the evaluation of risk to human health
Web: http://www.silsoe.cranfield.ac.uk/ieh/pdf/cr5.pdf

IEH (1999)
From risk assessment to risk management: Dealing with uncertainty
Web: http://www.silsoe.cranfield.ac.uk/ieh/pdf/cr6.pdf

IEH (1997)
Risk assessment strategies in relation to population subgroups
Web: http://www.silsoe.cranfield.ac.uk/ieh/pdf/cr3.pdf

Institute for Risk Assessment Sciences
Utrecht University
Web: http://www.iras.uu.nl

IARC Working Group (1999)
Predictive Value of Rodent Forestomach and Gastric Neuroendocrine Tumours in Evaluating Carcinogenic Risks to Humans
Technical Publication No. 39.
Web: http://monographs.iarc.fr/ENG/Publications/techrep39/IARCrep39.pdf

IARC Working Group (1994)
Peroxisome Proliferation and its Role in Carcinogenesis
IARC Technical Publication No. 24.
Web: http://monographs.iarc.fr/ENG/Publications/techrep24/IARCrep24.pdf

National Library of Medicine (NLM) TOXNET
NLM Toxicology and Environmental Health Information Program
Web: http://toxnet.nlm.nih.gov

RiskWorld
Tec-Com, Inc
Web: http://www.riskworld.com

Society of Toxicology Specialty Section: Risk Assessment
Society of Toxicology
Web: http://www.toxicology.org/ISOT/SS/RiskAssess/index.asp

U.S. EPA (2006)
A Framework for Assessing Health Risk of Environmental Exposures to Children
EPA/600/R-05/093F. Environmental Protection Agency, Washington, DC

U.S. EPA (2005)
Guidelines for Carcinogen Risk Assessment
EPA/630/P-03/001B. Environmental Protection Agency, Washington, DC

U.S. EPA. (2005)
Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens
EPA/630/R-03/003F. Environmental Protection Agency, Washington, DC

U.S. EPA (2003)
Framework for Cumulative Risk Assessment
EPA/600/P-02/001F. Environmental Protection Agency, Washington, DC

U.S. EPA (2002)
A Review of the Reference Dose and Reference Concentration Processes
EPA/630/P-02/002F. Environmental Protection Agency, Washington, DC

U.S. EPA (2000)
Supplementary Guidance for Conducting Health Risk Assessment of Chemical Mixtures
EPA/630/R-00/002. Environmental Protection Agency, Washington, DC

U.S. EPA (2000)
Science Policy Council Handbook: Risk Characterization
EPA 100-B-00-002. Environmental Protection Agency, Washington, DC

U.S. EPA (2000)
Benchmark Dose Technical Guidance Document
EPA/630/R-00/001, (DRAFT)
Web: http://www.epa.gov/ncea/pdfs/bmds/BMD-External_10_13_2000.pdf

U.S. EPA. (1998)
Guidelines for Neurotoxicity Risk Assessment
Federal Register 63(93): 26926-26954. Environmental Protection Agency, Washington, DC

U.S. EPA (1998)
Guidelines for Ecological Risk Assessment
Risk Assessment Forum. EPA/630/R-95/002. Environmental Protection Agency, Washington, DC

U.S. EPA (1997)
Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments – Interim Final
Web: http://www.epa.gov/oswer/riskassessment/ecorisk/ecorisk.htm

U.S. EPA (1996)
Guidelines for reproductive toxicity risk assessment
Federal Register 61(212): 56274-56322. Environmental Protection Agency, Washington, DC

U.S. EPA (1994)
Methods for Derivation of Inhalation Reference Concentrations and Application of Inhalation Dosimetry
EPA/600/8-90/066F. Environmental Protection Agency, Washington, DC

U.S. EPA (1991)
Alpha2u-Globulin: Association with Chemically Induced Renal Toxicity and Neoplasia in the Male Rat
EPA/625/3-91/019F (NTIS PB92143668). Environmental Protection Agency, Washington, DC

U.S. EPA (1989–2000)
Risk Assessment Guidance for Superfund Manuals
Web: http://www.epa.gov/oswer/riskassessment/policy

U.S. EPA (1988)
Assessment of Thyroid Follicular Cell Tumors
EPA/630/R-97/002. Environmental Protection Agency, Washington, DC

U.S. FDA (2006)
Redbook 2000: Toxicological Principles for the Safety Assessment of Food Ingredients
Web: http://www.cfsan.fda.gov/~redbook/redtoca.html

U.S. FDA (2005)
Guidance for Industry Premarketing Risk Assessment
Web: http://www.fda.gov/CDER/guidance/6357fnl.htm

U.S. FDA (2003)
Risk Assessment for Food Terrorism and Other Food Safety Concerns
Web: http://www.cfsan.fda.gov/~dms/rabtact.html

U.S. Navy (updated 2006)
Navy Guidance for Conducting Human Health Risk Assessments
Web: http://www-nehc.med.navy.mil/hhra

WHO (2006)
Environmental Health Criteria 233. Transgenic Animal Mutagenicity Assays
Web: http://www.who.int/entity/ipcs/publications/ehc/ehc233.pdf

WHO (2005)
Harmonization Project Document No. 2. Chemical-specific adjustment factors for interspecies differences and human variability: guidance document for use of data in dose/concentration-response assessment
Web: http://whqlibdoc.who.int/publications/2005/9241546786_eng.pdf

WHO (2005)
Harmonization Project Document No. 3. Principles of characterizing and applying human exposure models
Web: http://whqlibdoc.who.int/publications/2005/9241563117_eng.pdf

WHO (2004)
Environmental Health Criteria XXX. Principles for Modelling Dose–Response for the Risk Assessment of Chemicals (DRAFT)
Web: http://www.who.int/entity/ipcs/methods/harmonization/draft_document_for_comment.pdf

WHO (2002)
Environmental Health Criteria 228. Principles and methods for the assessment of risk from essential trace elements
Web: http://www.inchem.org/documents/ehc/ehc/ehc228.htm

WHO (2001)
Environmental Health Criteria 222. Biomarkers in risk assessment: Validity and validation
Web: http://www.inchem.org/documents/ehc/ehc/ehc222.htm

WHO (2001)
Environmental Health Criteria 223. Neurotoxicity risk assessment for human health: Principles and approaches
Web: http://www.inchem.org/documents/ehc/ehc/ehc223.htm

WHO (2001)
Environmental Health Criteria 225. Principles for evaluating health risks to reproduction associated with exposure to chemicals
Web: http://www.inchem.org/documents/ehc/ehc/ehc225.htm

WHO (1999)
Environmental Health Criteria 210. Principles for the assessment of risks to human health from exposure to chemicals
Web: http://www.inchem.org/documents/ehc/ehc/ehc210.htm

WHO (1999)
Environmental Health Criteria 212. Principles and methods for assessing allergic hypersensitization associated with exposure to chemicals
Web: http://www.inchem.org/documents/ehc/ehc/ehc212.htm

WHO (1996)
Environmental Health Criteria 180. Principles and methods for assessing direct immunotoxicity associated with exposure to chemicals
Web: http://www.inchem.org/documents/ehc/ehc/ehc180.htm

IARC (2004)
Overall evaluation of carcinogenicity to humans
International Agency for Research on Cancer, Lyon, France.
Web: http://www-cie.iarc.fr/monoeval/crthall.html

CHAPTER

47

Target Sites: General

TODD STEDEFORD

INTRODUCTION

The U.S. Environmental Protection Agency's (EPA) Integrated Risk Information System (IRIS) defines 'toxicology' as '[t]he study of harmful interactions between chemical, physical, or biological agents and biological systems' (IRIS n.d.). In the field of toxicology, and in science in general, it is often necessary to carve out a niche based on specialized interests and research activities. It is not uncommon for toxicologists to focus their research on a particular organ or organ system. For example, a neurotoxicologist specializes in research on chemicals that may produce or protect against adverse effects on the nervous system.

Chemical exposures may produce adverse effects to more than one part of the body. Typically, the organ(s) that is affected by a chemical is referred to as the 'target organ'. IRIS defines a 'target organ' as '[t]he biological organ(s) most adversely affected by exposure to a chemical, physical, or biological agent' (IRIS n.d.). For example, chronic consumption of alcoholic beverages has been associated with adverse effects to the liver, heart, and brain (Spies et al 2001, Koike & Sobue 2006, Yip & Burt 2006). Therefore, these organs are considered the target organs for alcohol-induced toxicity.

Because of the breadth of data on organ-specific toxicants, many specialized books, journals, organizations, and databases exist that aid toxicologists with sharing their findings with the scientific community as well as educating generalists or specialists from other disciplines in a particular subspecialty of toxicology.

This chapter provides resources on general organ toxicity and serves as a prelude to the more in-depth coverage of organ-specific resources provided in later chapters. A selection of books and journal articles addressing organ toxicity is provided, along with international organizations devoted to the toxicology of particular organ systems. In addition, an assortment of open-access databases, which provide full-text information on chemicals that cause directed toxicity to specific organs, has been compiled.

References

Glossary of Terms | IRIS | USEPA, http://www.epa.gov/iris/gloss8.htm#t

Koike H, Sobue G (2006) Alcoholic neuropathy. Curr. Opin. Neurol. 19: 481–486.

Spies CD, et al (2001) Effects of alcohol on the heart. Curr. Opin. Crit. Care 7: 337–343.

Yip WW, Burt AD (2006) Alcoholic liver disease. Semin. Diagn. Pathol. 23: 149–160.

RESOURCES

Books

Acosta D Jr (2001)
Cardiovascular Toxicology, 3rd Edition
Taylor & Francis, New York, New York
Web: http://www.taylorandfrancis.com/

Provides information on cardiovascular toxicology, including biological mechanisms as factors in the toxicity of chemicals and drugs to the cardiovascular system,

methods and principles of cell injury, cardiotoxicants, and vascular toxicity.

Chiou GCY (1999)
Ophthalmic Toxicology, 2nd Edition
Taylor & Francis, Philadelphia, Pennsylvania
Web: http://www.taylorandfrancis.com/

Covers specific actions and affinities of ophthalmic poisons to various eye tissues, research methods in vivo and in vitro, toxicities of chemicals via systemic and/or local delivery, and medical treatment of chemical injuries.

Gad SC (2007)
Toxicology of the Gastrointestinal Tract
CRC Press, Boca Raton, FL
Web: http://www.crcpress.com/

Provides an overview of the gastrointestinal system involved in the toxicity of exogenous agents, including normal structures and functions, regulatory mechanisms of control, and the role of absorption and metabolism in the systemic toxicity of toxic agents.

Gardner DE (2006)
Toxicology of the Lung, 4th Edition
CRC Press, Boca Raton, FL
Web: http://www.crcpress.com/

Provides a comprehensive introduction to inhalation toxicology and environmental and occupational lung disease. Focuses on the assessment of findings from clinical human, animal toxicology studies, and in vitro model of pulmonary toxicology. Explores the value of procedures presently being used to evaluate the risks associated with airborne contaminants

Harry GJ, Tilson HA (2008)
Neurotoxicology, 3rd Edition
CRC Press, Boca Raton, FL
Web: http://www.crcpress.com/

Provides in-depth coverage of the neurobiological basis underlying neurotoxic sites and modes of action.

Hood RD (2006)
Developmental and Reproductive Toxicology, 2nd Edition
CRC Press, Boca Raton, FL
Web: http://www.crcpress.com/

Covers genomics/proteomics, endocrine disruptors, testing for male and female reproductive toxicity, data interpretation in developmental and reproductive toxicity testing, non-clinical juvenile toxicity testing, and the FDA perspective on risk assessment. It includes material on postnatal developmental milestones and extensive glossaries of developmental defect terminology.

Hoyer PB (2004)
Ovarian Toxicology
CRC Press, Boca Raton, FL
Web: http://www.crcpress.com/

Provides coverage on ovarian physiology, ovarian target sites, and the effects of specific chemicals demonstrated in animal studies and in human epidemiological data.

Luebke R, House R, Kimber I (2007)
Immunotoxicology and Immunopharmacology, 3rd Edition
CRC Press, Boca Raton, FL
Web: http://www.crcpress.com/

Provides the latest methodologies for estimating human health risk from exposure to drugs and chemical agents, includes sections on immunopharmacology and immunotoxicology of therapeutics, developmental immunotoxicology, and neuroimmunology.

Maibach HI (2001)
Toxicology of Skin
Taylor & Francis, Philadelphia, PA
Web: http://www.taylorandfrancis.com/

Provides findings in skin toxicology including irritant dermatitis, percutaneous absorption, allergic contact dermatitis, contact urticaria, as well as wound healing, dermatological drugs, and in vitro viability assays.

Plaa GL, Hewitt WR (1998)
Toxicology of the Liver, 2nd Edition
Taylor & Francis, Washington, DC
Web: http://www.taylorandfrancis.com/

Reviews the characteristics of chemically induced hepatotoxicity, its mechanisms, and cholestasis.

Pour PM (2006)
Toxicology of the Pancreas
CRC Press, Boca Raton, FL
Web: http://www.crcpress.com/

Discusses the detoxification and toxification process at the cellular and sub-cellular level, the distribution of phase 1 and phase 2 drug-metabolizing enzymes and their role in pancreatic disease, and the role of diet and toxicants on pancreatic disease, as well as the role of altered genes in the integrity of the pancreas, and comparative toxicology in humans and experimental animals.

Salem H, Katz SA (2005)
Inhalation Toxicology, 2nd Edition

CRC Press, Boca Raton, FL
Web: http://www.crcpress.com/

Focuses on regulatory aspects of exposure and testing, testing equipment and methods, biomarkers, pathology, allergies, and immunology, irritation of the respiratory tract, and risk assessment. It also covers the inhalation of bioaerosols and toxins, ranging from anthrax to household molds. Other topics include low-level exposure toxicology, theory modeling, pharmaceutical aerosols, and the effects of individual toxicants such as tobacco smoke and chemical warfare agents.

Tarloff JB, Lash LH (2005)
Toxicology of the Kidney, 3rd Edition
CRC Press, Boca Raton, FL
Web: http://www.crcpress.com/

Focuses on the correlation between anatomy, biochemistry, and physiology of the kidney, and how this correlation is related to concepts of clinical nephrotoxicity and renal failure in humans and how animal models can be used to understand the mechanisms of human renal disease.

Zimmerman HJ (1999)
Hepatotoxicity: The Adverse Effects of Drugs and Other Chemicals on the Liver, 2nd Edition
Lippincott, Williams, & Wilkins, Philadelphia, PA

Provides coverage on general aspects of interactions between chemicals and the liver, an introduction to experimental hepatotoxicity, hepatic risks of chemicals in the environment, and drug-induced hepatic injury.

Journals

Alimentary Pharmacology & Therapeutics (1987–)
Blackwell Publishing, UK
Web: http://www.blackwellpublishing.com/journal.asp?ref=0269-2813

Concerned with the effects of drugs on the human gastrointestinal and hepato-biliary systems, particularly with relevance to clinical practice. The Journal accepts original papers concerned with all aspects of basic and clinical pharmacology, pharmacokinetics, and the therapeutic use of drugs in the alimentary tract including the liver, gall-bladder, and pancreas.

American Journal of Nephrology (1981–)
S. Karger AG, Switzerland
Web: http://www.karger.com/AJN

Focuses on timely topics including: basic science (cell, molecular, or animal research) and translational research dealing with mechanisms of disease or drug effects in man or animal models.

Birth Defects Research. Part B, Developmental and Reproductive Toxicology (2003–)
John Wiley & Sons, Inc., U.S.
Web: http://www.interscience.wiley.com/jpages/1542-9733/

Publishes articles focused on identifying the causes, mechanisms, and manifestations of abnormal development or reproduction, whether genetically, gestationally, or postnatally induced; and whether expressed as a lethality, malformation, growth retardation, or functional aberration.

Cardiovascular Toxicology (2001–)
Humana Press, Inc., U.S.
Web: http://www.humanapress.com/

Publishes articles that describe molecular mechanisms and signal pathways of cardiovascular toxicity, cardiovascular effects of environmental toxicants and pollutants, safety data of detrimental effects of new cardiovascular drugs and gene therapy, and the cardiovascular toxicity of non-cardiovascular drugs and therapies.

Current Opinion in Nephrology and Hypertension (1992–)
Lippincott Williams & Wilkins, U.S.
Web: http://www.co-nephrolhypertens.com/

Provides coverage on key subjects in nephrology, spanning topics such as circulation and hemodynamics; pathophysiology of hypertension; epidemiology and prevention; mineral metabolism; and pharmacology and therapeutics.

Cutaneous and Ocular Toxicology (2005–)
Taylor & Francis, Inc., UK
Web: http://www.tandf.co.uk/journals/titles/15569527.asp

Provides coverage on all types of harm to the cutaneous and ocular systems. Areas of particular interest include medical products, consumers and household products, as well as environmental and occupational exposures.

Frontiers of Gastrointestinal Research (1975–)
S. Karger AG, Switzerland
Web: http://www.karger.com/FGARE

Covers pathological, pharmacological, diagnostic, and therapeutic considerations relating to the digestive system, as well as the latest techniques and instrumentation used in the management of gastrointestinal disorders.

Hepatology (1981–)
John Wiley & Sons, Inc., U.S.
Web: http://www3.interscience.wiley.com/cgi-bin/jhome/106570044

Publishes articles concerning all aspects of liver structure, function, and disease as well as immunology, chronic hepatitis, viral hepatitis, cirrhosis, genetic and metabolic liver diseases and their complications, liver cancer, and drug metabolism.

Journal of Cardiovascular Pharmacology (1979–)
Lippincott Williams & Wilkins, U.S.
Web: http://www.cardiovascularpharm.com/

Provides information on the physiological and pharmacological bases of drug action, metabolism, drug interaction, side effects, and clinical results with both new and established cardiovascular drugs.

Journal of Cardiovascular Pharmacology and Therapeutics (1996–)
SAGE Publications, U.S.
Web: http://cpt.sagepub.com/

Offers cardiologists, clinical pharmacologists, and researchers involved in disease-relevant clinical and experimental investigations of newer cardiovascular drugs and other therapeutic options.

Immunopharmacology and Immunotoxicology (1987–)
Taylor & Francis, Inc., UK
Web: http://www.tandf.co.uk/journals/titles/08923973.asp

Specializes in coverage on immunomodifying agents to treat diseases such as cancer, immunodeficiency, chronic infection, allergy, and inflammatory and autoimmune disorders the action of agents on specific parameters of the immune system, mediated directly or through soluble cytokines secreted by various cellular components of the immune system the adverse or positive effects of xenobiotics on the immune system, including chemicals, metals, food additives, and airborne pollutants.

Inhalation Toxicology (1989–)
Taylor & Francis, Inc., UK
Web: http://www.tandf.co.uk/journals/titles/08958378.asp

Publishes articles addressing how the respiratory system functions in health and disease, the pathogenesis and mechanism of injury, extrapolation of animal data to humans, effects of inhaled substances on extra-pulmonary systems, and reliable and innovative models for predicting human disease.

International Immunopharmacology (2001–)
Elsevier B.V., Netherlands
Web: http://www.elsevier.com/

Aimed at publishing original research papers pertinent to the overlapping areas of immunology, pharmacology, cytokine biology, immunotherapy, immunopathology, and immunotoxicology.

Journal of Ocular Pharmacology and Therapeutics (1995–)
Mary Ann Liebert, Inc., U.S.
Web: http://www.liebertpub.com/publication.aspx?pub_id=40

Publishes articles addressing the pharmacokinetics and pharmacodynamics of biopharmaceuticals related to the treatment of the eye, and also a variety of other topics, including: glaucoma, cataracts, retinal degeneration, proliferative disorders of the eye, ocular infection, trauma, and toxicology, ocular drug delivery and biotransformation, ocular pharmacotherapy/clinical trials, gene therapy, ocular metabolic disorders, ocular ischemia and blood flow, and ocular inflammatory and immune disorders.

Neuropharmacology (1962–)
Elsevier B.V., Netherlands
Web: http://www.elsevier.com/

Includes broad coverage on a variety of topics including: neurotransmitters and their receptors, ion channels, systems (e.g. cognitive function of hippocampus), behavior, psychopharmacology (animal models of psychiatric disorders), depression, epilepsy, ischemia, neuroprotection, drugs of abuse, and pain.

NeuroToxicology (1979–)
Elsevier B.V., Netherlands
Web: http://www.neurotoxicology.com/journal.htm

Specializes in publishing original research papers dealing with the effects of toxic substances on the nervous system of humans and experimental animals of all ages. The Journal emphasizes papers dealing with the neurotoxic effects of environmentally significant chemical hazards, manufactured drugs, and naturally occurring compounds.

Neurotoxicology and Teratology (1979–)
Elsevier B.V., Netherlands
Web: http://www.elsevier.com/locate/neutera

Presents original reports of systemic studies in the areas of adult neurotoxicology and developmental neurotoxicology in which the primary emphasis and theoretical context are on the nervous system and/or behavior. The Journal publishes original studies that cover the developmental and adult neurotoxicity of pesticides, drugs of abuse, pharmaceuticals, solvents,

heavy metals, organometals, general industrial-use compounds, marine and plant toxins, atmospheric reaction compounds, and physical agents such as radiation and noise.

Pancreatology (2001–)
S. Karger AG, Switzerland
Web: http://www.karger.com/PAN

Dedicated to the understanding and treatment of pancreatic disease, this multidisciplinary periodical combines findings from various fields, including: gastroenterology, oncology, surgery, pharmacology, cell and molecular biology as well as endocrinology, immunology, and epidemiology, in order to present an integral picture.

Pulmonary Pharmacology & Therapeutics (1997–)
Elsevier B.V., Netherlands
Web: http://www.elsevier.com/

Broad coverage of the major diseases of the lung including asthma, cystic fibrosis, pulmonary circulation, ARDS, carcinoma, bronchitis, emphysema, and drug delivery.

Reproductive Toxicology (1988–)
Elsevier B.V., Netherlands
Web: http://www.elsevier.com/

Provides broad coverage on all aspects of reproduction, including the formation and maturation of male and female gametes, sexual function, the events surrounding the fusion of gametes and the development of the fertilized ovum, nourishment and transport of the conceptus within the genital tract, implantation, embryogenesis, intrauterine growth, placentation and placental function, parturition, lactation, and neonatal survival.

Skin Pharmacology and Physiology (2004–)
S. Karger AG, Switzerland
Web: http://www.karger.com/SPP

Aimed at the presentation of research on skin therapy, skin care, cosmeceuticals, quasi-drugs, and pharmacokinetics, pharmacodynamics, and xenobiotic metabolism in skin.

Vascular Pharmacology (1970–)
Elsevier B.V., Netherlands
Web: http://www.elsevier.com/

Provides broad coverage of vascular pharmacology, including angiogenesis, growth factors, nitric oxide, cell signaling, vasoactive mediators, hypertension, atherosclerosis, metabolic diseases, blood element–vessel wall interactions, thrombosis, microcirculation, vascular developmental biology and remodeling, vascular inflammation, and immunity.

Journal Articles

Andrade RJ, et al (2007) Assessment of drug-induced hepatotoxicity in clinical practice: a challenge for gastroenterologists. World J. Gastroenterol. 13: 329–340.

Baken KA, et al (2007) Toxicogenomics in the assessment of immunotoxicity. Methods 41: 132–141.

Chen J (2005) Animal models for acquired bone marrow failure syndromes. Clin. Med. Res. 3: 102–108.

Dietert RR, Holsapple MP (2007) Methodologies for developmental immunotoxicity (DIT) testing. Methods 41: 123–131.

Fennell DA, Rudd RM (2004) Pulmonary toxicity and cancer treatment. Hosp. Med. 65: 462–465.

Ferrari M, Moscato G, Imbriani M (2005) Allergic cutaneous diseases in hairdressers. Med. Lav. 96: 102–118.

Garner LA (2004) Contact dermatitis to metals. Dermatol. Ther. 17: 321–327.

Guest I, Uetrecht J (2000) Drugs toxic to the bone marrow that target the stromal cells. Immunopharmacology 46: 103–112.

Higenbottam T, et al (2004) Understanding the mechanisms of drug-associated interstitial lung disease. Br. J. Cancer. 91: S31–S37.

Hostynek JJ (2006) Sensitization to nickel: etiology, epidemiology, immune reactions, prevention, and therapy. Rev. Environ. Health, 21: 253–280.

Jha V, Chugh KS (2003) Nephropathy associated with animal, plant, and chemical toxins in the Tropics. Semin. Nephrol. 23: 49–65.

Morandi P, et al (2005) Cardiac toxicity of high-dose chemotherapy. Bone Marrow Transplant. 35: 323–334.

Sawyer RT, et al (2002) Chronic beryllium disease: a model interaction between innate and acquired immunity. Int. Immunopharmacol. 2: 249–261.

Selimoglu E (2007) Aminoglycoside-induced ototoxicity. Curr. Pharm. Des. 13: 119–126.

Slordal L, Spigset O (2006) Heart failure induced by non-cardiac drugs. Drug Saf. 29: 567–586.

Suttie AW (2006) Histopathology of the spleen. Toxicol. Pathol. 34: 466–503.

Travlos GS (2006) Histopathology of bone marrow. Toxicol. Pathol. 34: 566–598.

Van Vleet TR, Schnellmann RG (2003) Toxic nephropathy: environmental chemicals. Semin. Nephrol. 23: 500–508.

Weber LW, Boll M, Stampfl A (2003) Hepatotoxicity and mechanism of action of haloalkanes: carbon tetrachloride as a toxicological model. Crit. Rev. Toxicol. 33: 105–136.

Organizations

Behavioral Toxicology Society
John Chelonis, Secretary
Department of Psychology
State University of New York (SUNY), College at Brockport
350 New Campus Drive
Brockport, New York 14420
Email: jcheloni@brockport.edu
Web: http://www.behavioraltoxicology.org/

Formed in 1982, the BTS is a non-profit society that promotes excellence in scientific research into the effects of toxic agents on behavior and the nervous system; provides a forum for the presentation, discussion, and dissemination of relevant research; educates professionals and lay persons about the contributions to public health made in this field; and stimulates new growth and interest in behavioral toxicology in scientists engaged in the broader areas of behavioral sciences, neuroscience, toxicology, pharmacology, and risk assessment.

Dermal Toxicology Specialty Section
Society of Toxicology
1821 Michael Faraday Drive, Suite 300
Reston, Virginia 20190
Phone: 703-438-3115
Fax: 703-438-3113
Email: sothq@toxicology.org
Web: http://www.toxicology.org/isot/ss/specsection.asp#DERMAL

Founded in 1999, the objectives of the Dermal Toxicology Specialty Section are to provide a forum for the interaction of individuals involved in risk assessment, pharmacokinetics, dermal penetration/absorption, hypersensitivity and dermal toxicity, regulatory issues, basic skin biology, and other professionals working in the field of dermal research.

Immunotoxicology Specialty Section
Society of Toxicology
1821 Michael Faraday Drive, Suite 300
Reston, Virginia 20190
Phone: 703-438-3115
Fax: 703-438-3113
Email: sothq@toxicology.org
Web: http://www.toxicology.org/isot/ss/specsection.asp#IMMUNOTOXICOLOGY

Founded in 1985, the Immunotoxicology Specialty Section consists of members of the Society of Toxicology aimed at promoting immunotoxicology as a discipline by: (1) increasing the understanding of the impact that xenobiotics have on the immune system; (2) advocating research into the mechanisms of immunomodulation; and (3) encouraging the development of new methods and techniques to improve risk assessment.

Inhalation and Respiratory Specialty Section (ISS)
Society of Toxicology
1821 Michael Faraday Drive, Suite 300
Reston, Virginia 20190
Phone: 703-438-3115
Fax: 703-438-3113
Email: sothq@toxicology.org
Web: http://www.toxicology.org/isot/ss/specsection.asp#INHALATION

Founded in 1987, the ISS provides a focus for members of the Society of Toxicology dealing with the impact of airborne chemicals and particles on the body, including: indoor and outdoor air pollution, occupational exposure to airborne contaminants, therapeutic drug delivery by inhalation, deposition and pharmacokinetics of agents delivered by the inhalation route, and interactions between inhaled materials and infectious allergic stimuli.

International Neurotoxicology Association
Dr. Philip Bushnell, Secretary
Neurotoxicology Division, MD-B105-04
National Health and Environmental Effects Research Laboratory (NHEERL)
U.S. Environmental Protection Agency
Research Triangle Park, North Carolina 27711
Email: bushnell.philip@epa.gov
Web: http://www.neurotoxicology.org/

A non-profit association that holds annual meetings that promote collaboration between neurotoxicologists and scientists from other fields with the aim to delineate the basic mechanisms of neurotoxic insults. The INA's website provides visitors open-access to newsletters, information on forthcoming meetings, other links of interest, including a compilation of academic and government laboratories, books, reports, and book reviews, companies, industry laboratories and consulting services, grant information, neurotoxicology journals, and neurotoxicology societies.

International Society of Skin Pharmacology and Physiology
ISP Office
Ms. Susanna Ludwig, c/o S. Karger AG
Allschwilerstrasse 10
P.O. Box
CH-4009 Basel, Switzerland
Phone: 41 61 306 1280
Fax: 41 61 306 1234
Email: e.coscino@karger.ch
Web: http://www.isp-society.org/

Founded in 2003, the Society provides a high-profile international forum that promotes scientific activities of skin pharmacology and physiology, using molecular tools and state-of-the-art techniques and methodology.

Neurobehavioral Teratology Society
Dr. Susan M. Melnick, Secretary
SK Bio-Pharmaceuticals
22-10 State Route 208 South
Fair Lawn, New Jersey 07410
Email: melnicks@skbp.com
Web: http://www.nbts.org/

Established in 1977, the NBTS' purpose is to understand the behavioral and developmental alterations that result from genetic and environmental perturbations of the nervous system during the pre- and perinatal period. NBTS is also focused on communicating such findings to physicians, scientists, public health officials, and the general public in order to promote awareness and lessen the risks for teratologic occurrences in the population at large.

Neurotoxicology Specialty Section
Society of Toxicology
1821 Michael Faraday Drive, Suite 300
Reston, Virginia 20190
Phone: 703-438-3115
Fax: 703-438-3113
Email: sothq@toxicology.org
Web: http://www.toxicology.org/isot/ss/specsection.asp#NEUROTOXICOLOGY

Founded in 1983, the Neurotoxicology Specialty Section consists of members of the Society of Toxicology who are interested in the adverse effects of chemical, biological, or physical agents on the structure and function of the nervous system.

Reproductive and Developmental Specialty Section
Society of Toxicology
1821 Michael Faraday Drive, Suite 300
Reston, Virginia 20190
Phone: 703-438-3115
Fax: 703-438-3113
Email: sothq@toxicology.org
Web: http://www.toxicology.org/isot/ss/specsection.asp#REPRODUCTIVE

Founded in 1995, the Reproductive and Developmental Specialty Section consists of members of the Society of Toxicology focused on assessing toxicology of the reproductive system or development of offspring, including all areas of male and female reproductions, developmental biology, teratology, and developmental and reproductive risk assessment.

The Teratology Society
1821 Michael Faraday Drive, Suite 300
Reston, Virginia 20190
Phone: 703-438-3104
Fax: 703-438-3113
Email: tshq@teratology.org
Web: http://teratology.org/

Founded in 1960, the purpose of the society is to foster the exchange of information relating to congenital (birth) defects including their nature, cause, mechanism, and prevention by drawing from a wide range of scientific fields including pediatrics, anatomy, epidemiology, pharmacology and industrial toxicology, developmental biology, obstetrics, pathology, genetics, and dentistry.

Databases

Integrated Risk Information System
U.S. Environmental Protection Agency
Web: http://www.epa.gov/iris

An open-access, searchable database that contains human health assessments on over 500 chemicals. The 'Search IRIS' option allows users to identify chemicals that cause critical effects, precursor effects, or tumor types in specific tissues, e.g., liver, kidney, lung, etc.

IPCS INCHEM
International Programme on Chemical Safety
Web: http://www.inchem.org/pages/search.html

An open-access, searchable database that allows users to search by keywords (e.g., hepatotoxicity, nephrotoxicity, etc.) through multiple resources, including: Concise International Chemical Assessment Documents, Environmental Health Criteria Monographs, Poison Information Monographs, etc., to obtain organ-specific toxicant information.

IPCS INTOX Databank
International Programme on Chemical Safety
Web: http://www.intox.org/databank/index.htm

An online databank that contains physical, chemical, and toxicological information on chemicals, pharmaceuticals, animals, plants, bacteria, fungi, as well as treatment guides, antidotes, and supplemental documents.

The Merck Manual of Medical Information – Second Home Edition, Online Version
Merck & Co., Inc.
Web: http://www.merck.com/mmhe/index.html

An open-access, online manual with broad coverage of medical topics including: blood disorders; bone, joint, and muscle disorders; brain, spinal cord, and nerve disorders; digestive disorders; disorders of nutrition and metabolism; ear, nose, and throat disorders; eye disorders; heart and blood vessel disorders; hormonal disorders; immune disorders; infections; kidney and urinary tract disorders; liver and gallbladder disorders; lung and airway disorders; and skin disorders.

The Merck Veterinary Manual
Merck & Co., Inc.
Web: http://www.merckvetmanual.com/mvm/index.jsp

An open-access, online manual that provides in-depth coverage of advances in veterinary science, the emergence of new pathogens and new diseases, advances in diagnosis and treatment, and expanded coverage of specialty fields such as cardiology, neurology, ophthalmology, toxicology, and emergency medicine.

PathMax
Shawn E. Cowper, M.D.
Web: http://www.pathmax.com/

An open-access, online collection of links for general subject areas (e.g., medicine, pathology, anatomy) and specific subject areas (e.g., dermatopathology, hematopathology, neuropathology, etc.).

CHAPTER

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Target Sites: Cardiovascular

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INTRODUCTION

Cardiovascular toxicology has advanced rapidly in recent years, in part due to public health and policy needs to understand human health impacts of air pollutants such as diesel exhaust, environmental tobacco smoke, and fine particulate matter. Interactions of cardiovascular and other organ systems in complex diseases, such as chronic obstructive pulmonary disease, have also increased appreciation and use of cardiovascular toxicology by toxicologists in other areas. The books and articles in this section provide an up-to-date understanding of key principles, research issues, and applications of cardiovascular toxicology.

RESOURCES

Books

Acosta D, Jr (Ed.) (2001)
Cardiovascular Toxicology, Third Edition (Target Organ Toxicology Series)
Taylor & Francis, London and New York

Following an introduction to cardiovascular toxicology, this 17-chapter, multi-author book (available from the publishers in either hardcopy or as an e-book) explains molecular and cellular mechanisms and principles by which xenobiotics can potentially damage the cardiovascular system. Chapters discuss methods for investigating acute and chronic toxicity of drugs to the cardiovascular system, including in vitro cytotoxicity modeling, assessment of cardiovascular function in conscious animals, and use of mechanistic information on apoptosis and pathobiology of myocardial ischemic injury. Effects of particular agents (including antibiotics, lipopolysaccharides, catecholamines, CNS agents, steroidal agents, and chemotherapeutic agents) are reviewed in light of mechanisms by which xenobiotics or ischemic/hypoxic conditions may injure myocardial cells. A chapter entitled 'Passive Smoking Causes Heart Disease' argues for this conclusion. The book closes with major reviews of molecular- and cell-level mechanisms of vascular toxicology and the toxicity and pathobiology of drugs and chemicals to the myocardium and vascular system.

Web: http://www.amazon.com/Cardiovascular-Toxicology-Target-Organ/dp/0881679372
Note: Fourth Edition is scheduled for October, 2008.

Baskin SI (1991) (Ed.)
Principles of Cardiac Toxicology
CRC Press, Boca Raton, FL

This edited volume introduces principles and applications of cardiovascular toxicology to students and clinicians attempting to gain an understanding of how drugs and chemicals can impair cardiac or vascular tissues. The first three chapters cover anatomical, biochemical, and physiological principles of cardiac function and toxicology, respectively. Chapter 4 examines cardiac histopathology. The remaining chapters (5–18) discuss cardiotoxic effects of foods, organophosphates and related compounds, drugs (including digitalis and emetine and analogs) catecholamines, cyanide, trace metals, various cardiac depressants, and carbon monoxide.

Bishop SP, Kerns WD (1997) (Eds.)
Cardiovascular Toxicology
Elsevier Science, Inc., New York (Pergamon Imprint)
Web: http://www.elsevier.com/wps/find/bookvolume.cws_home/30368/vol8

This volume consists of 25 chapters, averaging about 20 pages each, by various experts, many from pharmaceutical companies, medical schools, and hospitals. Following an introductory chapter on the heart and blood vessels as target organs for toxic effects of xenobiotics, the book is divided into six sections: four chapters providing background on cardiovascular biology and molecular pharmacology; eight chapters on evaluation of the cardiovascular system by MRI, ECG, echocardiography, functional and morphological methods, and in vitro tests; three chapters on cardiovascular and responses to endothelial, smooth muscle, vascular, and myocardial injuries; eight chapters on cardiovascular toxicology (including pathogenesis of agent-caused arterial and myocardial lesions, inflammatory mechanisms of toxic and allergic reactions of the heart and blood vessels); and a final section on hazard identification and risk assessment, consisting of a single chapter on managing cardiovascular risk in phase 1 trials.

See also:

Dhalla NS, Rupp H, Aubie A, Pierce GN (Eds.) (2001)
Pathophysiology of Cardiovascular Disease (Series: Progress in Experimental Cardiology)
Kluwer Academic Publishers, Norwell, MA (now Springer, New York)

Discusses mechanisms, pathways, and experimental data on heart and vascular dysfunction and disease; ischemic heart disease; and therapeutic interventions.

Journals

Many journals address aspects of cardiovascular medicine, surgery, treatment, epidemiology, and drug research. However, relatively few journals specialize in cardiovascular toxicology. The following is an exception.

Cardiovascular Toxicology (2001–)
Humana Press, Totowa, NJ
Web: http://humanapress.com/index.php?option=com_journalshome&task=viewjournaldetails&journalmasterid=18&category=journals

Cardiovascular Toxicology publishes articles on molecular mechanisms and pathways of cardiovascular toxicity; safety data for new cardiovascular drugs; and experimental and clinical data and molecular biological studies elucidating adverse cardiovascular effects of environmental pollutants, drugs (both cardiovascular and non-cardiovascular) and therapies.

See also:

International Journal of Cardiology (1981–)
Elsevier, Amsterdam and New York
Web: http://ees.elsevier.com/ijc/

The *International Journal of Cardiology* publishes basic research and clinical papers on cardiology of interest to clinicians and research workers. The focus is not cardiac toxicology per se, but some articles do address toxic effects of drugs and molecular mechanisms of heart injury by drugs and other agents.

Journal of Molecular and Cellular Cardiology (1970–)
Elsevier, Amsterdam and New York (Academic Press Imprint, London and New York)
Web: http://www.elsevier.com/wps/find/journaldescription.cws_home/622889/description#description

The *Journal of Molecular and Cellular Cardiology* focuses on basic and clinical aspects of the molecular cell biology, physiology (for heart and smooth muscle), pharmacology, and pathophysiology of the heart and cardiovascular system. This focus includes experimental and clinical aspects of heart disease that reflect altered molecular and cellular properties of the heart and cardiovascular system, including its metabolism and cardiac performance and pathophysiology.

Environmental Health Perspectives (1972–)
Web: http://www.ehponline.org/docs/admin/about.html
The National Institute of Environmental Health Sciences (NIEHS), United States

Environmental Health Perspectives (EHP), published by the United States' National Institute of Environmental Health Sciences (NIEHS), is a leading monthly journal for research on potential impacts of the environment on human health. It has a section specifically on cardiovascular effects.

Toxicological Sciences (1998– Continues Fundamental and Applied Toxicology)
Oxford University Press, U.S.
Web: http://toxsci.oxfordjournals.org/

Toxicological Sciences is a publication of the Society for Toxicology. Although not specializing in cardiovascular toxicology, it does include some excellent articles on aspects of cardiovascular toxicology.

Journal Articles

Bernatova I, Babál P, Grubbs RD, et al (2006) Acetylcholinesterase inhibition affects cardiovascular structure in mice. Physiol. Res. 55 (Suppl 1): S89–97.

Boor PJ, Gotlieb AI, Joseph EC, et al (1995) Chemical-induced vasculature injury. Toxicol. Appl. Pharmacol. 132: 177–195.

Culic V (2007) Acute risk factors for myocardial infarction. Int. J. Cardiol. 117(2): 260–269.

Dogterom P, Zbinden G, Reznik GK (1992) Cardiotoxicity of vasodilators and positive inotropic/vasodilating drugs in dogs: An overview. Crit. Rev. Toxicol. 22: 203–242.

Doig JC (1997) Drug-induced cardiac arrhythmias: Incidence, prevention and management. Drug Saf. 17: 265–275.

Heideman W, Antkiewicz DS, Carney SA, et al (2005) Zebrafish and cardiac toxicology. Cardiovasc. Toxicol. 5(2): 203–214.

Keller DA, Roe DC, Lieder PH (1996) Fluoroacetate-mediated toxicity of fluorinated ethanes. Fundam. Appl. Toxicol. 30: 213–219.

Khedun SM, Maharaj B, Naicker T (1996) Hexane cardiotoxicity: An experimental study. Israel J. Med. Sci. 32: 123–128.

Li S, Mingyan E, Yu B (2008) Adriamycin induces myocardium apoptosis through activation of nuclear factor kappaB in rat. Mol. Biol. Rep. 35: 489–494.

Neely JL (1998) Tonic clonic seizures and tachycardia induced by fluoxetine (Prozac) overdose. W. Virginia Med. J. 94: 283–285.

Rhoden CR, Wellenius GA, Gholfi E, et al (2005) PM-induced cardiac oxidative stress and dysfunction are mediated by autonomic stimulation. Biochim. Biophys. Acta 1725(3): 305–313.

Sesso HD (2001) Alcohol and cardiovascular health: recent findings. Am. J. Cardiovasc. Drugs 1(3): 167–172.

Sullivan ML, Martinez CM, Gennis P, et al (1998) The cardiac toxicity of anabolic steroids. Prog. Cardiovas. Dis. 41: 1–15.

Thomsen MB, Matz J, Volders PGA, et al (2006) Assessing the proarrhythmic potential of drugs: current status of models and surrogate parameters of torsades de pointes arrhythmias. Pharmacol. Ther. 112(1): 150–170.

Wellenius GA, Batalha JRF, Diaz EA, et al (2004) Cardiac effects of carbon monoxide and ambient particles in a rat model of myocardial infarction. Toxicol. Sci. 80(2): 367–376.

Wold LE, Simkhovich BZ, Kleinman MT, et al (2006) In vivo and in vitro models to test the hypothesis of particle-induced effects on cardiac function and arrhythmias. Cardiovasc. Toxicol. 6(1): 69–78.

Younis J, Cooper JA, Miller GJ, et al (2005) Genetic variation in alcohol dehydrogenase 1C and the beneficial effect of alcohol intake on coronary heart disease risk in the Second Northwick Park Heart Study. Atherosclerosis 180(2): 225–232.

Zhang J, Herman EH, Knapton A, et al (2002) SK&F 95654-induced acute cardiovascular toxicity in Sprague-Dawley rats – histopathologic, electron microscopic, and immunohistochemical studies. Toxicol. Pathol. 30(1): 28–40.

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Organizations

International Society for Heart Research
Contact:
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Web: http://www.usouthal.edu/ishr/ishr1.htm

The International Society for Heart Research seeks to promote advances in knowledge in the cardiovascular sciences worldwide via publications (especially, the *Journal of Molecular and Cellular Cardiology*) and congresses. It has sections in Australasia, China, Europe, India, Japan, North America, and Latin America.

Other Resources

Health Canada
Web: http://search.hc-sc.gc.ca/cgi-bin/query?mss=hcsearch

Provides online search and retrieval of documents containing user-specified terms. For example, entering 'cardiovascular toxicity mechanisms' retrieves a listing of over 150 pages of hyperlinked documents.

Public Health Agency of Canada

Web: http://www.phac-aspc.gc.ca/ccdpc-cpcmc/cvd-mcv/publications/ccdb97_e.html

Publication entitled, 'Towards a Canadian Cardio-vascular Database' (1997).

CHAPTER

49

Target Sites: Endocrine

KAREN CHOU

INTRODUCTION

The endocrine system, along with the nervous system, comprise the primary regulators of body metabolism. While the nervous system acts through electrical impulses and neurotransmitters, the endocrine system operates through chemical messengers called hormones. Hormone production is regulated by a chain of choreographed interactions of many endocrine organs. As a response to physiological and environmental stress, hormones are synthesized and secreted in a timely and quantitative manner. They travel in the bloodstream to different parts of the body to elicit characteristic cellular responses through hormone-specific receptors in target endocrine organs. Upon binding to receptors at target organs, the hormone–receptor complex initiates a cascade of signal transduction reactions, which ultimately modulate expressions of genes, thus regulating physiological and cellular reactions that are essential for reproduction, growth, development, immune reactions, and neurobehavioral functions.

Furthermore, hormone production is controlled by negative feedback mechanisms. When there is sufficient concentration of a hormone in circulation, a control mechanism will send signals back to the hormone-producing organ to inhibit further hormone production. This mechanism prevents excessive stimulation and maintains the stability of the cellular status.

Many environmental factors, including the light cycle, temperature, naturally occurring ingredients in food, and anthropogenic pollutants, interact with the endocrine system and influence hormone production. Substances with the ability to interfere with hormone levels in the endocrine system, however, do not necessarily pose any health risk for humans and other organisms. The endocrine system has the capacity to tolerate moderate external challenges by evoking the above-described adaptable control/feedback mechanisms, thus maintaining functional homeostasis of the body. However, deleterious health effects could occur when the control mechanisms of equilibrium are overwhelmed by excessive amounts of exposure to endocrine disruptors.

Endocrine dysfunction could result from having either an excessive or insufficient amount of hormone production or failure to induce proper cellular responses. Excessive amounts of hormones may be caused by overproduction, rapid release from storage, decreased rate of metabolism or decreased excretion, while insufficient amount of hormone production may be caused by decreases in hormone synthesis or release, increased rate of metabolism or rapid excretion. Cellular injury of endocrine organs and altered enzymatic activities of hormone synthesis and metabolism could be the underlying etiology of endocrine toxicity. Endocrine dysfunction may also result from exposure to substances with structures similar to hormones that are capable of binding to receptors, thus either mimicking the function of a hormone or inhibiting the function of the normal hormone–receptor complex. An endocrine toxic substance may also change the way hormones are transported in circulation by adhering to or changing the amount of hormone-binding protein. In such cases, either the total concentration of a hormone or the amount in free form (i.e. biologically available form) can be altered. Furthermore, hormones are also involved in the differentiation and development of interrelated endocrine organs and the nervous systems.

The potential of a substance to cause developmental effects depends not only on the amount of exposure, but also on the timing of exposure in an organism's stage of life. During gestation and prepuberty, morphological and functional development in a fetus and young animal are highly sensitive to endocrine-disrupting agents.

RESOURCES

Books

Beck-Peccoz P (Ed) (2004)
Syndromes of Hormone Resistance on the Hypothalamic-Pituitary-Thyroid Axis
Kluwer Academic Publishers Group, Dordrecht, Netherlands

A book in the *Endocrine Updates* series. The authors explore the fundamental mechanisms and pathogenesis for thyroid hormone structure–function defects and provide information on clinical syndromes of thyroid hormone and thyroid-stimulating hormone resistance, the mechanisms of action of the various hormones, etiopathology of the syndromes, instruments for diagnosis, as well as the difficulties in managing these diseases.

Chou K (2005)
Endocrine System
In: Encyclopedia of Toxicology, Wexler P, et al. (Eds.), 2nd Edition
Elsevier Inc., London

This chapter, in the second edition of *Encyclopedia of Toxicology*, provides a concise overview of the endocrine system and presents the major aspects of the biological nature of endocrine disruptors, including the maintenance of homeostasis of body functions and mechanisms of endocrine disorders. It also summarizes potential etiology of endocrine disruption by using examples of endocrine disruptors in the environment.

Chyczewski L, Niklinski J, Pluygers E (Eds.) (2001)
Endocrine Disruptors and Carcinogenic Risk Assessment
IOS Press, Amsterdam, Netherlands

As a volume in the *NATO Science Series: Life and Behavioral Sciences* (Volume 340), it is devoted to the study of the endocrine-related effects on human health with special reference to carcinogenesis and the assessment of carcinogenic risk. The topics include basic information at the general, cellular, and molecular levels. The paradigm of Biologically Based Risk Assessment is introduced.

Committee on Hormonally Active Agents in the Environment, National Research Council (1999)
Hormonally Active Agents in the Environment
National Academy Press, Washington, DC

This book examines the science behind the prospect of 'estrogen mimics' threatening health and well-being, from the level of ecosystems and populations to individual people and animals. The committee identifies research needs and offers specific recommendations to decision makers. It evaluates the literature on hormonally active agents in the environment; identifies known and suspected toxicological mechanisms and effects in fish, wildlife, and humans; and examines whether and how exposure to hormonally active agents occurs in diet, in pharmaceuticals, and from industrial releases into the environment. It also identifies significant uncertainties, limitations of knowledge, and weaknesses in the scientific literature. The book is available online: http://www.nap.edu/catalog/6029.html#toc.

Crain DA, Guillette LJ Jr (Eds.) (2000)
Environmental Endocrine Disruptors: An Evolutionary Perspective
Taylor & Francis, New York

This book deals with the research aspects of endocrine disruption caused by exposure to contaminants in humans and other mammals and vertebrates. It addresses the problem of endocrine-disrupting contaminates from an evolutionary, comparative perspective. Initial chapters provide a background on the evolution of the vertebrate endocrine system and the evolution of vertebrate systems associated with lipid storage and utilization. Additional chapters examine specific aspects of endocrine disruption, including effects on the reproductive, immune, and nervous systems, the liver, and thyroid. Each chapter takes into consideration the evolution of endocrine signaling, the comparative nature of the supporting data, and differential biological effects between adults and developing embryos.

Harvey PW, Rush KC, Cockburn A (Eds.) (1999)
Endocrine and Hormonal Toxicology
John Wiley & Sons, Chichester, UK

This book addresses the integrated role of the endocrine system and hormones in toxicological responses and the mechanistic and molecular basis for toxicity in organs. It discusses the types of endocrine toxicity, endocrine organs as toxicological targets, comparative endocrine carcinogenesis, and hormonal mechanisms of toxicity in the immune, nervous, cardiovascular,

hepatic, renal, dermal, gastrointestinal, and reproductive systems. Specific sections are devoted to endocrine-disrupting chemicals, hormonal mechanisms in breast cancer, and regulatory trends in endocrine and hormonal toxicology.

Haschek WM, Rousseaux CG, Wallig MA (Eds.) (2001)
Handbook of Toxicologic Pathology: Two-Volume Set, 2nd Edition
Academic Press, San Diego, CA.

This two-volume handbook describes principles of toxicology and toxicological pathology. In addition to general toxicology and pathology, Volume 1 focuses on the practice of toxicological pathology and selected topics on pathological testing, risk assessment, risk communication, and agent-specific pathological toxicology. It contains a specific chapter on environmental toxicants, including endocrine disruptors (ED) and heavy metals. Volume 2 contains 18 chapters of discussions of organ-specific toxicologic pathology with an emphasis on organ systems and the effects that toxicity has on their structure and functions. It also covers several endocrine system-related topics, including reproductive systems, the nervous system, and developmental toxicity.

Henshel DS, Black MC, Harrass MC (Eds) (1999)
Environmental Toxicology and Risk Assessment: Standardization of Biomarkers for Endocrine Disruption and Environmental Assessment, Eighth Volume, STP 1364
ASTM, West Conshohocken, PA

A collection of 29 peer-reviewed papers that provide information on invertebrate and vertebrate endocrine-disruptor screening assays and tests, in vitro endocrine-disruptor testing, and an industrial perspective on endocrine screening testing. It focuses on the use of biomarker endpoints in toxicology and risk assessment, including biochemical, developmental, behavioral, and endocrine indicators. Specific topics include aquatic toxicology, behavioral toxicology, biochemical indicators, developmental indicators, endocrine indicators, biodegradation, and fate of chemicals, quality assurance and quality control within laboratory and field studies, risk assessment and communication, and harmonization of standards development. This may be a reference book for professionals dealing with product and chemical safety and chemical treatment and disposal issues.

Keith LH (1997)
Environmental Endocrine Disruptors: A Handbook of Property Data
Wiley, New York

Available in both print and electronic form, this book provides information on chemical, physical, and toxicological properties of known and suspected environmental endocrine disruptors, including properties and analytical methods for 67 agents. A searchable CD-ROM version is also available.

Keith LH, Jones-Lepp TL, Needham LL (Eds.) (2000)
Analysis of Environmental Endocrine Disruptors
American Chemical Society, Blacksburg, Virginia

This is a collection of lectures of the American Chemical Society Symposium series, focusing on several endocrine disruptors, their adverse effects on humans and animals, as well as related regulatory approaches. For the exposure and environmental contamination assessment, there are sections that describe the sources of endocrine disruptors, strategies for screening, and methods of monitoring environment media, including techniques of chemical analysis and bioassays.

Kendall R, Dickerson R, Giesy J, Suk W (Eds.) (1998)
Principles and Processes for Evaluating Endocrine Disruption in Wildlife
SETAC Press, FL

This is a joint effort of scientists from academia, government, and industry, as a result of the Workshop on Principles and Processes for Evaluating Endocrine Disruption in Wildlife (1996). It provides principles and processes for evaluating the effects of endocrine-disrupting chemicals in wildlife. It is written as a reference for educational purposes for environmental and industrial managers and planners in their decision-making involving endocrine-disrupting chemicals and protecting wildlife.

Lechago J, Gould VE, Bloodworth JMB (Eds.) (1997)
Bloodworth's Endocrine Pathology, 3rd Edition
Williams & Wilkins, Baltimore, MD

A review of endocrine system pathology, covering the aspects of mechanisms of hormone action, molecular and cellular basics of endocrine neoplasia, neurohypophysis, hypothalamus, and the pineal gland. The discussion includes endocrine aspects of the male and female reproductive systems.

McLachlan JA, Guillette LJ, Iquchi T, Toscano WA, Jr (Eds.) (2001)
Environmental Hormones: The Scientific Basis of Endocrine Disruption
New York Academy of Science, New York

This volume of the Annals of the New York Academy of Sciences aims to assist molecular endocrinologists, clinicians, and field biologists in their understanding of endocrine-disruption-related cellular and molecular biology, clinical medicine, and ecosystem dynamics.

Metzler M (Ed.) (2001)
Endocrine Disruptors, Part 1 and Part 2
Springer-Verlag, Berlin, Heidelberg, New York

As a part of the Handbook of Environmental Chemistry series, these two books are sub-volumes within the *Endocrine Disruptors: Volume 3*, dealing with endocrine disruption and endocrine active compounds. It covers the major classes of endocrine active chemicals, methods for their detection and their association with health disturbances in humans and wildlife. The etiology of several endocrine-disruptor-associated human diseases is illustrated. The book also stresses the concept that hormonally active agents can cause both adverse and beneficial effects.

Naz RK (Ed.) (1999)
Endocrine Disruptors: Effects on Male and Female Reproductive System
CRC Press LLC, Boca Raton, FL

This book examines the reproductive and health hazards of endocrine disruptors in the environment. It provides collective knowledge from multiple disciplinary areas, from epidemiology to the etiology of endocrine disruptions, with an emphasis on the effects and mechanisms of their action on sex differentiation during development, fertility, and breast cancer. It also addresses the effects of endocrine disruption on the male reproductive system, focusing on male fertility and the development of benign prostate hyperplasia and prostate cancer.

Norris DO, Carr JA (Eds.) (2005)
Endocrine Disruption: Biological Bases for Health Effects in Wildlife and Humans
Oxford University Press, New York

This is a three-volume book that describes the mechanisms, activities, risks, and health effects of the six most recognized chemical classes of endocrine disruptors: dioxins and other halogenated aromatic hydrocarbons, PCBs, DDT and other organochlorine pesticides, heavy metals, alkylphenol surfactants, and natural plant chemicals.

Journals

Birth Defects Research, Part B, Developmental and Reproductive Toxicology
John Wiley & Sons, Inc., Hoboken, New Jersey
Web: http://sciserver.lanl.gov/cgi-bin/sciserv.pl?collection=journals&journal=15429733

Original research and reviews in fields related to embryo-fetal development and reproduction, effects of chemical, biological, or physical agents on any aspect of the reproductive cycle, including the endocrine control of reproduction and development, safety studies, the mechanism of action of a toxicant or its risk to humans. There are also letters to the editor, short reviews, and commentaries.

BMC Endocrine Disorders
BioMed Central, London
Web: http://www.biomedcentral.com/bmcendocrdisord/

Original peer-reviewed research articles in all aspects of the prevention, diagnosis, and management of endocrine disorders, as well as related molecular genetics, pathophysiology, and epidemiology.

Clinical Endocrinology (1965–)
Blackwell Publishing, Malden, MD
Web: http://www.blackwellpublishing.com/journal.asp?ref=0300-0664&site=1

Papers and reviews which focus on the clinical aspects of endocrinology, including the clinical application of molecular endocrinology. It features reviews, original papers, commentaries, cases of the month, book reviews, and letters to the editor.

Comparative Biochemistry and Physiology Part C. Pharmacology, Toxicology and Endocrinology
Pergamon-Elsevier Ltd.
Web: http://www.sciencedirect.com/science/journal/07428413

The Journal receives editorial direction from all of the major societies in the field. It publishes articles concerned with chemical and drug action at different levels of organization, biotransformation of xenobiotics, mechanisms of toxicity, including reactive oxygen species and carcinogenesis, endocrine disruptors, natural products chemistry, and signal transduction with a molecular approach to these fields.

Endocrine-Related Cancer
Society for Endocrinology, Chevy Chase, MD
Web: http://erc.endocrinology-journals.org/

A global forum for basic, clinical, and experimental investigations which concern endocrine-related cancer in human and animal subjects. The journal publishes reviews, both submitted and commissioned, and also, from time to time, the proceedings of the world's key meetings in the field. Original research papers are only published if they are of exceptional quality. All papers are peer-reviewed and published with the minimum of delay.

Endocrine Reviews (1980–)
Endocrine Society, Chevy Chase, MD

Web: http://intl-edrv.endojournals.org

This journal contains reviews of the recently published books, articles, and other publications relating to the study of the endocrine system, such as endocrine disruptors and endocrine toxicology.

General and Comparative Endocrinology
Elsevier Inc., London
Web: http://www.elsevier.com/wps/find/journaldescription.cws_home/622837/description?navopenmenu=−2

The Journal has a strong focus on basic endocrinology and occasionally features brief reviews. The topics include cellular mechanisms of hormone action; functional, developmental, and evolutionary aspects of vertebrate and invertebrate endocrine systems; neuroendocrinology and reproductive biology.

Reviews in Endocrine & Metabolic Disorders (2000–)
Springer, Netherlands
Web: http://www.ingentaconnect.com/content/klu/remd

A relatively new quarterly review journal in which articles are limited to 8 to 10 pages long, to appeal to both clinical and academic endocrinologists. It includes both basic science and clinical knowledge in the broad area of endocrinology and metabolism. Each issue, with ten to twelve articles, is devoted to a single topic; with some topics extending over multiple issues.

Trends in Endocrinology and Metabolism
Elsevier Inc., London
Web: http://www.sciencedirect.com/science/journal/10432760

A review journal with ten issues per year. It provides critical reviews of recent advances across the field of endocrinology and metabolism. The content focuses not only on fundamental research but also on clinical disease and advances in therapy. Articles are directly commissioned from authors by the Editor-in-Chief on the basis of recommendations from the editorial board and other researchers to ensure that coverage encompasses the most interesting and important advances in the field of endocrinology, and that the articles are written by knowledgeable and respected authors. It also contains reports on meetings and symposia, correspondence, and book reviews.

Journal Articles

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Ashby J, Houthoff E, Kennedy SJ, et al (1997) The challenge posed by endocrine-disrupting chemicals. Environ. Health Perspect. 105(2): 164–169.

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endocrine disruptors on reproductive health in male offspring. Eur. J. Epidemiol. 21(Suppl. S): 56.

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Organizations

Agency for Toxic Substances and Disease Registry (1980)
ATSDR Region 8
999 18th Street
Denver, CO 80202-2466
Phone: 303-312-7010
Fax: 303-312-7018
Phone: 1-888-422-8737
Email: tucker.glenn@epa.gov
Web: http://www.atsdr.cdc.gov

The Agency for Toxic Substances and Disease Registry (ATSDR) is a federal public health agency based in Atlanta, Georgia, under the U.S. Department of Health and Human Services. ATSDR's mission is to 'serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and disease related exposures to toxic substances.' It produces 'Toxicological Profiles' for hazardous substances found at National Priorities List sites. Endocrine-disrupting nature is reviewed in many of the chemical specific 'Profiles.' The agency also conducts many in-class and distance education and training programs to the public, environmental researchers, and health professional on many environmental health related topics, which include public health assessments, exposure investigation, community involvement, and health risk communication.

U.S. Environmental Protection Agency
Ariel Rios Building
1200 Pennsylvania Avenue, N.W.
Washington, DC 20460
Phone: 202-272-0167
Email: opp-web-comments@epa.gov
Web: http://www.epa.gov

The United States Environmental Protection Agency (USEPA), first established in 1970, aims to protect human health and the environment. USEPA leads the nation's environmental science, research, education, and assessment efforts by developing and enforcing regulations, offering financial assistance, performing environmental research, sponsoring voluntary partnerships and programs, advancing environmental education, and publishing related information. To achieve its multiple goals, the USEPA consisted of many divisions, centers, offices and laboratories, including the National Exposure Research Laboratory (NERL), Office of Pollution Prevention and Toxic Substances, Congressional and Intergovernmental relations, Office of Science Coordination and Policy, Office of Research and Development and the National Agriculture Compliance Assistance Center. Many of the USEPA's programs have components related to managing endocrine disruptors in the environment. Examples of these programs are the Endocrine Disruptor Screening Program, Endocrine Disruptors Research Initiative, Brownfield Program, and the NERL Endocrine Disruptor Compounds Research.

The Endocrine Society
8401 Connecticut Avenue
Suite 900
Chevy Chase, MD 20815-5817
Phone: 301-941-0200
Web: http://www.endo-society.org/

The Society holds annual scientific meetings focusing on the recent developments in endocrinology. It publishes four peer-reviewed journals about endocrinology and metabolism: *The Journal of Clinical Endocrinology and Metabolism, Endocrinology, Molecular Endocrinology,* and *Endocrine Reviews*. These journals provide information on advances in endocrine research and clinical treatment of endocrine disorders such as diabetes, reproductive dysfunction, osteoporosis, thyroid disease, obesity/lipids, growth hormone, pituitary tumors, and adrenal

insufficiency. Its members represent a broad range of disciplines associated with endocrinology, including clinicians, researchers, educators, fellows, students, industry professionals, and health professionals.

Society for Endocrinology
22 Apex Court, Woodlands, Bradley Stoke, Bristol
BS32 4JT, UK
Phone: +44 (0)1454 642200
Fax: +44 (0)1454 642222
Reg. in England No. 349408
Reg. Charity No. 266813
Web: http://www.endocrinology.org/

This is an international society based in the United Kingdom. Its members include researchers, clinicians, and nurses who work with hormones. The society's primary foci are to provide a focus for sub-specialties within endocrinology to strengthen the overall discipline and provide a framework for different groups to come together to communicate and promote interdisciplinary interests within the Society; and to increase the profile of endocrinology as a specialty.

Databases

Endocrine Disruptors Knowledge Base (EDKB)
National Center for Toxicological Research,
U.S. Food and Drug Administration
Web: http://www.fda.gov/nctr/science/centers/toxicoinformatics/edkb/index.htm

This searchable database contains biological activity information, QSAR training sets, and computational models to predict estrogen and androgen activity. It is designed 'to serve as a resource for research and regulatory scientists and other interested parties to make use of an existing body of knowledge, foster the development of computational predictive toxicology models, and reduce dependency upon slow and expensive animal experiments.' It also provides website links to access other datasets and online models. The Knowledge Base is administered by NCTR's Center for Toxicoinformatics.

Other Resources

Endocrine News
Endocrine Society, Chevy Chase, Maryland
Web: http://www.endo-society.org/news/endocrine_news/

A monthly magazine published by The Endocrine Society. It is the source of trends and insights for members of the endocrine community. Special sections include Trends & Insights, Viewpoint, Spotlight on Policy, Feature Articles of Tri-Point Series (series explore subject areas from three different angles – the basic researcher, the clinical researcher, and the physician in practice), Practice Resources, A Look Back, and a Classified Section.

Our Stolen Future
Web: http://www.ourstolenfuture.org/

This is the website for the authors of the book 'Our Stolen Future,' where regular updates about science related to endocrine disruption are posted. 'The book Our Stolen Future brought world-wide attention to scientific discoveries about endocrine disruption and the fact that common contaminants can interfere with the natural signals controlling development of the fetus.' The website contains recent developments and information on endocrine disruptors. The site also has links to other related websites. There is also information regarding policy debates and a forum for public inputs.

CHAPTER

50

Target Sites: Gastrointestinal

MARION JOSEPH FEDORUK

The gastrointestinal (GI) system is composed of a luminal GI tract lined by mucous membranes and associated digestive organs, including the liver, exocrine pancreas, and gallbladder. This chapter focuses on the GI tract. The liver and pancreas are discussed in other sections of this book.

The primary function of the GI tract is absorption of nutrients, ions, and water from foods and water. This requires digestion that involves the breakdown or hydrolysis of food into smaller molecules in preparation for absorption into the body. Absorption refers to the transport of nutrients, ions, and water across intestinal cells into the body for metabolism.

The GI tract consists of five general segments, each with various specialized cell types that reflect a unique function. The oral cavity and hypopharynx initiate the process of digestion by mechanically breaking down and mixing food with salivary enzymes. The esophagus, a gullet, propels food from the hypopharynx to the stomach. The stomach further digests food by secreting gastric acid and the proteolytic precursor enzyme pepsinogen, which break down food. The stomach also churns food into smaller sizes through peristaltic action. Food is stored in the stomach and released to the small intestine in a controlled fashion to facilitate optimal absorption.

Absorption occurs primarily in the small intestine, which consists of three segments: duodenum, jejunum, and ileum. Pancreatic juices and enzymes are secreted into the proximal small intestine (duodenum), where they assist in digestion by breaking down nutrients into small molecules that can be absorbed directly. Bile acids are secreted through the bile duct into the duodenum to help form micelles that emulsify and facilitate the absorption of lipids. Most absorption occurs in the jejunum and ileum. The colon, the final segment of the GI tract, largely serves to absorb water and ions, including sodium, magnesium, and chloride, from undigested food passed from the ileum. Non-digestible carbohydrates, or fiber, and other unabsorbed materials are mixed with intestinal bacteria, known as gut flora, to form solid feces, which are stored and later eliminated from the colon.

The GI tract tube consists of (1) an inner mucosal layer that contains mucus-secreting cells and specialized cells; (2) a submucosal layer that consists of loose connective tissue containing blood and lymphatic vessels, inflammatory cells, and nerve fibers; (3) a muscular layer containing many smooth muscles, which is responsible for peristalsis and emesis; and (4) a serosal layer or covering that encloses the tube.

The epithelial cell is the most specialized cell in the intestine. This cell provides a barrier between the intestinal contents and the interior of the tube. Epithelial cell functions include nutrient absorption and immune response, which includes signaling to immune cells about the presence of microbial pathogens in the gut. The epithelial cell compartment is also one of the most rapidly proliferating pools of cells in the body and is very sensitive to xenobiotics or radiation that affect cell cycles.

The lymphatic tissue forms the GI mucosal immune system, which represents the largest lymphoid compartment in the human body. The neural tissue found throughout the GI tract is organized into a neural plexus that functions as an enteric nervous system and coordinates movement of luminal contents through the GI tract. Metabolism of ingested xenobiotics may occur

in the GI tract. Intestinal epithelial cells can metabolize compounds through multiple enzymatic pathways, including glucoronidation, sulfation, acetylation, and hydroxylation. Similar enzymes are also found in liver cells. Intestinal epithelial cells also contain export pumps that may secrete xenobiotic agents into the intestinal tract. Many factors may affect intestinal enzyme and/or export pump activity, including other xenobiotics, foods, or herbal products. For example, ingestion of grapefruit juice is recognized to inhibit intestinal CYP3A, possibly leading to exaggerated effects from statins and calcium channel blockers. Also, levels of enzymes such as glucuronidases vary significantly among individuals and may play a role in the detoxification of carcinogens and colorectal cancer.

The GI tract is colonized by endogenous bacteria or host flora. Over 40 types of bacteria have been detected in the intestine. There are approximately ten times more bacteria in the gut than human cells in the body. Host flora perform metabolic functions and serve to ferment undigested carbohydrates in the colon into short-chain fatty acids, which can be used for energy by colon cells. Host flora also play a role in immunity, growth repression of harmful microorganisms, growth of epithelial cells, and biotransformation of xenobiotics. Loss of intestinal flora following antibiotic therapy can lead to overgrowth of pathogenic organisms. Probiotic formulations of bacteria that are non-pathogenic and part of the human flora may be used as prophylatics or therapeutic agents for certain GI conditions.

From a toxicological perspective, the GI tract is an important organ system, because it serves as a site of entry for a broad array of toxicants. The GI tract has the second-largest surface area, after the lung, which is in direct contact with the external environment. Agents contacting the GI tract include foods, food contaminants, oral medications, and environmental contaminants found in water and soil that are swallowed inadvertently. Ingestion cases represent about 78% of the two million calls made to the U.S. Poison Control Centers in 2004. In addition, inhaled particles can be cleared from the lung via the mucociliary tree, and subsequently swallowed, resulting in direct contact with GI mucosa.

Agents known to cause inflammation of the stomach include caustics, arsenic, iron, mercuric chloride, alcohols, antineoplastics, salicylates, podophyllin, and non-steroidal anti-inflammatory drugs (NSAIDs). NSAIDs also interfere with the gastric mucosal barrier by inhibition of cyclooxygenase. Caustics (e.g., sodium hydroxide found in lye, drain cleaners) can produce severe liquefactive necrosis of the esophagus and permanent scarring. The type of toxic effect that is manifested depends on several factors, including the chemical characteristics of the agent, dose, magnitude of exposure, and type of tissue involved. Factors that affect the degree of tissue injury or destruction include the amount ingested, duration of contact with tissue, concentration, pH, physical form, and titratable alkaline and acid reserve.

Gastrointestinal function can also be affected by interaction with cellular receptors of the enteric nervous system. Stimulation of cholinergic muscarinic receptors by agents such as cholinesterase inhibitors (organophosphate pesticides and carbamates) and nicotine and opioid withdrawal can lead to an increase in motility and secretions of the GI tract. This process can lead to symptoms of abdominal pain, cramps, and diarrhea. Similarly, the administration of drugs that block with cholinergic muscarinic receptor functioning (e.g., atropine, tricyclic antidepressants, opiates, and sedative hypnotic medications) can slow motility and lead to constipation. In general, agents that exhibit parasympathetic activity promote motility while sympathetic agents decrease motility.

Indirect toxic effects of xenobiotics include vomiting as a consequence of the interaction of a chemical with the central chemoreceptor zone or vomiting center in the fourth ventricle of the brain. Glycosides, opiates, nicotine, and possibly carbon monoxide may act in this manner. Vomiting can also occur as a consequence of local GI-tract stimulation from a wide array of agents, including soaps, detergents, solvents, metals (e.g., arsenic and thallium), and toxins associated with several types of food poisoning.

The GI tract can also be a site of hypersensitivity reactions. For example, angioedema of the mouth, including the pharynx, can occur following use of several medications, including ACE inhibitors. The reaction is mediated via immunoglobin E (IgE).

Cancers of the GI tract constitute a large proportion of malignancies in the U.S. In 2006, GI cancers represented about 20% of all cancer deaths in the U.S., while colon cancers were nearly 10%, pancreas 5%, and esophagus and stomach 4.5%. Multiple causal factors have been postulated for one or more of these cancers, including diet, smoking, alcohol, medications, occupation, environment (including water and air pollution), and ionizing radiation. There are considerable geographic differences between cancer incidence of the same organ. In addition, migration studies have demonstrated that migrants who move to new countries, over time, will experience the same risks or cancer rate as people in the host country for some GI tumors.

Oral cavity cancers have been associated with cigarettes, alcohol, chewing tobacco or snuff, or betel nut quid (popular in parts of Asia). Esophageal cancer has

been related to the use of alcohol and nitrosamines and possibly chewing of betel nut. Diets high in fats and red meats may increase the risk of colon cancer by changing the intestinal flora or increasing the concentration of bile acids due to a secondary effect on metabolism of xenobiotics. Negative associations have been associated with intake of fresh vegetables and meats. Cancer of the rectum not only shares some risk factors with colon cancer overall, but also has distinct characteristics possibly related to sexually transmitted infections, chronic inflammation, and cigarette smoking.

RESOURCES

Books

Gad S (Ed.) (2007)
Toxicology of the Gastrointestinal Tract
Target Organ Toxicology Series
CRC Press, Boca Raton, FL.

Part of the Target Organ Toxicology Series, this is one of the few textbooks that address GI-tract toxicology. The chapters describe GI-tract anatomy, function, development, and functional assessment, as well as canine GI function, GI toxicology, and animal models to assess GI toxicity.

Kotler K, Flomenbaum N (2006)
Gastrointestinal Principles
In: Goldfrank's Toxicologic Emergencies (Chapter 25). Flomenbaum NE, Goldfrank LR, Hoffman RS, Howland MA, Lewin NA, Nelson LS (Eds.), Eighth edition
New York, McGraw-Hill.

This authoritative medical toxicology text is an excellent review of GI-tract anatomy, physiology, and pathology, and the toxicological effects of medications, biologic agents, radiation, and household products on GI function. This text describes symptom patterns, clinical findings, and medical management of a broad range of agents that can affect the GI system through direct and indirect mechanisms.

Shottenfeld D, Fraumeni J (Eds.)
Cancer Epidemiology and Prevention, 2nd Edition
New York, Oxford University Press.

This authoritative text discusses cancer epidemiology and causation, with detailed discussion of environmental, occupational, medicinal, dietary, infectious agents, ionizing, and solar radiation risk factors. This text includes separate chapters for cancers of the oral cavity and pharynx, esophagus, stomach, pancreas, small intestine, and large intestine.

Journals

Gastroenterology

This is the official journal of the American Gastroenterological Association (AGA) Institute (http://www.gastro.org). The publication website of AGA has lists of relevant listings of resources such as journals, reports, and books related to gastroenterology. It is the most important and popular journal in the field of GI-related disease and toxicology. It delivers up-to-date and authoritative coverage of both basic and clinical gastroenterology. Articles and reports by leading researchers on the latest treatments for diseases, and an exclusive correspondence section provides important information related to GI tract diseases and toxicology. Original research is organized into the Clinical Alimentary Tract; Clinical Liver, Pancreas and Biliary; Basic Alimentary Tract; and Basic Liver, Pancreas and Biliary. This journal also bridges the gap between basic and clinical science based on their publications of comprehensive reviews on important topics such as pancreatitis and liver disease. Additional features may include monthly special features in Gastroenterology, Gastroenterology and Hepatology News, Imaging and Advanced Technology, Clinical Challenges and Images in GI, Selected Summaries, Print and Media Reviews, Continuing Medical Education Activities, Editorials, Correspondence, and Biographical Sketches. This journal was ranked 1st out of 48 gastroenterology and hepatology titles on the 2006 ISI Journal Citation Reports®, published by Thomson Scientific (excerpted from http://www.gastrojournal.org/).

Journal Articles

Toxin-induced GI-tract pathology

Parora AS, Murray JA (2000) Iatrogenic esophagitis. Curr. Gastroenterol. Rep. 2(3): 224–229.

This paper examines nearly 1000 reported cases of drug-induced esophagitis. The article describes medications that have caused esophagitis. Associated clinical features are also described.

Parfitt JR, Driman DK (2007) Pathological effects of drugs on the gastrointestinal tract: A review. Hum. Pathol. 38(4): 527–536.

This review describes the morphological and pathophysiological features of drug-related injury of the upper and lower GI tract. Pathological findings associated with common medications are described. Practical guidelines for the recognition and diagnosis of drug-induced GI pathology are also proposed.

Price AB (2003) Pathology of drug-associated gastrointestinal disease. Br. J. Clin. Pharmacol. 56(5): 477–482.

This article describes diagnostic criteria for drug-associated GI disease, including histological features of the gut associated with drug-related GI disease, and clues for diagnosing a drug-induced injury.

Agent-specific publications

Fortun PJ, Hawkey CJ (2007) Nonsteroidal antiinflammatory drugs and the small intestine. Curr. Opin. Gastroenterol. 23(2): 134–141.

This article is an examination of literature concerning the toxic effects of non-steroidal anti-inflammatory drugs on small-bowel toxicity, and development of a subclinical small-bowel enteropathy. The clinical relevance and role of non-cyclooxygenase-mediated toxicity mechanisms of action are discussed.

Franke A, Teyssen S, Singer MV (2005) Alcohol-related diseases of the esophagus and stomach. Dig. Dis. 23(3–4): 204–213.

This article reviews the effects of acute and chronic alcohol consumption on function, inflammation, and cancer of the esophagus and the stomach. Pathophysiologic mechanisms for esophageal and gastric diseases are reviewed.

Guarner F (2006) Enteric flora in health and disease. Digestion 73(Suppl 1): 5–12.

This paper examines the scientific literature concerning the role of bacterial enteric flora on digestion and absorption. It covers intestinal, epithelium, and immune function and disease, including colon cancer, inflammatory bowel disease, and multi-organ failure.

McGarr SE, Ridlon JM, Hylemon PB (2005) Diet, anaerobic bacterial metabolism, and colon cancer: A review of the literature. J. Clin. Gastroenterol. 39(2): 98–109.

This literature review analyzes publications on the relationships between dietary habits, microbial flora, and cancer risk. Use of fecal flora analysis for colon cancer screening and diagnosis are also evaluated. Special discussion on bile acid metabolism is included. Chemopreventive, anticarcinogenic, and detoxifying activities of probiotics are discussed.

Niazi M, Kondru A, Levy J, Bloom AA (1997) Spectrum of ischemic colitis in cocaine users. Dig. Dis. Sci. 42(7): 1537–1541.

This article describes the clinical, endoscopic, and histopathologic findings observed in seven patients with cocaine colitis.

Ramasamy K, Gumaste VV (2003) Corrosive ingestion in adults. J. Clin. Gastroenterol. 37(2): 119–124.

This article is a review of medical management of corrosive substance ingestion and factors that affect clinical outcomes. Acute and chronic effects from ingestion and the role of steroid therapy are examined.

Salzman M, O'Malley RN (2007) Updates on the evaluation and management of caustic exposures. Emerg. Med. Clin. North Am. 25(2): 459–476.

This article provides guidelines for medical management of caustic ingestions, including controversies in patient care. Management of hydrofluoric acid ingestion, including use of antidotes, is also addressed.

Online web-based resources

American Cancer Society
Web: http://www.cancer.org/docroot/home/index.asp

This site provides information on GI and other cancers, cancer screening guidelines, and the roles of alcohol, nutrition, and other factors in cancer development.

GastroSource
Web: http://www.gastrosource.com/frameset_GI_NEW.asp

This free online website, maintained by Astra Zeneca, contains scientific and educational material for healthcare professionals interested in gastroenterology. Site content is targeted to clinical diagnosis and treatment of GI diseases. This source provides teaching materials, including access to PowerPoint® slides concerning NSAIDs toxicity. This site is dedicated to publication updates on NSAIDs.

CHAPTER

51

Target Sites: Hematopoietic

TONY COX

INTRODUCTION

Understanding of hematopoiesis (blood formation) has improved dramatically in recent years, due in part to rapid discovery and progress in two areas: (1) Improved molecular-biological understanding of the roles of the cytokine network and of the multiple roles and interactions of individual cytokines and their receptors in regulating hematopoiesis and maintaining homeostasis; and (2) Biomathematical and computer simulation models of normal and perturbed hematopoiesis. There are many other important aspects to hematopoiesis toxicology, including the crucial roles played by the bone marrow stromal microenvironment, marrow enzymes, and interactions among events in the bone marrow (the primary site of adult hematopoiesis) and in other systems (especially the immune system) and organs involved in development and regulation of hematopoiesis (e.g., the liver and kidney). Recent advances in understanding regulation of hematopoiesis by the cytokine network and quantitative simulation modeling of hematopoiesis have each been very fruitful in focusing, consolidating, and organizing the huge amounts of information now available about hematopoiesis to make it more useful in toxicology research and applications.

This section identifies resources that can be used to help quickly understand aspects of the current state-of-the-art in hematopoiesis that are most useful in toxicology and modeling. Over 60 journals and dozens of high-quality monographs and textbooks deal with aspects of hematotoxicity and hematopoiesis. Therefore, this section emphasizes resources that synthesize much of what is known and that provide practical computational models that can be used in planning and interpreting results of hematotoxicity investigations.

RESOURCES

Books

The following texts provide useful overviews of hematopoiesis and summaries of experimental and clinical methods and data. Although more recent work has deepened understanding of many details, even the older books on this list are still useful today. A newcomer to this area might begin with early chapters in the introductory texts of McKenzie or Stevens for quick overviews of normal and perturbed hematopoiesis, then read relevant chapters in the collections edited by Irons and by Zon.

Irons RD (Ed.) (1985)
Toxicology of the Blood and Bone Marrow
Raven Press, New York

Provides an overview of hematology and a summary of methods and approaches to the study of blood and bone marrow toxicity. Areas covered include development, structure, and function of the bone marrow, regulation of hemopoiesis, toxicology of the erythrocyte and granulocyte/macrophage lineages, use of stem cell assays, flow cytofluorometry, and cytogenetic techniques for assessing bone marrow damage.

McKenzie SB (2009)
Clinical Laboratory Hematology 2nd edition
Pearson/Prentice Hall, USA
ISBN-10: 0135137322
ISBN-13: 978-0135137321

Web: http://www.amazon.com/Clinical-Laboratory-Hematology-Shirlyn-McKenzie/dp/0130199966

Succinctly reviews the structure and function of hematopoietic organs and normal blood cells. This text gives an up-to-date introduction to clinical hematology, emphasizing the use of a range of laboratory techniques and diagnostic tests to identify leukemic, myelodysplastic, and non-leukemic disorders of hematopoiesis. A related free website offers supplementary information and on-line quizzes on key topics. This site is at: http://wps.prenhall.com/chet_mckenzie_clinicallabhema_1/0,7639,700799-main,00.html/.

Metcalf D (1988)
The Molecular Control of Blood Cells
Harvard University Press, Cambridge, MA
ISBN: 0674581571
ISBN-13: 978-0674581579

This short, beautifully written monograph introduces the key colony-stimulating factors (CSFs) involved in regulating the differentiation and maturation of granulocytes and macrophages and discusses their interactions and roles within hematopoiesis. (The edited volume by Zon updates much of this material, and includes an introductory survey paper by Metcalf, but is much longer.)

Stevens M (1997)
Fundamentals of Clinical Hematology
Saunders, Philadelphia
ISBN: 0721641776

Gives a relatively brief (320 pages of text organized in 16 chapters) introduction to the basic components of hematopoiesis: leukocytes (granulocytes, monocytes-macrophages, lymphocytes and plasma cells, and leukocyte testing); erythrocytes (including normal and diseased responses and erythrocyte testing); hemostasis and its maintenance by thrombocytes (platelets) and by coagulation and fibrinolysis; and body fluid analysis and clinical laboratory practice.

Wichmann HE (Ed.) (1985)
Mathematical Modeling of Cell Proliferation: Stem Cell Regulation in Hemopoiesis: Erythropoietic Suppression, Combined Stresses, Drug Effects
Crc Pr I Llc
ISBN-10: 0849355044
ISBN-13: 978-0849355042

Wichmann HE, Loeffler M (1985)
Mathematical Modeling of Cell Proliferation: Stem Cell Regulation in Hemopoiesis. Vol. 1: Model Description, Irradiation, Erythropoietic Stimulation
Crc Pr I Llc

Shows how a wealth of experimental data (primarily from laboratory rats and mice) can be integrated into and explained by a mathematical model consisting of multiple compartments connected by flows of cells and non-linear feedback control loops. The model is described by a system of ordinary differential equations and algebraic equations with parameter values for cell birth and death rates and transit times estimated from experimental data.

Zon LI (2001)
Hematopoiesis: A Developmental Approach
Oxford University Press, New York
ISBN-10: 0195124502
ISBN-13: 978-0195124507

This edited volume is divided into sections on hematopoietic progenitor cells and stem cells; early embryology and ontology; important factors in signaling (including surveys of gene-level regulation of myelopoiesis, signal transduction in hematopoiesis, roles of chemokines and of transcriptional control of erythrocyte and megakaryocyte development); myeloid and lymphoid biology, genetics of blood formation, stroma, and vascularzation. The first section – approximately 150 pages on hematopoietic progenitor cells and stem cells – surveys hematopoietic stem cell biology (development, regulation and homeostasis and isolation and purification techniques) as well as aspects of hematopoietic stem cell cultures and gene therapy.

Online Textbooks

American Society of Hematology Self-Assessment Program (ASH-SAP)

The American Society of Hematology offers an online textbook of hematology (http://www.ash-sap.org/ebooks/view.asp) and a set of online tests for continuing medical education credit and certification. Access depends on buying the textbook. The self-assessment program is directed at internists, hematologists, pediatricians, and hematology-oncology fellows.

Journals

A current list of journals in hematology can be found online, e.g., using the following link: http://www.medbioworld.com/cgi-bin/displaycontents.cgi?table=med&type=Journals&filecode=(M)%20Hematology.

Current information and research articles on normal, stressed, and pathological hematology, including leukemia and anemia, can be found in the following journals.

Blood
The American Society of Hematology (ASH), Washington, DC
Web: http://www.bloodjournal.org/

Experimental Hematology (1970–)
Elsevier, Amsterdam, Netherlands.
ISSN: 0301-472X
Web: http://www.exphem.org/

This journal of the International Society for Experimental Hematology publishes original research articles, reviews, and abstracts of the annual meeting of the International Society for Experimental Hematology. Includes articles on in vivo and ex vivo studies of hematopoietic cell cycle regulation, roles of the cytokines network, gene therapy, normal and malignant hematopoiesis, immunobiology, the stromal microenvironment, and molecular genetics, signal transduction, and stem cell biology for hematopoietic cells.

International Journal of Laboratory Hematology
Wiley, USA
Print ISSN: 1751-5521
Online ISSN: 1751-553X
Frequency: Bi-monthly
The official journal of the International Society of Laboratory Hematology.

Journal Articles

Abkowitz JL, Golinelli D, Harrison DE, Guttorp P (2000) In vivo kinetics of murine hemopoietic stem cells. Blood 96(10): 3399–3405.

Badham HJ, Winn LM (2007) Investigating the role of the aryl hydrocarbon receptor in benzene-initiated toxicity in vitro. Toxicology 229(3): 177–185.

Chan TY (1996) Food-borne nitrates and nitrites as a cause of methemoglobinemia. Southeast Asian J. Trop. Med. Public Health 27: 189–192.

Cox LA, Jr (2000) A biomathematical model of cyclophosphamide hematotoxicity. J. Toxicol. Environ. Health A 61(5–6): 501–510.

Faiola B, Fuller ES, Wong VA, Recio L (2004) Exposure of hematopoietic stem cells to benzene or 1,4-benzoquinone induces gender-specific gene expression. Stem Cells 22(5): 750–758.

Greenberger JS (1991) Toxic effects on the hematopoietic microenvironment. Exp. Hematol. 19(11): 1101–1109.

Hatake K, Tomizuka H, Ikeda M, et al (1998) Apoptosis-gene expression in hematopoietic system: Normal and pathological conditions. Int. J. Mol. Med. 1: 121–129.

Hirabayashi Y, Yoon BI, Li GX, Kanno J, Inoue T (2004) Mechanism of benzene-induced hematotoxicity and leukemogenicity: current review with implication of microarray analyses. Toxicol. Pathol. 32(Suppl 2): 12–16.

Kibbe MR, Rhee RY (1996) Heparin-induced thrombocytopenia: Pathophysiology. Sem. Vascular Surg. 9(4): 284–291.

Loeffler M, Bungart B, Goris H, Schmitz S, Nijhof W (1989) Hemopoiesis during thiamphenicol treatment. II. A theoretical analysis shows consistency of new data with a previously hypothesized model of stem cell regulation. Exp. Hematol. 17(9): 962–967.

Metcalf D (1998) Lineage commitment and maturation in hematopoietic cells: The case for extrinsic regulation. Blood 92(2): 345–347.

Ogilvie GK (1995) Hematopoietic growth factors: Frontiers for cure. Vet. Clin. North Am. Small Anim. Practice 25: 1441–1456.

Recio L, Bauer A, Faiola B (2005) Use of genetically modified mouse models to assess pathways of benzene-induced bone marrow cytotoxicity and genotoxicity. Chem. Biol. Interact. 153–154. 159–164.

Roeder I (2006) Quantitative stem cell biology: computational studies in the hematopoietic system. Curr. Opin. Hematol. 13(4): 222–228.

Shepherd BE, Guttorp P, Lansdorp PM, Abkowitz JL (2004) Estimating human hematopoietic stem cell kinetics using granulocyte telomere lengths. Exp. Hematol. 32(11): 1040–1050.

Sefc L, Psenak O, Sykora V, Sulc K, Necas E (2003) Response of hematopoiesis to cyclophosphamide follows highly specific patterns in bone marrow and spleen. J. Hematother. Stem Cell Res. 12(1): 47–61.

Thompson DF, Gales MA (1996) Drug-induced pure red cell aplasia. Pharmacotherapy 16(6): 1002–1008.

Troncale S, Tahi F, Campard D, Vannier JP, Guespin J (2006) Modeling and simulation with Hybrid Functional Petri Nets of the role of interleukin-6 in human early haematopoiesis. Pac. Symp. Biocomput.: 427–438.

Uetrecht J (1990) Drug metabolism by leukocytes and its role in drug-induced lupus and other idiosyncratic drug reactions. Crit. Rev. Toxicol. 20: 213–236.

Wohl JS, Cotter SM (1995) Blood substitutes: Oxygen-carrying acellular fluids. Vet. Clin. North Am. Small Anim. Practice 25: 1417–1440.

Yoon BI, Li GX, Kitada K, et al (2003) Mechanisms of benzene-induced hematotoxicity and leukemogenicity: cDNA microarray analyses using

mouse bone marrow tissue. Environ. Health Perspect. 111(11): 1411–1420.

Organizations

American Society of Hematology (ASH)
1900 M Street, NW, Suite 200
Washington, DC 20036
Phone: 202.776.0544
Fax: 202.776.0545
Email: ash@hematology.org
Web: http://www.hematology.org/

ASH's mission is 'to further the understanding, diagnosis, treatment, and prevention of disorders affecting the blood, bone marrow, and the immunologic, hemostatic and vascular systems, by promoting research, clinical care, education, training, and advocacy in hematology.'

International Society for Experimental Hematology (ISEH)
2025 M Street, N.W., Suite 800, Washington, DC 20036-3309, USA
Phone: (+1/202) 367-1183
Fax: (+1/202) 367-2183
Email: ISEH@smithbucklin.com
Web: http://www.iseh.org/

ISEH's mission is 'to further basic translational and clinical research and to foster communication, education, collaboration in the field of experimental hematology and stem cell biology' by providing up-to-date scientific information on advances in experimental hematology.

Databases

Integrated Risk Information System (IRIS)
Sponsored by the U.S. Environmental Protection Agency (EPA) Office of Research and Development, National Center for Environmental Assessment.
Web: http://www.epa.gov/iris/

The Integrated Risk Information System (IRIS) database allows keyword search for information about potential human health effects of environmental chemicals. It 'is intended for those without extensive training in toxicology, but with some knowledge of health sciences.' IRIS provides oral reference doses and inhalation reference concentrations (RfDs and RfCs, respectively) for chronic noncarcinogenic health effects and hazard identification, and oral slope factors, and oral and inhalation unit risks for carcinogenic effects.

The Risk Assessment Information System (RAIS)
Sponsored by U.S. Department of Energy (DOE), Office of Environmental Management, Oak Ridge Operations (ORO) Office
Web: http://rais.ornl.gov/

Like IRIS, this resource allows quick online search using keywords such as 'hematopoiesis' and retrieves descriptions of health effects of chemicals in the system's database.

CHAPTER

52

Target Sites: Immune

JACQUES DESCOTES

INTRODUCTION

Immunotoxicology, the science of poisons to the immune system, is devoted to the study of adverse effects of pharmaceuticals and all other chemicals on the immune responsiveness of treated or exposed living hosts (immunosuppression and immunostimulation) as well as the induction of hypersensitivity and autoimmunity. Although immunotoxicology is an active area of toxicology, this is still a relatively small area. Therefore, an extensive list of all books devoted to immunotoxicology published since 1999 is provided below. Because immunotoxicology is a cornerstone between toxicology and immunology, key immunology textbooks potentially useful for toxicologists with limited immunological background in immunology are listed as well. Over the past 30 years, the main focus of immunotoxicologists has been on non-clinical aspects of immunotoxicity, especially from a mechanistic or regulatory perspective. A lot of efforts have been paid to designing and validating animal models and in vitro assays useful for the non-clinical evaluation of immunotoxicity and risk assessment. This is reflected in the selection of journal articles among the most relevant review articles on immunotoxicology published since 2000.

RESOURCES

Books

Cohen MD, Zelikoff ZT, Schlesinger RB (2000)
Pulmonary Immunotoxicology
Springer, Boston, MA

A source of information about how a pollutant might affect susceptibility to infection, allergies, or other lung diseases associated with the immune system. The first six chapters provide the reader with the basic background on the structure of the respiratory system, the pulmonary immune system, the fate of inhaled gases and particles, and the allergic, fibrotic, or autoimmune diseases that can affect the lung. The next 10 chapters give specific examples of immunotoxicants and the last two chapters deal with risk assessment and biomarkers.

Descotes J (1999)
An Introduction to Immunotoxicology
Taylor & Francis, London.

Provides a concise, but broad-ranging introduction to key immunological issues. The first section explores the health consequences of immunotoxicity. The book next describes the latest methods used to detect and evaluate, preclinically and clinically, the unexpected immunotoxic effects of xenobiotics.

Descotes J (2004)
Immunotoxicology of Drugs and Chemicals: an Experimental and Clinical Approach. Vol. 1: Principles and Methods of Immunotoxicology
Elsevier, Amsterdam

For students and toxicologists specializing in immunotoxicology. Provides a detailed description of immunological issues including adverse health consequences of immunotoxicity, currently available methods used to detect and evaluate, preclinically and clinically, the unexpected immunotoxic effects of xenobiotics, regulatory requirements, and possible strategies applicable to immunotoxicity risk assessment.

Detrick B, Hamilton RG, Folds JD (Eds.) (2006)
Manual of Molecular and Clinical Laboratory Immunology, 7th edition
ASM Press, Washington, DC.

A very comprehensive textbook providing a detailed description of most standard and recent methods in molecular and clinical laboratory immunology. Covers nearly all current aspects of immunology techniques.

Frankel AE (Ed.) (1998)
Clinical Application of Immunotoxins
Springer-Verlag, Berlin

A reference source for review of results seen with immunotoxins in patients. Covers targeted toxins, ribosome inactivating proteins, bacterial toxins, and clinical trials. Volume 234 of *Current Topics in Microbiology and Immunology*.

Holladay S (Ed.) (2004)
Developmental Immunotoxicology
CRC Press, Boca Raton, FL

For specializing students and toxicologists. Provides an extensive overview of the adverse postnatal immunotoxicological consequences of perinatal exposure. Describes different models used to study developmental immunotoxicology and examples of specific developmental immunotoxic agents, including therapeutics.

House RV, Descotes J (Eds.) (2007)
Cytokines in Human Health: Immunotoxicology, Pathology and Clinical Applications
Humana Press, Totowa, NJ

Provides information on recent advances in the understanding of cytokines' roles in selected organs of toxicity, immunotoxicity, and clinical pathological conditions on a number of levels ranging from basic research to highly applied therapeutic applications.

Kimber I, Selgrade MJ (Eds.) (1998)
T Lymphocytes in Immunotoxicology
Wiley, Chichester, UK

For graduate students and professionals specializing in immunotoxicology, immunopharmacology, and clinical allergy. Provides a review of research into functional subpopulations of T lymphocytes.

Male D, Brostoff J, Roth DB, Roitt I (2006)
Immunology, 7th edition
Mosby-Elsevier, London

Latest edition of the famous immunology textbook for students and toxicologists with no particular immunological background.

Nijkamp FP, Parnham MJ (Eds.) (2005)
Principles of Immunopharmacology, 2nd edition
Birkhauser Verlag, Basel, Switzerland

Provides essential knowledge on the immune response, its diagnosis and modification by drugs and chemicals. The first section of the book includes a basic introduction to immunology and its relevance for human disease. The second section deals with immunodiagnostics. The book concludes with a chapter on immunotoxicology.

Repetto RC (1996)
Pesticides and the Immune System
World Resource Institute, Washington, DC

Considers pesticides' effects on the immune system as an emerging issue imperfectly understood by those evaluating health risks of chemical exposures. The evidence assembled in this report underscores the need to continue improving our understanding of such risks.

Smialowicz RJ, Holsapple MP (Eds.) (1996)
Experimental Immunotoxicology
CRC Press, Boca Raton, FL

Provides information on advances in experimental immunotoxicology. The major sections include definitions and approaches, target organ specificity in immunotoxicology, chemical-induced immunosuppression, and chemical-induced immunoenhancement.

Tryphonas H, Fournier M, Blakley BR, Smits JEG, Brousseau P (Eds.) (2005)
Investigative Immunotoxicology
CRC Press, Boca Raton, FL

Provides a critical evaluation of current immunotoxicological models and approaches, and their contribution to the overall assessment of chemical-induced adverse health effects on humans and the ecosystem.

Vohr HW (Ed.) (2005)
Encyclopedic Reference of Immunotoxicology
Springer-Verlag, Berlin

First book devoted to immunotoxicology that is presented in an encyclopedic format. All entries are organized in alphabetical order and a description for each item is provided by a panel of specialists in the area. Each chapter also includes a regulatory section with related guidelines. Conflicting opinions are detailed in the 'Pros and Cons' section of several chapters.

World Health Organization (WHO) (1996)
Principles and Methods for Assessing Direct Immunotoxicity Associated with Exposure to Chemicals
WHO, Geneva.

Volume 180 of the monographic series *Environmental Health Criteria*.

Offers a thorough look at immunotoxicology, health impacts of selected immunotoxic agents, strategies for testing the immunotoxicity of chemicals in animals, methods of immunotoxicology in experimental animals, essentials of immunotoxicity assessment in humans, and risk assessment.

Zelikoff J, Thomas PT (Eds.) (1998)
Taylor & Francis, London
Immunotoxicology of Environmental and Occupational Metals

Provides information on the immunotoxic effects of selected metals encountered environmentally and occupationally.

Journals

Immunopharmacology and Immunotoxicology
Informa Healthcare
Frequency: 4 issues per year

This international journal is an authoritative source for groundbreaking clinical and basic research in immunopharmacology and immunotoxicology. It publishes original scientific papers, brief communications, and reviews on the alterations of the immune system and other important topics such as the disease-mediating capacity of immunomodulating agents. This journal also features experimental and clinical results on cytokines and chemokines, vaccines, nutrition, and neuroimmunopharmacology. *Immunopharmacology and Immunotoxicology* provides up-to-date and comprehensive coverage on immunomodifying agents to treat diseases such as cancer, immunodeficiency, chronic infection, allergy, and inflammatory and autoimmune disorders. Further, the journal also focuses on the action of agents on specific parameters of the immune system, mediated directly or through soluble cytokines secreted by various cellular components of the immune system. Furthermore, the adverse or positive effects of xenobiotics on the immune system, including chemicals, metals, food additives, and airborne pollutants are covered in the journal (excerpted from http://www.gbhap.com/journals/journal.asp?issn=0892-3973&linktype=1).

Journal of Immunotoxicology
Informa Healthcare
Frequency: 4 issues per year

This is a peer-reviewed journal – a singular forum for the immunotoxicologists, immunologists, and toxicologists in academia, government, consulting, and industry to publish their original research and to be made aware of the research findings in a timely manner. Several subdisciplines are also presented in the journal, including molecular, developmental, pulmonary, regulatory, nutritional, mechanistic, wildlife, and environmental immunotoxicology, immunology, and toxicology. Original research articles as well as timely comprehensive reviews are published (excerpted from http://www.tandf.co.uk/journals/titles/1547691X.asp).

Perspectives in Experimental and Clinical Immunotoxicology
Free electronic journal: http://www.school-immunotoxicology.org/inter.php?rubrique=34.

Additional information on this online journal and summer school of immunotoxicology can be obtained from this website. This website has preliminary information on 'Immunotoxibase.' See Database section of the chapter for additional information.

Journal Articles

Bala S, Weaver J, Hastings KL (2005) Clinical relevance of preclinical testing for allergic side effects. Toxicology 209: 195–200.

Barrow PC, Ravel G (2005) Immune assessments in developmental and juvenile toxicology: practical considerations for the regulatory safety testing of pharmaceuticals. Regul. Toxicol. Pharmacol. 43: 35–44.

Bondy GS, Pestka JJ (2000) Immunomodulation by fungal toxins. J. Toxicol. Environ. Health B Crit. Rev. 3: 109–143.

Dean JH (2004) A brief history of immunotoxicology and a review of the pharmaceutical guidelines. Int. J. Toxicol. 23: 83–90.

Descotes J (2004) Importance of immunotoxicity in safety assessment: a medical toxicologist's perspective. Toxicol. Lett. 149: 103–108.

Descotes J (2005) Immunotoxicology: role in the safety assessment of drugs. Drug Saf. 28: 127–136.

Descotes J (2006) Methods of evaluating immunotoxicity. Expert Opin. Drug Metab. Toxicol. 2: 249–259.

Descotes J, Ravel G (2005) Role of NK cells in immunotoxicity: an update. Exp. Rev. Clin. Immunol. 1: 605–610.

Descotes J, Ravel G, Ruat C (2002) Vaccines: predicting the risk of allergy and autoimmunity. Toxicology 174: 45–51.

Dietert RR, Piepenbrink MS (2006) Perinatal immunotoxicity: why adult exposure assessment fails to predict risk. Environ. Health Perspect. 114: 477–483.

Dietert RR, Piepenbrink MS (2006) Lead and immune function. Crit. Rev. Toxicol. 36: 359–385.

Fairbrother A, Smits J, Grasman K (2004) Avian immunotoxicology. J. Toxicol. Environ. Health B Crit. Rev. 7: 105–137.

Galloway T, Handy R (2003) Immunotoxicity of organophosphorus pesticides. Ecotoxicology 12: 345–363.

Germolec DR (2004) Sensitivity and predictivity in immunotoxicity testing: immune endpoints and disease resistance. Toxicol. Lett. 149: 109–114.

Gore ER (2006) Immune function tests for hazard identification: a paradigm shift in drug development. Basic Clin. Pharmacol. Toxicol. 98: 331–335.

Haley PJ (2003) Species differences in the structure and function of the immune system. Toxicology 188: 49–71.

Holdapple MP (2003) Developmental immunotoxicity testing: a review. Toxicology 185: 193–203.

Holsapple MP, Paustenbach DJ, Charnley G, et al (2004) Symposium summary: children's health risk – what's so special about the developing immune system?. Toxicol. Appl. Pharmacol. 199: 61–70.

House RV (2001) Cytokine measurement techniques for assessing hypersensitivity. Toxicology 158: 51–58.

Kerkvliet NI (2002) Recent advances in understanding the mechanisms of TCDD immunotoxicity. Int. Immunopharmacol. 2: 277–291.

Kuper CF, Harleman JH, Richter-Reichelm HB, Vos JG (2000) Histopathologic approaches to detect changes indicative of immunotoxicity. Toxicol. Pathol. 28: 454–466.

Luebke RW, Chen DH, Dietert R, Yang Y, King M, Luster MI (2006) The comparative immunotoxicity of five selected compounds following developmental or adult exposure. J. Toxicol. Environ. Health B Crit. Rev. 9: 1–26.

Luebke RW, Holsapple MP, Ladics GS, et al (2006) Immunotoxicogenomics: the potential of genomics technology in the immunotoxicity risk assessment process. Toxicol. Sci. 94: 22–27.

Luster MI, Johnson VJ, Yucesoy B, Simeonova PP (2005) Biomarkers to assess potential developmental immunotoxicity in children. Toxicol. Appl. Pharmacol. 206: 229–236.

Luster MI, Simeonova PP, Gallucci RM, Matheson JM, Yucesoy B (2000) Immunotoxicology: role of inflammation in chemical-induced hepatotoxicity. Int. J. Immunopharmacol. 22: 1143–1147.

Merk HF, Sachs B, Baron J (2001) The skin: target organ in immunotoxicology of small-molecular-weight compounds. Skin Pharmacol. Appl. Skin Physiol. 14: 419–430.

Nierkens S, Pieters R (2005) Murine models of drug hypersensitivity. Curr. Opin. Allergy Clin. Immunol. 5: 331–335.

Oswald IP, Marin DE, Bouhet S, Pinton P, Taranu I, Accensi F (2005) Immunotoxicological risk of mycotoxins for domestic animals. Food Addit. Contam. 22: 354–360.

Pieters R, Ezendam J, Bleumink R, Bol M, Nierkens S (2002) Predictive testing for autoimmunity. Toxicol. Lett. 127: 83–91.

Putman E, van der Laan JW, van Loveren H (2003) Assessing immunotoxicity: guidelines. Fundam. Clin. Pharmacol. 17: 615–626.

Ravel G, Descotes J (2005) Popliteal lymph node assay: facts and perspectives. J. Appl. Toxicol. 25: 451–458.

Van Loveren H, Ross PS, Osterhaus AD, Vos JG (2000) Contaminant-induced immunosuppression and mass mortalities among harbor seals. Toxicol. Lett. 112–113: 319–324.

Vial T, Descotes J (2003) Immunosuppressive drugs and cancer. Toxicology 185: 229–240.

Veraldi A, Costantini AS, Bolejack V, Miligi L, Vineis P, van Loveren H (2006) Immunotoxic effects of chemicals: A matrix for occupational and environmental epidemiological studies. Am. J. Ind. Med. 49: 1046–1055.

Zelikoff JT, Raymond A, Carlson E, Li Y, Beaman JR, Anderson M (2000) Biomarkers of immunotoxicity in fish: from the lab to the ocean. Toxicol. Lett. 112–113: 325–331.

Databases

IMMUNOTOXIBASE

This is intended to be a comprehensive immunotoxicology database providing the latest available information on the adverse effects on the immune system of all kinds of chemicals including medicinal products, agrochemicals, industrial, household and environmental chemicals, cosmetics, food additives and ingredients, natural substances, and any other chemicals.

Web: http://www.school-immunotoxicology.org/inter.php?rubrique=34.

IMMTOX

Initial version of this immunotoxicology database was based on a 1992 publication by Luster et al in *Fundamental Applied Toxicology* (18: 200–210). It includes battery of immunotoxicology test summary results for at least 70 chemicals from National Toxicology Program (NTP) immunology study data in B6C3F1 mice, and supplemented by mouse study information for additional chemicals extracted from online NTP Immunology Study Reports (http://ntp.niehs.nih.gov/).

This is excerpted from: http://www.epa.gov/ncct/dsstox/WorkInProgress.html.

CHAPTER

53

Target Sites: Kidney

GARY O. RANKIN AND MONICE A. VALENTOVIC

INTRODUCTION

The kidney serves many important functions within the body including maintaining homeostasis of electrolytes, excretion of waste products, stimulation of red blood cell formation, and contributing to vitamin D metabolism. The kidney is also a target for the toxic effects of a wide range of compounds including drugs (e.g. cisplatin, amphotericin B, cyclosporine), metals (e.g. mercury, lead, cadmium), agricultural chemicals (e.g. paraquat), halogenated solvents (e.g. chloroform, trichloroethylene), natural products (e.g. mycotoxins), anoxiants (e.g. carbon monoxide, cyanide), and many other compounds.

The reasons for the kidney's susceptibility to the toxic effects of drug and non-drug chemicals are related closely to its normal kidney function. The kidney is a highly dynamic organ, receiving 20–25% of the cardiac output. Thus, chemicals that enter the blood are rapidly distributed to the kidney. As a result, the kidney often sees high concentrations of absorbed chemicals and/or their toxic metabolites. The kidney can also concentrate organic anions or cations within proximal tubule cells via the various organic anion (e.g. OATs) or organic cation (e.g. OCTs) transport systems to levels that are much higher than blood levels. Concentration of the luminal fluid as it passes toward the transition from the descending to the ascending limb of the loop of Henle can lead to the precipitation of poorly water-soluble compounds, such as oxalate, methotrexate or some of the early sulfa drugs which can lead to obstruction of flow and, possibly, renal failure.

Since the nephron must transport large amounts of electrolytes and organic compounds across the basolateral (blood side) and luminal or apical membranes to promote secretory and reabsorptive functions, the nephron has a high requirement for producing energy in the form of ATP to support the active transport processes. Thus, any chemical or chemical metabolite capable of decreasing the ability of mitochondria to produce ATP can induce nephrotoxicity.

The kidney also contains enzymes which can bioactivate chemicals to the ultimate nephrotoxic species. For example, proximal tubule cells contain a number of the cytochromes P450 which are capable of bioactivating a wide range of chemicals to nephrotoxic metabolites, including halogenated hydrocarbons such as chloroform and carbon tetrachloride and drugs such as acetaminophen. The cyclo-oxygenase enzymes located in renal tissue that are critical for producing renal prostaglandins may also play a role in bioactivating aminophenols and other related compounds via a co-oxidation mechanism. Also, there is a vast literature concerning the nephrotoxicity induced by glutathione conjugates of halogenated hydrocarbons and their subsequent metabolites (cysteine and N-acetylcysteine conjugates). The kidney has the enzymes necessary to form many of these metabolites directly or process glutathione-derived metabolites formed primarily in the liver to the ultimate nephrotoxicant species.

RESOURCES

Books

General textbooks and reference books on toxicology usually contain chapters related to nephrotoxicants. Books focused on kidney toxicology include the following.

Broe ME, de Porter GA, Bennett WM, Verpooten GA (eds) (2003)
Clinical Nephrotoxins: Renal Injury from Drugs and Chemicals
Springer, San Diego, CA.
ISBN: 978-1-4020-1277-8.

Goldstein RS (Volume Ed.), Sipes IG, McQueen CA, Gandolfi AJ (Eds-in-chief) (1997)
Comprehensive Toxicology: Volume 7, Renal Toxicology
Pergamon, Elsevier Science Ltd., New York.
ISBN: 0-08-042972-6.

Tarloff JB, Lash LH (Eds) (2005)
Toxicology of the Kidney, 3rd Edition
Target Organ Toxicology Series, Hayes AW, Thomas JA, Gardner DE (Series Eds)
CRC Press, Boca Raton, FL.
ISBN: 0-415-24864-7

Zalups RK, Lash LH (eds) (1996)
Methods in Renal Toxicology
CRC Press, Boca Raton, FL.
ISBN: 0-8493-3341-5

Review Articles

Drugs

Calcineurin Inhibitors

Burdmann EA, Andoh TF, Yu L, Bennett WM (2003) Cyclosporine nephrotoxicity. Semin. Nephrol. 23: 465–476.

Liptak P, Ivanyi B (2006) Primer: Histopathology of calcineurin-inhibitor toxicity in renal allographs. Nat. Clin. Pract. Nephrol. 2: 398–404.

Parra Cid T, Conejo Garcia JR., Carballo Alvarez F, de Arriba G (2003) Antioxidant nutrients protect against cyclosporine A nephrotoxicity. Toxicology 189: 99–111.

Williams D, Haragsim L (2006) Calcineurin nephrotoxicity. Adv. Chronic Kidney Dis. 13: 47–55.

Wu MS (2007) From bedside to bench drug-induced tubulointerstitial disease cyclosporine nephropathy study from models of cultured renal epithelial cells. Chang Gung Med. J. 30: 7–16.

Cisplatin

Ali BH, Al Moundhri MS (2006) Agents ameliorating or augmenting the nephrotoxicity of cisplatin and other platinum compounds: a review of some recent research. Food Chem. Toxicol. 44: 1173–1183.

Arany I, Safirstein RL (2003) Cisplatin nephrotoxicity. Semin. Nephrol. 23: 460–464.

Taguchi T, Nazeen A, Abid MR, Razzaque MS (2005) Cisplatin-associated nephrotoxicity and pathological events. Contrib. Nephrol. 148: 107–121.

Contrast Media

Andrew E, Berg KJ (2004) Nephrotoxic effects of x-ray contrast media. J. Toxicol. Clin. Toxicol. 42: 325–332.

Aspelin P (2004) Nephrotoxicity and the role of contrast media. Radiat. Med. 22: 377–378.

Katzberg RW, Haller C (2006) Contrast-induced nephrotoxicity: clinical landscape. Kidney Int. 100(Suppl.): S3–S7.

Non-steroidal Anti-inflammatory Drugs (NSAIDs)

Cheng HF, Harris RC (2005) Renal effects of nonsteroidal anti-inflammatory drugs and selective cyclo-oxygenase-2 inhibitors. Curr. Pharm. Des. 11: 1795–1804.

Knights KM, Tsoutsikos P, Miners JO (2005) Novel mechanisms of nonsteroidal anti-inflammatory drug-induced renal toxicity. Expert opin. Drug Metab. Toxicol. 1: 399–408.

Sandhu GK, Heyneman CA (2004) Nephrotoxic effects of selective cyclo-oxygenase-2 inhibitors. Ann. Pharmacother. 38: 700–704.

Miscellaneous Reviews

Izzedine H, Launay-Vacher V, Deray G (2005) Antiviral drug-induced nephrotoxicity. Am. J. Kidney Dis. 45: 804–817.

Perazella MA (2003) Drug-induced renal failure: update on new medications and unique mechanisms of nephrotoxicity. Am. J. Med. Sci. 325: 349–362.

Rougier F, Claude D, Maurin M, Maire P (2004) Aminoglycoside nephrotoxicity. Curr. Drug Targets Infect. Disord. 4: 153–162.

Schetz M, Dasta J, Goldstein S, Golper T (2005) Drug-induced acute kidney injury. Curr. Opin. Crit. Care 11: 555–565.

Szeto CC, Chow KM (2005) Nephrotoxicity related to new therapeutic compounds. Renal Fail. 27: 329–333.

Valle R, Haragism L (2006) Nephrotoxicity as a complication of antiretroviral therapy. Adv. Chronic Kidney Dis. 13: 314–319.

Non-drug Nephrotoxicants

Metals

Ekong EB, Jaar BG, Weaver VM (2006) Lead-related nephrotoxicity: a review of the epidemiologic evidence. Kidney Int. 70: 2074–2084.

Sabolic I (2006) Common mechanisms in nephropathy induced by toxic metals. Nephron Physiol. 104: 107–114.

Thevenod F (2003) Nephrotoxicity and the proximal tubule. Insights from cadmium. Nephron Physiol. 93: 87–93.

Non-metals

Dekant W (2003) Biosynthesis of toxic glutathione conjugates from halogenated alkenes. Toxicol. Lett. 144: 49–54.

Rankin GO (2004) Nephrotoxicity induced by C- and N-arylsuccinimides. J. Toxicol. Environ. Health B Crit. Rev. 7: 399–416.

Sitprija V (2006) Snakebite nephropathy. Nephrology 11: 442–448.

Solhaug MJ, Bolger PM, Jose PA (2004) The developing kidney and environmental toxins. Pediatrics 113: 1084–1091.

Van Vleet TR, Schnellmann RG (2003) Toxic nephropathy: environmental chemicals. Semin. Nephrol. 23: 500–508.

Genomics, Proteomics and Nephrotoxicity

Gibbs A (2005) Comparison of the specificity and sensitivity of traditional methods for assessment of nephrotoxicity in the rat with metabolomic and proteomic methodologies. J. Appl. Toxicol. 25: 277–295.

Goodsaid FM (2004) Identification and measurement of genomic biomarkers of nephrotoxicity. J. Pharmacol. Toxicol. Methods 49: 183–186.

van de Water B, de Graauw M, le Devedec S, Alderliesten M (2006) Cellular stress and molecular mechanisms of nephrotoxicity. Toxicol. Lett. 162: 83–93.

Witzmann FA, Li J (2004) Proteomics and nephrotoxicity. Contrib. Nephrol. 141: 104–123.

Renal P450

Cummings BS, Zangar RC, Novak RF, Lash LH (1999) Cellular distribution of cytochromes P-450 in the rat kidney. Drug Metab. Dispos. 270: 542–548.

Hall PM, Stupans I, Burgess W, Birkett DJ, McManus ME (1989) Immunohistochemical localization of NADPH-cytochrome P450 reductase in human tissues. Carcinogenesis 10: 521–530.

Ito O, Nakamura Y, Tan L, et al (2006) Expression of cytochrome P-450 4 enzymes in the kidney and liver: regulation by PPAR and species-difference between rat and human. Mol. Cell. Biochem. 284: 141–148.

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Seliskar M, Rozman D (2007) Mammalian cytochromes P450–importance of tissue specificity. Biochim. Biophys. Acta. 1770: 458–466.

Zhao X, Imig JD (2003) Kidney CYP450 enzymes: biological actions beyond drug metabolism. Curr. Drug Metab. 4: 73–84.

Journals

Articles about nephrotoxic drugs and non-drug chemicals appear in many clinical journals and most journals dedicated to toxicology. There are no specific journals dedicated solely to publishing articles related to nephrotoxicants. However, the following journals frequently contain articles about nephrotoxicants.

American Journal of Kidney Diseases

American Journal of Physiology – Renal Physiology

Biochemical Pharmacology

Chemical Research in Toxicology

Chemico-Biological Interactions

Contributions to Nephrology

Drug Metabolism and Disposition

Environmental Toxicology

Human & Experimental Toxicology

In Vitro Toxicology

Journal of Applied Toxicology

Journal of the American Society of Nephrology

Journal of Pharmacology and Experimental Therapeutics

Journal of Toxicology and Environmental Health

Kidney International

Life Sciences

Renal Failure

Seminars in Nephrology

Toxicology

Toxicology and Applied Pharmacology

Toxicology In Vitro

Toxicology Letters

Toxicological Sciences

Organizations

National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK)
Web: http://www2.niddk.nih.gov/

National Kidney Foundation, Inc (NKF)
Web: http://www.kidney.org/

CHAPTER

54

Target Sites: Liver

JANET KESTER

INTRODUCTION

Liver injury by chemical substances has been recognized for more than 100 years. The liver's anatomical and functional interposition between the digestive tract and the systemic circulation is responsible for both its primary role in metabolism of xenobiotics and its susceptibility to their toxic actions. It directly receives all ingested material absorbed from the intestine (except lipid chylomicrons). The absorbed materials are taken up and further metabolized by the liver or transformed and released to the blood for utilization or storage elsewhere in the body.

RESOURCES

Textbooks

General Texts

Byer T, Wright T, Manns M (2006)
Zakim and Boyer's Hepatology, 5th Edition
W.B. Saunders, Philadelphia, PA.

The latest update of a definitive two-volume medical text that is also available online. The emphasis is largely clinical, but Section I (Chapters 1 through 11) provides a superb current overview of liver anatomy and pathophysiology. Section IV (Chapters 26 through 29) covers 'toxin mediated liver injury' (a misnomer as the term 'toxin' specifically refers to compounds produced by organisms).

Kanel GC, Korula J (2005)
Atlas of Liver Pathology. 2nd Edition
W.B. Saunders, Philadelphia, PA.

A beautifully illustrated medical textbook reflecting the most recent World Health Organization classification of liver and biliary tract diseases. Chapter 4 discusses alcoholic liver disease, and Chapter 5 discusses other forms of toxic liver cell injury. Excellent source of basic information for the pathologically inclined.

Texts with Focus on Toxicology

Dienes J-P, Leuschner U, Lohse AW, Manns MP (2005)
Autoimmune Liver Disease (Falk Symposium)
Springer, Dordrecht, The Netherlands.
ISBN-10: 1402028946, ISBN-13: 978-1402028946.

This book, authored by hepatologists of different countries, memorializes the proceedings of Falk Symposium 142 on 'Autoimmune Liver Disease' held in Freiburg, Germany, on 12–13 October 2004. It describes possible mechanisms of pathogenesis and discusses diagnostic criteria and treatment options, with particular emphasis on childhood autoimmune hepatitis.

Kaplowitz N, DeLeve LD (2007)
Drug-Induced Liver Disease, 2nd Edition
ISBN: 9780849398964.

Drugs are the most common cause of toxic liver injury in the United States. Chapters written by international authorities are divided into four main sections dealing with: (1) mechanisms of liver injury; (2) diagnosis and

management; (3) hepatoxicity of specific drugs; and (4) regulatory perspectives.

Plaa GL, Hewitt WR (Eds) (1998)
Toxicology of the Liver (Target Organ Toxicology Series), 2nd Edition
Taylor & Francis, London.
ISBN 1-56032-719-7.

This book aims to provide state-of-the-art reviews of selected areas of hepatotoxicity. It is divided into three parts: characterization of chemical-induced hepatotoxicity, mechanisms, of hepatotoxicity, and cholestasis.

Romano JA, Lukey BJ, Salem H (2007)
Chemical Warfare Agents: Chemistry, Pharmacology, Toxicology, and Therapeutics, Second Edition

Sahu S (Ed.) (2008)
Hepatotoxicity: From Genomics to In Vitro and In Vivo Models
John Wiley & Sons, Ltd., Chichester, UK

Zimmerman HJ (1999)
Hepatotoxicity: The Adverse Effects of Drugs and Other Chemicals on the Liver, 2nd Edition
Lippincott Williams & Wilkins, Philadelphia, PA.

Review Articles

Amacher DE (2002) A toxicologist's guide to biomarkers of hepatic response. Hum. Exp. Toxicol. 21(5): 253–262.

Bannasch P, Haertel T, Su Q (2003) Significance of hepatic preneoplasia in risk identification and early detection of neoplasia. Toxicol. Pathol. 31(1): 134–139.

Bodo A, Bakos E, Szeri F, Varadi A, Sarkadi B (2003) The role of multidrug transporters in drug availability, metabolism and toxicity. Toxicol. Lett. 140–141, 133–143.

Borst P, Elferink RO (2002) Mammalian ABC transporters in health and disease. Annu. Rev. Biochem. 71: 537–592.

Bosch FX, Ribes J, Diaz M, Cleries R (2004) Primary liver cancer: worldwide incidence and trends. Gastroenterology 127(5 Suppl 1): S5–S16.

Bull RJ (2000) Mode of action of liver tumor induction by trichloroethylene and its metabolites, trichloroacetate and dichloroacetate. Environ. Health Perspect. 108(Suppl 2): 241–259.

Caro AA, Cederbaum AI (2004) Oxidative stress, toxicology, and pharmacology of CYP2E1. Annu. Rev. Pharmacol. Toxicol. 44: 27–42.

Casini A (2000) Alcohol-induced fatty liver and inflammation: where do Kupffer cells act? J. Hepatol. 32(6): 1026–1030.

Cattley RC (2004) Peroxisome proliferators and receptor-mediated hepatic carcinogenesis. Toxicol. Pathol. 32(Suppl 2): 6–11.

Cohen SM, Meek ME, Klaunig JE, Patton DE, Fenner-Crisp PA (2003) The human relevance of information on carcinogenic modes of action: overview. Crit. Rev. Toxicol. 33(6): 581–589.

Doull J, Cattley R, Elcombe C, et al (1999) A cancer risk assessment of di (2-ethylhexyl) phthalate: application of the new U.S. EPA Risk Assessment Guidelines. Regul. Toxicol. Pharmacol. 29(3): 327–357.

Ganey PE, Luyendyk JP, Maddox JF, Roth RA (2004) Adverse hepatic drug reactions: inflammatory episodes as consequence and contributor. Chem. Biol. Interact. 150(1): 35–51.

Goodman JI (1998) The traditional toxicologic paradigm is correct: dose influences mechanism. Environ. Health Perspect. 106(Suppl 10): 285–288.

Groopman JD, Johnson D, Kensler TW (2005) Aflatoxin and hepatitis B virus biomarkers: a paradigm for complex environmental exposures and cancer risk. Cancer Biomark. 1(1): 5–14.

Heijne WH, Stierum RH, Leeman WR, van Ommen B (2005) The introduction of toxicogenomics; potential new markers of hepatotoxicity. Cancer Biomark. 1(1): 41–57.

Kaplowitz N (2005) Idiosyncratic drug hepatotoxicity. Nat. Rev. Drug Discov. 4(6): 489–499.

Kato Y, Suzuki H, Sugiyama Y (2002) Toxicological implications of hepatobiliary transporters. Toxicology 181–182: 287–290.

Kessova I, Cederbaum AI (2003) CYP2E1: biochemistry, toxicology, regulation and function in ethanol-induced liver injury. Curr. Mol. Med. 3(6): 509–518.

Klaunig JE, Babich MA, Baetcke KP, et al (2003) PPARalpha agonist-induced rodent tumors: modes of action and human relevance. Crit. Rev. Toxicol. 33(6): 655–780.

Knasmuller S, Mersch-Sundermann V, Kevekordes S, et al (2004) Use of human-derived liver cell lines for the detection of environmental and dietary genotoxicants; current state of knowledge. Toxicology 198(1–3): 315–328.

Knerr S, Schrenk D (2006) Carcinogenicity of 2,3,7,8-tetrachlorodibenzo-p-dioxin in experimental models. Mol. Nutr. Food Res. 50(10): 897–907.

Lai DY (2004) Rodent carcinogenicity of peroxisome proliferators and issues on human relevance. J. Environ. Sci. Health C Environ. Carcinog. Ecotoxicol. Rev. 22(1): 37–55.

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Merrick BA, Bruno ME (2004) Genomic and proteomic profiling for biomarkers and signature profiles of toxicity. Curr. Opin. Mol. Ther. 6(6): 600–607.

Oliver JD, Roberts RA (2002) Receptor-mediated hepatocarcinogenesis: role of hepatocyte proliferation and apoptosis. Pharmacol. Toxicol. 91(1): 1–7.

Phillips SD, Waksman JC (2004) Hepatorenal solvent toxicology. Clin. Occup. Environ. Med. 4(4): 731–740, vi.

Ramaiah SK (2007) A toxicologist guide to the diagnostic interpretation of hepatic biochemical parameters. Food Chem. Toxicol. 45(9): 1551–1557.

Roberts RA, Ganey PE, Ju C, Kamendulis LM, Rusyn I, Klaunig JE (2007) Role of the Kupffer cell in mediating hepatic toxicity and carcinogenesis. Toxicol. Sci. 96(1): 2–15.

Ruch RJ (2002) Intercellular communication, homeostasis, and toxicology. Toxicol. Sci. 68(2): 265–266.

Schwarz M, Appel KE (2005) Carcinogenic risks of dioxin: mechanistic considerations. Regul. Toxicol. Pharmacol. 43(1): 19–34.

Sellers RS, Morton D, Michael B, et al (2007) Society of Toxicologic Pathology position paper: organ weight recommendations for toxicology studies. Toxicol. Pathol. 35(5): 751–755.

Stehbens WE (2003) Oxidative stress, toxic hepatitis, and antioxidants with particular emphasis on zinc. Exp. Mol. Pathol. 75(3): 265–276.

Suematsu M (1999) Recent developments in hepatic circulatory physiology. Hepatogastroenterology 46(Suppl 2): 1406–1408.

Vickers AE, Fisher RL (2005) Precision-cut organ slices to investigate target organ injury. Expert Opin. Drug Metab. Toxicol. 1(4): 687–699.

Weber LW, Boll M, Stampfl A (2003) Hepatotoxicity and mechanism of action of haloalkanes: carbon tetrachloride as a toxicological model. Crit. Rev. Toxicol. 33(2): 105–136.

Williams GM, Iatropoulos MJ (2002) Alteration of liver cell function and proliferation: differentiation between adaptation and toxicity. Toxicol. Pathol. 30(1): 41–53.

Williams JH, Phillips TD, Jolly PE, Stiles JK, Jolly CM, Aggarwal D (2004) Human aflatoxicosis in developing countries: a review of toxicology, exposure, potential health consequences, and interventions. Am. J. Clin. Nutr. 80(5): 1106–1122.

Wogan GN (2000) Impacts of chemicals on liver cancer risk. Semin. Cancer Biol. 10(3): 201–210.

Yokohama Y, Nimura Y, Nagino M, Bland KI, Chaudry IH (2005) Current understanding of gender dimorphism in hepatic pathophysiology. J. Surg. Res. 128(1): 147–156.

Journals

The American Journal of Physiology – Gastrointestinal and Liver Physiology
The American Physiological Society, Bethesda, MD
Web: http://www.the-aps.org/publications/ajpgi/

Comparative Hepatology
BioMed Central Ltd., London, UK
Web: http://www.comparative-hepatology.com/.

European Journal of Gastroenterology and Hepatology
Lippincott Williams & Wilkins, London, UK
Web: http://www.ovid.com/site/catalog/Journal/657.jsp

Gut
BMJ Public Health Journals
British Society of Gastroenterology, London, UK
Web: http://gut.bmj.com/

Hepatology
American Association for the Study of Liver Diseases
John Wiley & Sons, Haboken, NJ
Web: http://www3.interscience.wiley.com/journal/106570044/home

Hepatology International
Asian Pacific Association for the Study of the Liver
Springer, New York
Web: http://www.springer.com/medicine/journal/13072

Journal of Gastroenterology and Hepatology
Asian Pacific Association of Gastroenterology
Wiley-Blackwell, Australia
Web: http://www.blackwellpublishing.com/journal.asp?ref=0815-9319&site=1

Journal of Hepatology
European Association for the Study of the Liver
Elsevier, London, UK
Web: http://www.elsevier.com/science/journal/01688278

Liver International
International Association for the Study of the Liver
Blackwell Munksgaard, London, UK
Web: http://www.blackwellpublishing.com/journal.asp?ref=1478-3223&site=1

Newsletters

American Association for the Study of Liver Diseases News
Web: http://www.aasld.org/eweb/DynamicPage.aspx?Site=AASLD3&webcode=Newsletter

General Interest Works

Wikipedia contributors
Liver
Wikipedia, The Free Encyclopedia.
Accessed July 2007, 15:28 UTC. Wikimedia Foundation, Inc.
Web: http://en.wikipedia.org/w/index.php?title=Liver&oldid=147243750

Databases

Cold Spring Harbor Laboratory.
The Liver-Specific Gene Promoter Database
Web: http://rulai.cshl.edu/LSPD/

National Digestive Diseases Information Clearinghouse
Web: http://digestive.niddk.nih.gov/index.htm

U.S. Food and Drug Administration Center for Drug Evaluation and Research
Human Liver Adverse Effects Database
Web: http://www.fda.gov/cder/Offices/OPS_IO/adverse_effect_database.htm

Organizations

American Association for the Study of Liver Diseases
Web: http://www.aasld.org/eweb/StartPage.aspx

American Association for the Study of Liver Diseases
Web: http://www.aasld.org/eweb/StartPage.aspx

American Liver Foundation
Web: http://www.liverfoundation.org/

American Physiological Society, Gastrointestinal and Liver Physiology Section
Web: http://www.the-aps.org/sections/gastro/index.htm

Canadian Liver Foundation
Web: http://www.liver.ca/

European Association for the Study of the Liver
Web: http://www.easl.ch/

Hepatitis Foundation International
Web: http://www.hepfi.org/

The National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK)
Web: http://www2.niddk.nih.gov/

National Liver Foundation
Web: http://www.nlfindia.com/index.asp

Society of Toxicology
Web: http://www.toxicology.org/

CHAPTER

55

Target Sites: Nervous System

ABBY A. LI

INTRODUCTION

The nervous system is composed of billions of neurons and supporting glial cells that are interconnected to form complex integrated electrochemical circuits. It is through these neuronal circuits that animals perceive and respond to external stimuli, and coordinate the activities of all other organ systems. All mental activity including thought, learning, and memory are controlled by the nervous system.

Neurotoxicity can be defined as unintended adverse effects on the structure and function of the nervous system. Although the nervous system has compensatory and adaptive mechanisms, the nervous system is more sensitive to some injuries because of its limited ability to regenerate compared to other organ systems. The developing nervous system is especially vulnerable to injury because of the lack of a complete blood–brain barrier and because interference to critical processes such as neurogenesis, migration, and programmed cell death have profound effects on the development of the nervous system. The potential for neurotoxicity also depends upon the route, pattern and duration of exposure, the metabolism of the chemical, and the ability of the chemical to pass through the blood–brain barrier.

The field of neurotoxicity draws from disciplines of neuroscience, physiology, psychology, biochemistry, and others. Much neurotoxicological research focuses on identifying adverse outcomes on the structure and/or function of the nervous system (both central and peripheral) due to exposure to chemicals, and determining the mechanisms for these toxic responses. In addition, neurotoxicologists develop, validate, and refine methodology with which to accomplish these goals. Neurotoxic agents are also used to develop animal models of clinical syndromes, to aid in studying the causes of, and therapy for, these diseases.

Multidisciplinary approaches are necessary to study the integration of the highly interconnected nervous system. This ranges from molecular studies of genes and proteins, cellular studies of neurons, to interactions between neurons, to behavior, including higher levels of learning and memory. While most studies are conducted using laboratory animals, cell cultures, or isolated cells, epidemiological studies of humans are critical for relating the laboratory findings to the human population.

The following reference list focuses primarily on selected books and publications that review the neurotoxic potential of natural and synthetic chemicals and/or the methods used to detect or characterize neurotoxic effects. Books that have contributions from multiple experts covering wide range of topics are emphasized. These general references can be used as resources for more in-depth publications of original research on the neurotoxicity of specific chemicals. Websites for general guidance on neurotoxicity testing are included at the end of this list because they are free to the public and provide useful introductions to the field of neurotoxicology.

RESOURCES

Books

Annau Z (Ed.) (1986)
Neurobehavioral Toxicology
Johns Hopkins University Press, Baltimore, MD.

Addresses research strategies for evaluating behavioral effects of neurotoxic chemicals, examines the effects of exposure to neurotoxic chemicals during critical periods in the development of the nervous system, considers mechanism of toxicity at the neurobehavioral level, and deals with epidemiological and experimental approaches to neurobehavioral toxicity.

Arlien-Soborg P (1992)
Solvent Neurotoxicity
CRC Press, Boca Raton, FL.

A comprehensive look at solvent neurotoxicity. The first chapter describes methods for assessing human neurological effects. The remaining chapters present research and epidemiological data regarding classic neurotoxins.

Aschner M, Costa L (2004)
The Role of Glia in Neurotoxicity, 2nd edition
CRC Press, Boca Raton, FL.

Glia are identified as an essential and modifiable component of the nervous system. This book is concerned with the reciprocal relationships between neurons and glia that are vital for mutual differentiation, development, and optimal functioning of the CNS.

Bellinger DC (2006)
Human Developmental Neurotoxicology
Taylor & Francis/CRC Press

This reference describes recent developments in the design, execution, analysis, and interpretation of human developmental neurotoxicology studies. This reference focuses on dose–response/effect relationships and discusses challenges in measuring exposure to different types of chemicals, including selected metals, organic pollutants, pesticides, and recreational and therapeutic drugs.

Berent S, Albers J (2005)
Neurobehavioral Toxicology: Neuropsychological and Neurological Perspectives, Vol. 1 (Vol 2, 2005 and Vol 3 were scheduled to be published in 2007)
Taylor & Francis, Inc., New York.

This three-volume series is focused on human clinical case studies and addresses general issues that need to be considered when evaluating case studies.

Bleecker ML, Hansen JA (Eds.) (1994)
Occupational Neurology and Clinical Neurotoxicology
Williams & Wilkins, Baltimore, MD.

Defines the multidisciplinary components of occupational neurology, including study design, exposure assessment, methods for quantifying dysfunction, outcomes associated with exposure to neurotoxins, and ergonomic stressors. The text offers several perspectives on the issues in the field and specifically does not present classical animal experimentation.

Brust JC (1996)
Handbook of Neurotoxic Side Effects of Prescription Drugs
Butterworth-Heinemann, Boston, MA

Presents in a concise manner the reports from the literature that deal with the unwanted nervous system effects of prescription drugs. The arrangement allows easy access to specifics on either a drug or a drug class. Supporting information from animal studies is often included for reference purposes.

Chang LW (1994)
Principles of Neurotoxicology
Taylor and Francis, New York

Presents the basics of neurotoxicology. Covers neurotoxicology of the central and peripheral nervous systems, behavioral aspects of laboratory assessment and modeling, and biochemical and molecular neurotoxicology.

Chang LW, Dyer RS (1995)
Handbook of Neurotoxicology
Dekker, New York

Volume 36 of *Neurological Disease and Therapy.* Focuses on the effects and mechanisms of major categories of neurotoxicants. Part I covers the traditional neurotoxicants – metals, organic solvents, and agricultural chemicals. Part II covers the non-traditional neurotoxicants – natural neurotoxins, drugs of abuse, and narcotics/environmental agents.

Chang LW, Slikker W (Eds.) (1995)
Neurotoxicology: Approaches and Methods
Academic Press, San Diego, CA

Covers in-depth basic principles of neurotoxicity, current concepts on the effects and mechanisms of various classes of neurotoxicants, and state-of-the-art approaches and methods in toxicologic research and testing. The first sections consider whole-animal integrated responses, followed by detailed methods for teasing out the mechanisms of damage, the descriptions of the specific agents, and targets within the nervous system.

Cooper JR, Bloom FE, Roth RH (2003)
Biochemical Basis of Neuropharmacology, 8th edition
Oxford University Press, New York

Concentrates on the biochemistry and physiology of nervous tissue, with an emphasis on neurotransmitters. Also discusses neuropharmacologic agents and their actions.

Crawley J (Ed.) (1997)
Current Protocols in Neuroscience
Wiley, New York

Up-to-date collection of neuroscience methods. The publication draws from techniques in neurophysiology, neuroanatomy, neuropharmacology, and behavioral neuroscience to meet the specific needs of researchers in the full range of disciplines that are involved in studying the brain, nervous system, and corresponding behaviors.
Web: http://www.currentprotocols.com/WileyCDA/CPTitle/isbn-0471163597.html

European Centre for Ectoxicology and Toxicology of Chemicals (ECETOC) (1992)
Monograph No. 18: Evaluation of the Neurotoxic Potential of Chemicals
ECETOC, Brussels

Examines the current test methods for the evaluation of the neurotoxic potential of chemicals in order to provide adequate safeguards for human health. A tiered testing strategy is recommended for this evaluation.

Feldman RG (1998)
Occupational and Environmental Neurotoxicology
Lippincott Williams & Wilkins, Philadelphia, PA

Presents clinically relevant information on a number of major neurotoxicants. Describes chemical structure, sources of exposure, recommended exposure limits, metabolism, symptoms, and therapeutic measures.

Harry GJ (Ed.) (1994)
Developmental Neurotoxicology
CRC Press, Boca Raton, FL.

Addresses the basic principles of development in structure and functional components and presents information covering the various methodological approaches. Evidence for the value of examination of the developing nervous system for environmentally induced perturbations is well covered. Chemical effects in the system as well as methods to assess such end points are discussed.

Hartman DE (2007)
Neuropsychological Toxicology: Identification and Assessment of Human Neurotoxic Syndromes, 3rd Edition
Plenum, New York

Intended as a reference for clinical practitioners who must evaluate the history, symptoms, behavior, and neuropsychological functioning of individuals exposed to neurotoxic substances. The book focuses on human psychological applications of toxicology research. The book contains a basic overview, an evaluation of neurotoxic syndromes, the effects of metals, solvents, alcohol, drugs, pesticides, and other neurotoxins, and psychosomatic disorders and forensic issues.

Jain KK (2001)
Drug-Induced Neurological Disorders, 2nd, revised and expanded edition
Hogrefe & Huber, Seattle

Covers the wide range of central nervous system disorders which have been related to use of drugs and drug families.

Kostrzewa RM (Ed.) (1998)
Highly Selective Neurotoxins: Basic and Clinical Applications
Humana Press, Totowa, NJ

Critically reviews and evaluates the most common and important neurotoxins used today to precisely destroy selected neurons. Describes the mechanisms of action plus the limits on the use and clinical applicability of these neurotoxins.

Lowndes HE (1987)
Electrophysiology in Neurotoxicology
CRC Press, Boca Raton, FL.

A good basic text regarding the major techniques of electrophysiology. The first volume contains four chapters which include the structure, function, and pharmacology of acetylcholine and sodium channel receptors; the effects of toxic agents on neural membranes; physiology of synaptic transmission; and clinically used electrophysiological end points.

Maines MD, Costa LG, Reed DJ, Sass S, Sipes IG (initiated 1999; continually updating)
Current Protocols in Toxicology
John Wiley and Sons, Inc.

Included in this compendium is a section on methods for in vivo and in vitro testing for neurotoxicity, as well as animal models of neurotoxicity. Updates with new or revised methodology are sent out several times a year.

Massaro EJ (Ed.) (2001).
Handbook of Neurotoxicology, Volume 1 and Volume 2
Humana Press

Leading experts review the status of research in in vivo neurotoxicology of a wide spectrum of neurotoxicologic agents. The first volume focuses on natural and human-made neurotoxins. The second volume discusses neurobehavioral and imaging methods for evaluating neurotoxins.

Moser A (Ed.) (1998)
Pharmacology of Endogenous Neurotoxins: A Handbook
Birkhauser, Boston, MA

Surveys some of the important areas of neurotoxicological research and the impact of endogenously synthesized heterocyclic neurotoxins on normal and patho-physiological regulation in the central nervous system.

Moser VC, Aschner M, Richardson RJ, Philbert MA (2007)
Toxic Responses of the Nervous System
In: Casarett and Doull's Toxicology: The Basic Science of Poisons, 6th edition
McGraw-Hill Co.

Overview chapter provides biological factors rendering the nervous system sensitive to toxicity, It also includes a thorough discussion of mechanisms of different manifestations of neurotoxicity, as well as prototypical chemicals which produce neurotoxicity.

Niesink RJM (1998)
Introduction to Neurobehavioral Toxicology: Food and Environment
CRC Press, Boca Raton, FL.

Examines the effects of chemicals on the central and peripheral nervous system and the subsequent changes in behavior, with a focus on the toxicity of food components and behavioral effects of environmental toxicants.

Pentreath V (Ed.) (1999)
Experimental in Vitro Neurotoxicology
Taylor & Francis, Philadelphia, PA

Covers the accelerating field of in vitro replacement tests for whole animal models. The main impetus for this shift comes from the increased understanding of the behavior and properties of different types of nerve cells in vitro.

Slikker W, Chang LW (Eds.) (1998)
Handbook of Developmental Neurotoxicology
Academic Press, San Diego, CA.

Provides a comprehensive account of the impacts, mechanisms, and clinical relevances of chemicals on the development of the nervous system.

Spencer PS, Schaumburg HH, Ludolph AC (Eds.) (2000)
Experimental and Clinical Neurotoxicology, 2nd Edition
Oxford University Press, New York.

The first edition of the book laid the groundwork for the field of neurotoxicology. This second edition is an essential reference for anyone concerned with the neurotoxic potential of drugs, experimental agents, environmental pollutants, and other substances. The second edition has been reorganized and completely rewritten and covers nearly 450 chemical compounds. The first edition is available on the web (see web references below).

Tilson HA, Harry GJ (1999)
Neurotoxicology, 2nd Edition
Taylor & Francis, Philadelphia, PA.

Provides the basis for an understanding of the sites and mechanisms of neurotoxicity as well as the adverse effects of chemicals on the nervous system. Recent advances in neurotoxicological research are reviewed.

Tipton KF, Dajas F (Eds.) (1994)
Neurotoxins in Neurobiology: Their Actions and Applications
Ellis Horwood, New York.

Includes information on how toxins are obtained and fractionated; tabulation of toxin sources and their nature and actions; and synthetic toxins and their possible relationship to CNS diseases.

Journals

Neurotoxicity Research (1999–)
F.P.Graham Publishing Co., Montain Home, TN
Web: http://www.fpgrahamco.com/Neuro/index.html

Neurotoxicity Research is the official journal of the Neurotoxicity Society, publishing research on processes and mechanisms in neurodegeneration, neuroregeneration, neurotropic action, and neuroprotection.

Neurotoxicology (1979–)
Elsevier, Orlando, FL
Web: http://www.neurotoxicology.com/journal.htm

Neurotoxicology is a well-respected journal that publishes research and reviews on the effects of toxic substances on the nervous system of humans and experimental animals of all ages.

Neurotoxicology and Teratology (1979–)
Elsevier, Orlando, FL
Web: http://www.elsevier.com/wps/find/journaldescription.cws_home/525481/description#description

Neurotoxicology and Teratology is sponsored by the Behavioral Toxicology Society and the Neurobehavioral Teratology Society. The journal publishes studies on developmental and adult neurotoxicity of animals and humans, as well as reviews and commentary.

Journal Articles

Adams J, et al (1985) Collaborative Behavioral Teratology Study: protocol design and testing procedures. Neurobehav. Toxicol. Teratol. 7: 579–586.

Anger WK, et al (1996) Symposium on computerized behavioral testing of humans in neurotoxicology research: Overview of the proceedings. Neurotoxicol. Teratol. 18: 347–350.

Ben-Avi I, et al (1998) Malingering assessment in behavioral toxicology: What, why, and how. Am. J. Indust. Med. 34: 325–330.

Boyes WK, et al (1997) EPA's neurotoxicity risk assessment guidelines. Toxicol. Appl. Pharmacol. 40: 175–184.

Boyes WK, et al (2007) Integrating epidemiology and toxicology in neurotoxicity risk assessment. Hum. Exp. Toxicol. 26(4): 283–293.

Buelke-Sam J, et al (1985) Collaborative Behavioral Teratology Study: results. Neurobehav. Toxicol. Teratol. 7: 591–624.

Burbacher TM, Grant KS (2000) Methods for studying nonhuman primates in neurobehavioral toxicology and teratology. Neurotoxicol. Teratol. 22(4): 475–486.

Bushnell PJ, et al (2007) Approaches to extrapolating animal toxicity data on organic solvents to public health. Neurotoxicology 28: 221–226.

Claudio L, Kwa W, Russell A, Wallinga D (2000) Testing methods for developmental neurotoxicity of environmental chemicals. Toxicol. Appl. Pharmacol. 164(1): 1–14.

Coecke S, et al (2007) Workgroup report: incorporating in vitro alternative methods for developmental neurotoxicity into international hazard and risk assessment strategies. Environ. Health Perspect. 115: 924–931.

Cory-Slechta DA, et al (2001) Methods to identify and characterize developmental neurotoxicity for human health risk assessment. I: behavioral effects. Environ. Health Perspect. 109: 79–91.

Costa LG (1998) Signal transduction in environmental neurotoxicity. Annu. Rev. Pharmacol. Toxicol. 38: 21–43.

Costa LG, Manzo L (1995) Biochemical markers of neurotoxicity: Research strategies and epidemiological applications. Toxicol. Lett. 77(1–3): 144–147.

Costa LG (1996) Biomarker research in neurotoxicology: The role of mechanistic studies to bridge the gap between the laboratory and epidemiological investigations. Environ. Health Perspect. 104(Suppl. 1): 55–67.

Costa LG (1998) Biochemical and molecular neurotoxicology: Relevance to biomarker development, neurotoxicity testing and risk assessment. Toxicol. Lett. 102–103: 417–421.

Dawson R, Jr, et al (1995) Excitotoxins, aging, and environmental neurotoxins: Implications for understanding human neurodegenerative diseases. Toxicol. Appl. Pharmacol. 134: 1–17.

Dorman DC, et al (2001) Methods to identify and characterize developmental neurotoxicity for human health risk assessment. III: Pharmacokinetic and pharmacodynamic considerations. Environ. Health Perspect. 109: 101–111.

Dorman DC (2000) An integrated approach to neurotoxicity. Toxicol. Pathol. 28: 37–42.

ECETOC Working Group (1996) Chronic neurotoxicity of solvents. ECETOC Tech. Rep. 70.

Environmental Health Perspectives 104(Suppl. 2) (1996) This supplement contains a variety of relevant articles on topics such as neurobehavioral epidemiology, behavioral toxicology, behavioral effects of lead, clinical neurologic indices of toxicity in animals, and the SGOMSEC joint report.

Garman RH, et al (2001) Methods to identify and characterize developmental neurotoxicity for human health risk assessment. II: Neuropathology. Environ. Health Perspect. 109: 93–100.

Grandjean P, Landrigan PJ (2006) Developmental neurotoxicity of industrial chemicals. Lancet 368: 2167–2178.

Harry GJ, et al (1998) In vitro techniques for the assessment of neurotoxicity. Environ. Health Perspect. 106(Suppl. 1): 131–158.

Holson RR, et al (2007) Statistical issues and techniques appropriate for developmental neurotoxicity testing. Neurotoxicol. Teratol. doi:10.1016/j.ntt.2007.06.001.

Jacobson JL, Jacobson SW (1996) Prospective, longitudinal assessment of developmental neurotoxicity. Environ. Health Perspect. 104(Suppl 2): 275–283.

Ladies GS, et al (2005) Developmental toxicology evaluations – issues with including neurotoxicology and immunotoxicology assessments in reproductive toxicology studies. Toxicol. Sci. 88: 24–29.

Lein P, et al (2005) In vitro and other alternative approaches to developmental neurotoxicity testing (DNT). Environ. Toxicol. Pharmacol. 19(3): 735–744.

Li AA (2005) Regulatory developmental neurotoxicology testing: data evaluation for risk assessment purposes. Environ. Toxicol. Pharmacol 19: 727–733.

Lucchini R, et al (2005) Neurobehavioral science in hazard identification and risk assessment of neurotoxic agents – what are the requirements for further

development? Intern. Arch. Occ. Environ. Health 78(6): 427–437.

Manzo L, et al (1996) Biochemical markers of neurotoxicity. A review of mechanistic studies and applications. Hum. Exp. Toxicol. 15: S20–S35.

Moser VC, et al (1997) The IPCS collaborative study on neurobehavioral screening methods: II. Protocol design and testing procedures. Neurotoxicology 18: 929–938.

Moser VC, et al (1997) The IPCS collaborative study on neurobehavioral screening methods: V. Results of chemical testing. Neurotoxicology 18: 969–1056.

Moser VC (2000) The functional observational battery in adult and developing rats. Neurotoxicology 21: 989–996.

Moser VC, et al (2007) Cognitive evaluation: is it needed in neurotoxicity screening? Symposium presented at the annual Behavioral Toxicology Society meeting. Neurotoxicol. Teratol. 22: 785–798.

Moser VC (2007) Animal models for chronic pesticide neurotoxicity. Hum. Exp. Toxicol. 26(4): 321–331.

Middaugh LD, et al (2003) Neurobehavioral assessment: A survey of use and value in safety assessment studies. Tox. Sci. 76: 250–261.

O'Callaghan JP, et al (2005) Glial-fibrillary acidic protein and related glial proteins as biomarkers of neurotoxicity. Expert Opin. Drug Saf. 4(3): 433–442.

Rice DC, et al (1996) Lessons for neurotoxicology from selected model compounds: SGOMSEC report. Environ. Health Perspect. 104(Suppl. 2): 205–215.

Rice DC, Barone S (2000) Critical periods of vulnerability for the developing nervous system: evidence from humans and animal models. Environ. Health Perspect. 108(3): 511–533.

Sharbaugh C, et al (2003) Comparable measures of cognitive function in human infants and laboratory animals to identify environmental health risks to children. Environ. Health Perspect. 111(13): 1630–1639.

Slikker W, Jr, et al (1998) Biologically based dose-response model for neurotoxicity risk assessment. Toxicol. Lett. 102–103: 429–433.

Slikker W, Jr, et al (2005) Behavioral test methods workshop. Neurotox. Teratol 27: 417–427.

Tilson HA, Kodavanti PR (1998) The neurotoxicity of polychlorinated biphenyls. Neurotoxicology 19: 517–525.

Viviani B, Marinovich M (1998) Neurotoxicity: An active role for glia?. Neurosci. Res. Commun. 23: 1–12.

Watson RE (2006) Postnatal growth and morphological development of the brain: a species comparison. Birth Defects Res. B Dev. Reprod. Toxicol. 77: 471–484.

Organizations

Behavioral Toxicology Society (BTS)
No official address, check website
Web: http://www.behavioraltoxicology.org

Founded in 1982, BTS promote research and forums for the presentation of research on the effects of toxic agents on behavior and the nervous system.

Institute of Neurotoxicology & Neurological Disorders (INND)
8232 14th Ave NE
Seattle, WA 98115
Phone: 206-527-0926
Fax: 206-525-5102
Email: sgilbert@innd.org
Web: www.asmalldoseof.org ("A Small Dose of Toxicology")
Web: www.toxipedia.org – connecting science and people

INND was founded almost ten years ago and focuses on education and policy issues related to neurotoxicology.

International Neurotoxicology Association (INA)
No official address, check website
Web: http://www.neurotoxicology.org

INA was founded in the early 1980s to foster and support an international perspective on neurotoxicology. They hold an international meeting every two years.

Neurobehavioral Teratology Society (NBTS)
No official address, check website
Web: http://www.nbts.org/

The Neurobehavioral Teratology Society, formed in 1977, focuses on understanding the behavioral and developmental alterations that result from genetic and environmental perturbations of the nervous system during the pre- and perinatal period. The society publishes the journal *Neurotoxicology and Teratology* and hosts an annual conference.

Neurotoxicity Society
Richard M Kostrzewa PhD
Professor, Department of Pharmacology
Quillen College of Medicine
East Tennessee State University
PO Box 70,577

Rm. 1-44, Carl Jones Hall at VA Mtn Home
Johnson City, TN 37614-1708
USA
Web: http://www.neurotoxicitysociety.org

The aim of the Neurotoxicity Society is to unite basic and clinical scientists working on neurotoxicity issues.

Neurotoxicology Specialty Section of the Society of Toxicology
No official address, check website
Web: http://www.toxicology.org/isot/ss/neurotox/neuro.html

This group works to promote collaboration and networking amongst neurotoxicologists associated with the Society of Toxicology.

Other Resources

Experimental and Clinical Neurotoxicology, First Edition
Spencer PS, Schaumberg H (1980)
Williams & Wilkins, 929 pp.

Free download http://www.ohsu.edu/croet/faculty/spencer/book/first_ed.html.

Guidelines for Neurotoxicity Risk Assessment
Web: www.epa.gov/ncea/raf/pdfs/neurotox.pdf
U.S. EPA Guidelines for Neurotoxicity Risk Assessment Published on May 14, 1998, Federal Register 63(93):26926–26954.

International Pregramme on Chemical Safety (IPCS) Environmental Health Criteria 60
Principles and methods for the assessment of neurotoxicity associated with exposure to chemicals.
Web: http://www.inchem.org/documents/ehc/ehc/ehc060.htm

International Pregramme on Chemical Safety (IPCS) Environmental Health Criteria 223
Neurotoxicity risk assessment for human health: principles and approaches.
Web: http://www.inchem.org/documents/ehc/ehc/ehc223.htm

Organization of Economic Cooperation and Development (OECD) Guidance Document No. 20 for Neurotoxicity
Web: http://appli1.oecd.org/olis/2004doc.nsf/linkto/env-jm-mono(2004)25

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CHAPTER

56

Target Sites: Respiratory

VICTORIA A. CASSANO, AND TEE L. GUIDOTTI

INTRODUCTION

The lung is both a major pathway for toxic exposures and a vulnerable target organ in its own right. Receiving many liters of airflow per day, it has evolved a variety of host defenses and barriers to protect its structures, especially the delicate alveolar membrane. For that reason, pulmonary toxicology cannot be understood without a firm grasp of host defense mechanisms. Concepts of the respiratory tract as a target organ have changed fundamentally in the last 10 years with the discovery of ultrafine particles and their seeming ability to avoid these defense mechanisms, penetrate the vascular barrier and exert effects outside the lung. As well, the lung is a relatively limited (although not simple) structure which can respond only in a few different ways to a toxic event. The inflammatory effects of ultrafines and of synthetic nano-sized particles (see Dusts and Fibers) were initially unexpected and their study has opened new doors to the investigation of the lung and its responses. Inhalation toxicology is one of the most technically difficult fields of experimental toxicology and the study of particles presents particular challenges.

RESOURCES

Books

Bernstein IL, Chan-Young M, Malo J, Bernstein DI (Eds.) (2006)
Asthma in the Workplace Third Edition
Taylor and Francis, New York.

Prepared by leading experts in occupational asthma, this reference book addresses mechanisms, evaluation, workplace allergens and triggers, diagnosis, treatment, and categories of causative agents, asthma genetics, environmental monitoring, skin and pulmonary interactions and the value of allergy testing, and surveillance. Does not go into much detail on aggravational asthma or irritant-induced asthma.

Bush RK (Ed.) (2001)
Environmental Asthma
Marcel Dekker, New York

An excellent summary of what is known regarding environmental factors and the immunology and pathophysiology of occupational and environmental asthma. The book discusses individual allergens and pollutants, describes methods of investigation and clinical evaluation, the role of inflammatory mediators, atopy, immunotherapy, and indoor air quality.

Chiyotani Kv, Hosoda Y, Aizawa Y (1998)
Advances in the Prevention of Occupational Respiratory Diseases
Proceedings of the 9th International Conference, Tokyo, Japan, 13–16 October 1997
Elsevier, Amsterdam; San Diego

A conference proceedings monograph devoted to prevention of occupational respiratory diseases from the 9th International Conference on Lung Diseases in Kyoto. This conference series is sponsored by the International Labour Organisation and represents a key source for specific issues of regulation and international standardization of methodology. A valuable resource for the specialist, not suitable for the general user.

Cohen MD, Zeilikoff JT, Schlesinger RB (2000)
Pulmonary Immunotoxicology
Kluwer Academic Publishers, Boston, MA

http://www.directtextbook.com/author/This is a comprehensive source on the immune system of the respiratory tract, containing information useful in inhalation toxicology, immunotoxicology studies, and biomarkers. Divided into four sections: basic science, pathophysiology, immunological outcomes, and agents known to alter the immune function of the respiratory tract. Includes discussion of risk assessment and application of principles to regulation and prevention, which is more complicated for immune and immunotoxicologic responses than for other effects upon the lungs.

Cordasco EM, Demeter SL, Zenz C (Eds.) (1995)
Environmental Respiratory Diseases
Van Nostrand, New York

This reference book came out at the same time as the Harber et al text and did not fare well in the competition for sales. It is now hard to find. However, it has several chapters that bring together material not easily found elsewhere, such as toxic inhalation and pulmonary edema, the investigation of building-associated outbreaks, and respiratory health in the aerospace sector.

Corren J, Togias A, Bousquet J (2003)
Upper and Lower Respiratory Disease
Marcel Dekker, New York

Other sources cover the lower respiratory tract well but this source is unusual in providing a comprehensive view of the upper and lower respiratory tract, both as anatomic divisions and as interacting structures. Discusses physiology, immunology, and mechanisms of disease with a special emphasis on rhinitis and sinusitis. A valuable resource for the specialist, not suitable for the general user.

Gardner DL, Crapo JD, McLellan RO (Eds.) (1999)
Toxicology of the Lung, 3rd Edition
Taylor and Francis, Philadelphia, PA

This is an authoritative sourcebook for inhalation toxicology, covering anatomy, physiology, particle behavior, carcinogenicity, airways reactivity, and immunology. Although equal attention is paid to human and animal models, the emphasis is on research and applications of research for purposes of regulation, not clinical issues. Indispensable for the serious inhalation toxicologist.

Harber P, Schenker M, Balmes J (Eds.) (1995)
Occupational and Environmental Respiratory Diseases
Mosby, St. Louis, MO

Authoritative and comprehensive reference work on the diagnosis, management, and prevention of occupational and environmental respiratory diseases. Describes the clinical presentation of lung diseases, diagnostic methods, diseases associated with specific occupations and industries, clinical management of specific disorders, regulatory issues, compensation, and assessment of pulmonary impairment.

Hendrick D, Beckett W, Burge PS (Eds.) (2002)
Occupational Disorders of the Lung: Recognition, Management and prevention, 1st Edition
W.B. Saunders, London, New York

An authoritative textbook on occupational lung disorders with several unusual features. Issues of legislation and compensation management are addressed in unusual detail, for many countries. A feature called 'Difficult Cases' provides guidance from leading pulmonary and occupational disease specialists.

Laurent G, Shapiro S (2006)
Encyclopedia of Respiratory Medicine (Four volume set (1–4))
Academic Press, New York

This publication provides a comprehensive coverage of the complete field of respiratory medicine. It also provides a vital interface between the pure and clinical science environments covering various aspects of respiratory medicine from the relevant molecular biology to the treatment of diseases that affect the respiratory system. Further, it includes lung cells – the structural components of the lung and key molecules that regulate lung function as well as all the major respiratory diseases. The target audiences (upper level undergraduates, graduate students, post docs and professionals in pulmonology, biochemistry, cell biology, immunology, physiology, anesthesiology, intensive care, and respiratory medicine) will find this source of information very important. This publication is also available online via ScienceDirect (www.sciencedirect.com) which features extensive browsing, searching, and internal cross-referencing between articles in the work. Additionally, dynamic linking to journal articles and abstract databases are also available. The following topics are included in these four volumes: Anatomy and development of the respiratory tract; Anesthesia and surgery; Biologic processes and associated cells and molecules; Defence mechanisms; Diagnostic evaluation; Disorders of the control of breathing; Disorders of the pleura; Disorders of pulmonary circulation; Environmental and occupational disease; Exercise Infectious diseases; Infiltrative and interstitial lung diseases; Laboratory techniques for studying the lung in health and disease; Lung growth; Lung injury

defence and repair; Lung tissues; Manifestations of respiratory disease; Mechanics; Morphogenesis; Neonatal and pediatric lung; Neoplasms; Obstructive diseases; Oxygen delivery; Peripheral gas exchange; Pulmonary circulation and fluid exchange; Pulmonary gas exchange; Respiratory failure; Respiratory manifestations of extrapulmonary disease; Respiratory physiology; Respiratory pharmacology; and Sleep.

Qi G (1994)
The Atlas of Occupational Lung Diseases
Shanxi Science Technology Publishers, Taiyuan City, China

An outstanding refer.ence work, difficult to find but invaluable for the investigator engaged in studies of the pneumoconioses. Provides chest films, ink drawings, and short descriptions. Unfortunately, only labels are provided for diagnosis. There are no occupational histories or histology provided. Captions are in English, Chinese, Japanese, French, and Russian.

Salem H, Katz SA (2006)
Inhalation Toxicology, 2nd Edition
Taylor and Francis Group, CRC Press, Boca Raton, FL

This book provides practicing professional, student, scientist, academic, commercial, industrial, and governmental sectors on regulatory aspects of exposure and testing, testing equipment and procedures, biomarkers and pathology of exposure, respiratory allergy and irritation of the respiratory tract, risk assessment, bioaerosols ranging from household molds to anthrax and botulinum toxins, low-level exposures, toxicology theory and modeling, and toxic effects of some individual toxicants ranging from tobacco smoke to botulinum toxins. Furthermore, this book recognizes that the 100-m^2 surface of the lungs coupled with 15-l/min respiration rate provide opportunity for the entry of toxic and therapeutic chemicals into the human body via inhalation pathway. Transfer across the alveolar–gas interface is rapid and often enhanced by large partition coefficients. Toxicokinetic models have been developed for the absorption, distribution, metabolism, and inhaled chemicals. Recently, this approach has been extended to understand exposure to biologic materials such as mold and fungi. Emerging proteomics and genomic approaches are also included in this book. Other chapters on topics such as updated testing procedures and testing equipment have been included in this book. Recent changes in the European and North American guidelines for testing procedures are also included in the book.

Schwartz MI, King TE (2003)
Interstitial Lung Disease, 4th Edition
BC Dekker, London

Many occupational and environmental lung diseases affect the connective tissue skeleton of the lung and the structures between airspaces, called the interstitium. However, many interstitial lung diseases have other causes or no known cause. This reference book describes methods of diagnosis and describes the various interstitial lung diseases. It is therefore valuable not only for its toxicological content but in sorting out alternatives and the differential diagnosis when patients present with an interstitial disease pattern.

Swift DL, Foster WM (1999)
Air Pollutants and the Respiratory Tract, Second Edition (Lung Biology in Health and Disease)
Marcel Dekker, New York

An authoritative survey of the state of the art of air pollution studies as of the date of publication. Includes coverage of basic biology, epidemiology, methodology, sources, clinical evaluation, and details of specific toxic effects. As with all monographs, new information may arise since the date of publication. In this case, the gap falls mostly in coverage of fine and ultrafine particulate air pollution and mechanisms of cardiovascular response.

Journals

Inhalation Toxicology
Informa Healthcare, UK

This is a peer-reviewed publication that provides an important forum for the accomplishments and advancements in concepts, approaches, and procedures to evaluate the health risk associated with airborne chemicals. Topics include original research, reviews, symposiums and workshops focusing on how the respiratory system functions in health and disease, the pathogenesis and mechanism of injury, extrapolation of animal data to humans, effects of inhaled substances on extrapulmonary systems, and reliable and innovative models for predicting human disease. This journal is listed in Index Medicus/MEDLINE and other services and has been ranked 16th out of a total of 63 journals in toxicology, placing it in the top 25% of all toxicology journals. This description has been excerpted from http://www.tandf.co.uk/journals/titles/08958378.asp.

Journal Articles

Ahmed FE (2001) Toxicology and human health effects following exposure to oxygenated or reformulated gasoline. Toxicol. Lett. 123(2–3): 89–113. Review.

American Thoracic Society Ad Hoc Committee on Impairment/Disability Criteria (1986) Evaluation of

impairment/disability secondary to respiratory disorders. Am. Rev. Resp. Dis. 134: 1205–1209. Dated but critical document.

Antonini JM, Lewis AB, Roberts JR, Whaley DA (2003) Pulmonary effects of welding fumes: review of worker and experimental animal studies. Am. J. Ind. Med. 43(4): 350–360. Review.

Beckett WS (2000) Occupational respiratory diseases. N. Engl. J. Med. 342(6): 406–413. Concise review.

Bhalla DK (1999) Ozone-induced lung inflammation and mucosal barrier disruption: toxicology, mechanisms, and implications. J. Toxicol. Environ. Health B Crit. Rev. 2(1): 31–86. Review.

Blanc PD, Toren K (1999) How much adult asthma can be attributed to occupational factors? Am. J. Med. 107(6): 580–587. Important contribution on burden of disease.

Bright P, Burge PS (1996) Occupational lung disease. 8. The diagnosis of occupational asthma from serial measurements of lung function at and away from work. Thorax 51(8): 857–863. Important contribution on serial measurement.

Centers for Disease Control Work-Related Lung Disease Surveillance Report (2002) Washington DC, National Institute for Occupational Safety and Health, December 2002. Standard resource for surveillance.

Chan-Yeung M (1995) Assessment of asthma in the workplace. ACCP consensus statement. American College of Chest Physicians. Chest 108(4): 1084–1117. Review and guidelines.

Collins MA (2002) Toxicology of toluene diisocyanate. Appl. Occup. Environ. Hyg. 17(12): 846–855. Review.

Delaunois LM (2004) Mechanisms in pulmonary toxicology. Clin. Chest Med. 25(1): 1–14. Review.

Dewitte J-D, Chan-Yeung M, Malo J-L (1994) Medicolegal and compensation aspects of occupational asthma. Eur. Respir. J. 7(5): 969–980. Review.

Donaldson K, Aitken R, Tran L, et al (2006) Carbon nanotubes: a review of their properties in relation to pulmonary toxicology and workplace safety. Toxicol. Sci. 92(1): 5–22. Epub 2006 Feb 16. Review.

Elsayed NM (1997) Toxicology of blast overpressure. Toxicology 121(1): 1–15. Review.

Finkelstein MM (2000) Silica, silicosis, and lung cancer: a risk assessment. Am. J. Ind. Med. 38(1): 8–18. Health risk assessment.

Fishwick D, Bradshaw LM, D'Souza W, et al (1997) Chronic bronchitis, shortness of breath, and airway obstruction by occupation in New Zealand. Am. J. Respir. Crit. Care Med. 156(5): 1440–1446. Useful contribution.

Genter MB (2006) Molecular biology of the nasal airways: how do we assess cellular and molecular responses in the nose? Toxicol. Pathol. 34(3): 274–280. Review.

Harkema JR, Carey SA, Wagner JG (2006) The nose revisited: a brief review of the comparative structure, function, and toxicologic pathology of the nasal epithelium. Toxicol. Pathol. 34(3): 252–269. Review.

Hendrick DJ (1994) Management of occupational asthma. Eur. Respir. J. 7(5): 961–968. Review.

Henneberger PK, Metayer C, Layne LA, et al (2000) Nonfatal work-related inhalations: surveillance data from hospital emergency departments, 1995–1996. Am. J. Ind. Med. 38(2): 140–148. Surveillance report.

Kuschner WG, Chitkara RK, Sarinas PS (1998) Occupational asthma: practical points for diagnosis and management. West J. Med. 169(6): 342–350. Clinical guidance.

Levin SM, Kann PE, Lax MB (2000) Medical examination for asbestos-related disease. Am. J. Ind. Med. 37(1): 6–22. Medical monitoring guidance.

Mast RW, Maxim LD, Utell MJ, Walker AM (2000) Refractory ceramic fiber: toxicology, epidemiology, and risk analyses – a review. Inhal. Toxicol. 12(5): 359–399. Review.

Naeher LP, Brauer M, Lipsett M, et al (2007) Woodsmoke health effects: a review. Inhal. Toxicol. 19(1): 67–106. Review.

Ohar J, Sterling DA, Bleecker E, Donohue J (2004) Changing patterns in asbestos-induced lung disease. Chest 125: 744–753.

Pauluhn J (2003) Issues of dosimetry in inhalation toxicity. Toxicol. Lett. 140–141: 229–238. Review.

Schick S, Glantz S (2005) Philip Morris toxicological experiments with fresh sidestream smoke: more toxic than mainstream smoke. Tob. Control, 14(6): 396–404. Review.

Shusterman D, Matovinovic E, Salmon A (2006) Does Haber's law apply to human sensory irritation? Inhal. Toxicol. 18(7): 457–471. Review.

Shusterman D (2003) Toxicology of nasal irritants. Curr. Allergy Asthma Rep. 3(3): 258–265. Review.

Tarlo SM, Liss G, Corey P, et al (1995) A workers' compensation claim population for occupational asthma: comparison of subgroups. Chest 107(3): 634–641.

Townsend MC (2007) Conflicting definitions of airways obstruction: drawing the line between normal

and abnormal. Chest 131(2): 335–336. Guidance for clinical and epidemiological standards.

Townsend MC (2005) Evaluating pulmonary function change over time in the occupational setting. J. Occup. Environ. Med. 47(12): 1307–1316. Guidance for clinical and epidemiological standards.

Troncy E, Francoeur M, Blaise G (1997) Inhaled nitric oxide: clinical applications, indications, and toxicology. Can. J. Anaesth. 44(9): 973–988. Review.

U.S. Preventive Services Task Force (2004) Lung cancer screening: recommendation statement. Ann. Int. Med. 140(9): 738–739.

van Kampen V, Merget R, Baur X (2000) Occupational airway sensitizers: an overview on the respective literature. Am. J. Ind. Med. 38(2): 164–218. Review.

Venables KM, Chan-Yeung M (1997) Occupational asthma. Lancet 349(9063): 1465–1469. Review.

Wagner GR, Wegman DH (1998) Occupational asthma: prevention by definition. Am. J. Ind. Med. 33(5): 427–429. Review and commentary.

Wang X, Yu ITS, Wong TW, et al (1999) Respiratory symptoms and pulmonary function in coal miners: looking into the effects of simple pneumoconiosis. Am. J. Ind. Med. 35(2): 124–131. Useful contribution.

Winder C (2001) The toxicology of chlorine. Environ. Res. 85(2): 105–114. Review.

Organizations

American College of Chest Physicians
3300 Dundee Road
Northbrook, Illinois 60062-2348
Phone: 847 498-1400
Fax 800 343-2227
Web: www.chestnet.org

American Thoracic Society
61 Broadway
New York, NY 10006-2755
Phone: 212 315-8600
Fax: 212 315-6498
Web: www.thoracic.org

European Respiratory Society
4, Ave Sainte-Luce
CH-1003, Lausanne
Switzerland
Phone: +41 21 213 01 01
Fax: +41 21 213 01 00
Web: www.ersnet.org

CHAPTER

57

Target Sites: Sensory

LEWIS NELSON

INTRODUCTION

Among the most complex of mammalian organs are the special sensory organs, engendering great sensitivity to toxicologic assault. Humans and other animals have developed sophisticated mechanisms to prevent the special sensory organs from injury by bloodborne toxins. Despite the development of this 'blood–organ barrier,' certain toxins are characteristically capable of gaining access to the organs and causing injury. Furthermore, given their obligatory exposure to the environment, these organs remain susceptible to external chemical assault.

RESOURCES

Books

Campbell KCM (2006)
Pharmacology and Ototoxicity for Audiologists
Thomson Delmar Learning, Clifton Park, NY

Clinically focused text for paraprofessionals involved in clinical practice.

Chiou GCY (1999)
Ophthalmic Toxicology, 2nd Edition (Target Organ Toxicology Series)
CRC, New York

A classic discussion of the basic science of toxicology, including in vitro and animal models of toxicity.

Donaldson K, Borm P (2006)
Particle Toxicology
CRC, Boca Raton, FL

Though not specific to nasal toxicology, this book reviews the pathophysiology and research methodology of inhalational toxins.

Fraunfelder FT, Fraunfelder FW (Eds.) (2001)
Drug-Induced Ocular Side Effects, 5th Edition
Butterworth Heinemann, Boston, MA

Fraunfelder FT, Fraunfelder FW, Chambers WA (2008)
Clinical Ocular Toxicology
Saunders, New York

Grant WM, Schuman JS (1993)
Toxicology of the Eye, 4th Edition
Charles C. Thomas Publisher, Springfield, IL

This is the most authoritative and comprehensive work on the subject. The text summarizes mechanisms of injury, clinical findings, and treatment of more than 3000 substances in an alphabetized format.

Hayes AW (1985)
Toxicology of the Eye, Ear, and Other Special Senses
CRC, New York

This book reviews the fundamental clinical science of toxic exposures of the special senses. Although not specifically focused on human senses, it discusses both the clinical and laboratory assessment in animals following exposure.

Miller FJ, Boorman GA (1995)
Nasal Toxicity and Dosimetry of Inhaled Xenobiotics
CRC, New York

Roland PS, Rutka JA (2004)
Ototoxicity
B.C. Decker, Hamilton, ON, Canada

This book serves as a resource for the human ototoxic potential of drugs used in clinical practice. It discusses both the ototoxicity of drugs used for non-otic conditions as well as the toxicity of otopharmaceuticals.

(2001)
The Wills Eye Drug Guide: Diagnostic and Therapeutic Medications, 2nd Edition
Lippincott Williams & Wilkins, Philadelphia, PA

Clearly focused on ophthalmic pharmacology.

Review Articles

Bhattacharya SK, Hom GG, Fernandez C, Hom LG (2007) Ocular effects of exposure to industrial chemicals: clinical management and proteomic approaches to damage assessment. Cutan. Ocul. Toxicol. 26: 203–225.

Fraunfelder FW, Rosenbaum JT (1997) Drug-induced uveitis incidence, prevention and treatment. Drug Saf. 17: 197–207.

Genter MB (2006) Molecular biology of the nasal airways: how do we assess cellular and molecular responses in the nose?. Toxicol. Pathol. 34: 274–280.

Gobba F (2003) Occupational exposure to chemicals and sensory organs: a neglected research field. Neurotox-icology 24(4–5): 675–691.

Griffin JP (1992) Drug-induced disorder of taste. Adv. Drug React. Rev. 11: 229–239.

Harkema JR, Carey SA, Wagner JG (2006) The nose revisited: a brief review of the comparative structure, function, and toxicologic pathology of the nasal epithelium. Toxicol. Pathol. 34: 252–269.

Haynes DS, Rutka J, Hawke M, Roland PS (2007) Ototoxicity of ototopical drops – an update. Otolaryngol. Clin. North Am. 40(3): 669–683. xi.

Henkin RI (1994) Drug-induced taste and smell disorders. Incidence, mechanisms and management related primarily to treatment of sensory receptor dysfunction. Drug Saf. 11: 318–377.

Ishiyama G, Ishiyama A, Kerber K, Baloh RW (2006) Gentamicin ototoxicity: clinical features and the effect on the human vestibulo-ocular reflex. Acta Otolaryngol. 126(10): 1057–1061.

Li J, Tripathi RC, Tripathi BJ (2008) Drug-induced ocular disorders. Drug Saf. 31(2): 127–141.

Morata TC (2003) Chemical exposure as a risk factor for hearing loss. J. Occup. Environ. Med. 45(7): 676–682.

Roland PS, Rybak L, Hannley M, et al (2004) Animal ototoxicity of topical antibiotics and the relevance to clinical treatment of human subjects. Otolaryngol. Head Neck Surg. 130(3 Suppl): S57–S78. Review.

Rybak LP, Kelly T (2003) Ototoxicity: bioprotective mechanisms. Curr. Opin. Otolaryngol. Head Neck Surg. 11(5): 328–333.

Rybak LP, Ramkumar V (2007) Ototoxicity. Kidney Int. 72(8): 931–935.

Rybak LP, Whitworth CA, Mukherjea D, Ramkumar V (2007) Mechanisms of cisplatin-induced ototoxicity and prevention. Hear Res. 226(1–2): 157–167.

Selimoglu E (2007) Aminoglycoside-induced ototoxicity. Curr. Pharm. Des. 13(1): 119–126.

Sells DM, Brix AE, Nyska A, Jokinen MP, Orzech DP, Walker NJ (2007) Respiratory tract lesions in non-inhalation studies. Toxicol. Pathol. 35: 170–177.

Sliwinska-Kowalska M, Prasher D, Rodrigues CA, et al (2007) Ototoxicity of organic solvents – from scientific evidence to health policy. Int. J. Occup. Med. Environ. Health, 20(2): 215–222.

Upadhyay UD, Holbrook EH (2004) Olfactory loss as a result of toxic exposure. Otolaryngol. Clin. North Am. 37(6): 1185–1207.

Wagoner MD (1997) Chemical injuries of the eye: Current concepts in pathophysiology and therapy. Surv. Ophthalmol. 41: 275–312.

Yorgason JG, Fayad JN, Kalinec F (2006) Understanding drug ototoxicity: molecular insights for prevention and clinical management. Expert Opin. Drug Saf. 5(3): 383–399.

Journals

Cutaneous and Ocular Toxicology (previously Journal of Toxicology – Cutaneous and Ocular Toxicology)

Inhalation Toxicology

Journal of Ocular Pharmacology and Therapeutics

Neurotoxicology and Teratology

Toxicologic Pathology

Databases

Diseases Database
http://www.diseasesdatabase.com/

Organizations

International Society of Ocular Toxicology
http://www.isot.org/isot/html/index.php

CHAPTER

58

Target Sites: Skin

JULIE GOODMAN AND CARRIE YU

INTRODUCTION

The skin is the largest organ in the human body, with surface area of approximately $2\,m^2$ in an adult male. It serves the vital purpose of acting as a barrier between the human and the outside world, moderating both the introduction of foreign substances and the escape of body fluids and heat. In addition to serving as a physical barrier, the skin has the ability to metabolize some of the agents that pass through it. Human skin is made up of two layers, with the surface of the skin made up of an unvascularized external epidermis with a highly vascularized dermis located just below that. The skin is not an impermeable barrier, however, and many substances have the ability to penetrate the skin. This ability to pass through the skin is affected by many factors including area of the body where skin is located, preexisting skin diseases, genetic factors, temperature, humidity, and season. Skin toxicology examines the ability of various potentially toxic substances to affect the skin and to pass through the skin and into general systemic circulation to cause other potential effects.

RESOURCES

Books

Anderson BD, Wexler P (Eds.) (2005)
Encyclopedia of Toxicology, 2nd Edition
Elsevier, San Diego, CA.

Includes several skin-related topics: Safety Testing, Clinical Studies by A Pagnoni, Skin by P Robinson, Toxicity Testing, Alternatives by SC Gad, Toxicity Testing, Dermal by SE Gad and SC Gad, and Toxicity Testing, Irritation by PJ Hakkinen.

Baker S, Driver J, McCallum D (Eds.) (2001)
Residential Exposure Assessment. A Sourcebook
Kluwer Academic/Plenum Publishers, New York.

Includes Chapter 5 by P Robinson and C Ferenbacher on dermal exposure in residences.

Chilcott RP, Price S (Eds.) (2008)
Principles and Practice of Skin Toxicology
John Wiley & Sons, Chichester, UK.

Discusses principles of skin absorption, methods for assessing skin toxicity (both in vivo and in vitro testing), clinical and occupational skin toxicity, and regulating aspects.

Maibach HI, Strauss S (2001)
Toxicology of Skin
Taylor and Francis, Philadelphia, PA.

Part of Target Organ Toxicology Series.

Olin SS (Ed.) (1999)
Exposure to Contaminants in Drinking Water. Estimating Uptake through the Skin and by Inhalation
CRC Press, Boca Raton, FL.

Presents the current state of the science for assessing dermal and inhalation exposures from various uses of residential water. Includes the identification and review of available information resources, models, and approaches, along with several exposure assessment case studies. For example, Chapter 6 by AL Bunge and JN McDougal is on dermal uptake.

Riviere JE (Ed.) (2005)
Dermal Absorption Models in Toxicology and Pharmacology
Taylor and Francis, CRC Press, Boca Raton, FL.

Roberts MS, Walters KA (Eds.) (2008)
Dermal Absorption and Toxicity Assessment, 2nd Edition
Informa Healthcare, New York.

This book provides a state-of-the-art overview of the dermal absorption process, and is divided into sections covering skin structure and absorption, measurement of absorption, modeling of dermal absorption and risk assessment, skin toxicity and its prevention, regulatory issues and specific examples of the absorption of environmental materials. It also covers the methods used to assess skin absorption and the various governmental and industrial programs concerned with skin permeation and toxicity, including alternative in silico, in vitro, and in vivo strategies to conduct studies for regulatory approval.

U.S. Environmental Protection Agency (EPA) (2000)
Summary Report for the Workshop on Issues Associated with Dermal Exposure and Uptake
USEPA, Washington, DC.
Web: http://cfpub.epa.gov/ncea/raf/recordisplay.cfm?deid=20679

The EPA Risk Assessment Forum organized a workshop on December 10 and 11, 1998, to address generic technical issues related to dermal exposure and risk assessment that were raised during the February 1998 peer review of the Superfund Dermal Guidance (SDG). The issues were organized into four categories: (1) dermal exposure to contaminants in water, (2) dermal exposure to contaminants in soil, (3) adjustment of toxicity factors to reflect absorbed dose, and (4) risk characterization and uncertainty analysis for dermal assessments. This report summarizes the discussions at the workshop.

U.S. Environmental Protection Agency (EPA) (2004)
Risk Assessment Guidance for Superfund (RAGS). Volume I: Human Health Evaluation Manual (Part E, Supplemental guidance for dermal risk assessment) (Final)
USEPA, Washington, DC.
Web: http://www.epa.gov/oswer/riskassessment/ragse/index.htm.

The EPA developed Risk Assessment Guidance for Superfund: Volume I Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) to address human health risk related to dermal exposures. Parts A, B, C, and D address other aspects of a human health risk assessment on a Superfund site. Part E uses a consistent methodology for assessing the exposures from the dermal pathway for Superfund human health risk assessments. Part E does not address dermal exposure to vapors.

Journal Articles

Auletta CS (2004) Current in vivo assays for cutaneous toxicity: local and systemic toxicity testing. Basic Clin. Pharmacol. Toxicol. 95(5): 201–208.

Felter SP, Ryan CA, Basketter DA, Gilmour NJ, Gerberik GF (2003) Application of the risk assessment paradigm to the induction of allergic contact dermatitis. Reg. Toxicol. Pharmacol. 37: 1–10.

Hanifin JM, Api AM, Bickers DR (2003) Considerations for testing irritancy, allergy, and photoreactivity in fragrance safety evaluations. Am. J. Contact Dermat. 14(2): 100–103.

Paustenbach DJ (2000) The practice of exposure assessment: a state-of-the-art review. J. Toxicol. Environ. Health Part B 3(3): 179–291.

Poet TS, McDougal JN (2002) Skin absorption and human risk assessment. Chemico-Biological Interact. 140(1): 19–34.

Robinson MK, Perkins MA (2002) A strategy for skin irritation testing. Am. J. Contact Dermatitis, 13(1): 21–29.

Robinson MK (1999) Population differences in skin structure and physiology and the susceptibility to irritant and allergic contact dermatitis: implications for skin safety testing and risk assessment. Contact Dermatitis 41: 65–79.

Welss T, Basketter DA, Schroder KR (2004) In vitro skin irritation: facts and future. State of the art review of mechanisms and models. Toxicol. In Vitro, 18(3): 231–243.

Journals

American Journal of Contact Dermatitis
Contact Dermatitis
Journal of the American Academy of Dermatology
Toxicology in vitro

Newsletters

Skin & Allergy News

Online Resources

DermWeb
Web: http://www.dermweb.com/dermatology_links/organizations_societies.htm

Listings of dermatology-related organizations and societies around the world. DermWeb also provides access to a directory of international dermatology departments, societies, and journals, journal abstracts and teaching modules. Common skin problems with information and support for each, and a comprehensive directory of dermatology photo collections.

(U.S.) National Library of Medicine, Medline Plus, Skin Conditions
Web: http://www.nlm.nih.gov/medlineplus/skinconditions.html

Includes a variety of up-to-date information including: the news, diagnoses/symptoms, treatment, prevention/screening, pictures and photographs, nutrition, specific skin conditions, related issues, clinical trials, genetics, research, anatomy/physiology, dictionaries/glossaries, directories, organizations, statistics, and children.

Organizations

American Academy of Dermatology
Web: http://www.aad.org/default.htm

Includes a Public Resource Center of information on dermatology topics, news and events, publications, other resources, etc.

Society of Toxicology (SOT), Dermal Toxicology Specialty Section
Web: http://www.toxicology.org/ISOT/SS/dtss/

Presents and sponsors programs and educational activities; acts as a resource to the SOT in dermal toxicology; relates developments in dermal toxicology to SOT activities; and stimulates growth in the science of dermal toxicology.

CHAPTER

59

Terrorism and Warfare (Chemical, Biological, and Radioactive and Nuclear)

BARBARA PRICE AND RICHARD PRICE

INTRODUCTION

Previous editions of *Information Resources in Toxicology* have not contained a chapter on Terrorism and Warfare (Chemical, Biological and Radioactive and Nuclear CBRN); but in fact, the use of chemicals, biological and toxin agents, and radiological materials as military weapons does not fall under conventional weapons. These materials, used in war and in terrorism, are often referred to as weapons of mass destruction (WMD). In many cases, this is a misnomer and in fact these weapons do not destroy as much as they cause fear, require extensive and intensive medical treatment that ties up civilian and military medical facilities and material, limit the use of areas contaminated with these agents (denial of material and terrain), and, require careful time-consuming decontamination. These WMD, especially radioactive agents, are sometimes more aptly referred to as weapons of mass disruption because although they can kill many people, their biggest effect is disruption of operations.

Both the Chemical Weapons Convention and the Biological Toxin Weapon Convention, although originally developed to deal with military use of CB agents, include sections that can be applied to civilian and terrorist use. However, this is not the main thrust for either convention. Terrorism is not always defined the same way by different groups or from the same perspective. Terrorism used here refers to attacks on civilians and non-military targets to incite fear among targeted groups to bend them to another's political motives, whether that of an individual, a group, or a state. Distinguishing terrorist attacks from military attacks and even industrial accidents is not always straightforward. There may also be difficulties in proving a terrorist component to a military attack, especially if the collateral damage releases CBRN agents that can threaten civilian populations. When is an attack on a chemical plant not a strategic military target, but instead done to collaterally release chemicals to terrorize the local civilian population? It is not always easy to differentiate these.

Chemicals, toxins, and biological agents have been used for many years as weapons in war and as weapons of terror. World War I saw the first military organized use of chemicals, specifically chlorine and mustard, between the British and the Germans as the first effective use of chemical agents. However before that, chemicals had been used as far back as 1000 BC when Chinese used arsenic in fires to poison their enemies.

The first generally cited use of biological agents in war is in 184 BC when Hannibal's forces threw snakes into his enemies' boats during a naval battle, and then 1364 when the Tartars threw dead plague victim bodies into the walled city of Kaffa with the intention of causing plague. Another example in more modern history frequently cited is the British, fighting the French and Indian Wars in North America, who gave the Indians blankets contaminated with dried body fluids from smallpox victims.

Groups with political motives have used chemical, biological, and radiological materials as agents to terrorize populations and enhance their apparent power

when their real power is small. Recent examples include: Aum Shimrykio's use of nerve agents in Tokyo, 1990, ricin in an umbrella in London to kill a former Bulgarian citizen in 1978; a religious cult sprayed a food bar in The Dalles Oregon, with *Salmonella* to create city-wide illness and thwart an election in 1984; *Shigella* reportedly used by groups in Myanmar in the 1990s to weaken the Karen ethnic group on the Thai–Myanmar border; butyric acid used in attacks on abortion clinics in the US; and, most recently, Po-210, a difficult-to-produce isotope, was used to kill a former Russian citizen in 2006. These are a few recent uses designed to induce terror among the victims and those associated with them. In many cases the use of CBRN agents sends the message that more agents that may be more dangerous may be next.

In the 1990s, terrorism and terrorist threats became more widespread with the attention gained by the Aum Shinrykio Cult, the poisonings in The Dalles, butryic acid attacks at abortion clinics, and other isolated incidents. These increased dramatically after the September and October 2001 attacks on the World Trade Center in NYC and the Pentagon in Washington DC, and the 'anthrax letters' in the USA. Speculation on the threat of CBRN terrorism became 'popular.' Consequently almost every medical, military, and 'soldier of fortune' magazine and journal has had at least one article on CBRN terrorism's threat and medical treatment. There are hundreds of websites and dozens of books in the popular literature that are devoted to or include a discussion of the CBRN terrorism threat. Many of these include mistakes and inaccuracies. The sources cited here are those that are reliable.

The tactics behind the use of CBRN agents for terrorism are different to those agents used as military CBRN weapons. The 'payload,' i.e., the amount of agent needed to cause a significant disruption in operations, is much smaller than in military use. It does not matter if the amount of agent is limited to a plastic bag, as in the Tokyo subway attack. The method of dispersal can be crude and inefficient, such as an umbrella to puncture the bag. The delivery can be even simpler, because bombs and missiles are not needed to deliver the agent to where people are. The goal of the terrorist is often just to be noticed and incite fear.

Chemical Terrorism

Military chemical warfare agents, nerve agents (sarin, soman, tabun, VX, etc.), blister agents (mustard), choking agents (phosgene), blood agents (cyanides), are only a few of the many chemicals that can be used for terrorism. Many of the chemicals used in manufacturing and chemical processes in the industrial world have been characterized for their toxicity, but most have not been.

Our industrial society manufactures, ships, stores, and uses many toxic industrial chemicals (TICs) and materials (TIMs), most of them safely. In our safety-conscious and post-Bhopal and post-9/11 world, these TICs (and TIMs) can present possible threats to our safety and security. The manufacture, shipping, and storing of TICs and TIMs are essential in the industrial world, however, they also represent a weakness that could be exploited by determined terrorist groups. There are many different scenarios which can be imagined, e.g., the direct use of TICs by attackers (state or terrorist groups), the collateral release of TICs by attacks with conventional explosives and weapons, large-scale TIC attacks, more local or personalized attacks, etc. Preparations for protecting the employees and nearby public from such threats include evaluating the potential threat and also the medical treatment. For those TICs and facilities that present the largest threat in terms of potential for release and impact to the surrounding communities, preparations for medical treatment can be expensive and should be prioritized. A medical stockpile containing equipment and materials, including drugs, for treating them can then be assembled. The medical stockpile will be different in different areas of countries, depending upon industrial facilities and budgets.

Most CBRN or terrorism scenarios have a safety counterpart, i.e., the scenario can be viewed as a safety assessment. For example, a plant safety assessment that evaluates explosive reactions and releases from worker error can be essentially the same assessment used to protect a plant from sabotage or even a terrorist attack. Other scenarios unrelated to a terrorist threat can look at the environmental release and pollution potential or pollution mitigation. Each industrial facility should have as part of its safety plan, provisions to treat those workers and even nearby citizens who may be exposed to the chemicals and materials used, made, and stored at the facility. This can be a very expensive undertaking, but should be considered part of business operations. The prioritization of drugs and equipment for medical treatment is part of a safety analysis for the industrial facility.

If the consideration is an attack by terrorists, with a large choice of scenarios, it is difficult to predict which ones are most likely. At first glance scenarios with the most toxic chemicals might seem to be the best choices and consequently the most likely terrorist weapon. However, a more balanced view may discover both physical and historical properties that can differentiate between choices. It is useful to evaluate TICs from the standpoint of possible use by terrorists, as well as from safety viewpoints.

Biological Terrorism

Biological agents are usually those that can cause a disease, primarily infectious diseases from bacteria, viruses, rickettsia, and protein changes, such as prions. Biological agents also include toxins produced by specific agents, such as bacterial toxins, which are easily made in the organism, such as anthrax, clostridium, and botulinum toxins.

One of the important topics in characterizing and detecting bioterrorism, terrorism using biological agents, as well as covert use of biological weapons and covert biological warfare (BW), is determining whether or not a disease has occurred from natural sources or is the result of an intentional release. Unlike many of the chemical terrorism scenarios, bioterrorism may occur against a background of disease. Are there 5% more cases of West Nile Fever than occurred last year or has the incidence of flu increased by 50% compared to the same time last year? Are there anthrax spores in the background soils and are they the same type of anthrax spores that are in the dust?

A robust public health infrastructure is one of the best ways to prevent or mitigate bioterrorism. Such a public health system will be one that already monitors diseases in its populations so that it is possible to distinguish between intentional and natural occurrences of disease. A good public health system will also be flexible enough to provide sufficient medications, doctors, nurses, and beds in the event of a bioterrorist attack or any number of natural disasters that may increase population susceptibility to disease.

A good source for learning about chemical and biological terrorism and public health is at CDC's website, http://www.bt.cdc.gov/.

Radiological Terrorism

Radioactive materials have many uses in industrial societies. They may be used in medical procedures, radioisotopes, in which case they emit low energies and are in low concentrations. Other radioactive materials, especially alpha emitters, may be used for very short-range ionization, as in the Americium-241 that is used in smoke detectors.

There is a very large distinction between nuclear terrorism or attacks and radiological terrorism. The former threatens the release of huge amounts of energy in a nuclear explosion with a nuclear bomb. A nuclear bomb also releases radioactive materials created during the fission of the bomb and from the starting materials.

Radiological terrorism involves the use of conventional weapons to disperse or spread radioactive materials. The radioactive materials may be in a nuclear power plant or recycling plant; this would be an attack with conventional weapons on a nuclear facility. Alternatively, the radioactive materials may be included in the bomb, the so-called 'dirty bomb' or radiological bomb or Radiological Dispersal Device (RDD).

Another option that is also called radiological terrorism is the placement of highly radioactive materials, radioactive emitting device (RED), in a high-traffic area without any protection for the exposed population, such as placing a cobalt-60 tube in a schoolyard.

A good source for learning about nuclear and radiological terrorism is at the website for the Nuclear Threat Initiative http://www.nti.org/.

RESOURCES

In the Resources section, those materials that include chapters or discussions on the use of CBRN agents by terrorists or in terrorist-like incidents are highlighted. There are many resources for descriptions of classic military CBRN agents and these are not all included in this list unless they also include a discussion of terrorism use.

Books

Many books, and even novels, have been written on the use of CBRN agents, especially military use. Only a few of the more authoritative books are listed here. There are few books devoted to CBRN terrorism, although some of the books on CBRN or NBC weapons have included a chapter on terrorism.

Sidell FR, Takafuji ET, Franz DR (Eds.) (1997)
Medical Aspects of Chemical and Biological Warfare
Borden Institute
Office of the Surgeon General, Department of the Army, USA
Washington, DC
Web: http://www.bordeninstitute.army.mil/published_volumes/chemBio/fm.pdf

This is the definitive military discussion of chemical and biological agents, weaponry, and effects from the perspective of the US military. This book has chapters on the history of CB use, descriptions of the 'classic military' CB agents, and medical treatment of military exposed to these agents. The new edition includes a discussion on the use of these CB agents in terrorism incidents.

Somani SM (Editor), Romano Jr JA
Chemical Warfare Agents: Toxicity at Low Levels
Chemical Warfare Agents: Toxicity at Low Levels, First Edition (December, 2000), Second Edition (November 2007)
464 pages First Edition
CRC Press, Boca Raton, FL.
ISBN-10: 0849308720
ISBN-13: 978-0849308727

This book, first published in 2000, was recently updated and includes a chapter on the effects of chemical exposures resulting from terrorism incidents and was scheduled to be published in November 2007. The book focuses on the more subtle changes, physiological and biochemical, which occur at less than lethal exposures to chemical agents. Most of the chapter authors have been involved in military medical defense research for many years and the chapters reflect this history and perspective.

SIPRI Scorpion Series
Stockholm International Peace Research Institute, SIPRI
Signalistgatan 9
SE-169 70 Solna
Sweden
Phone: +46-8-655 97 00
Fax: +46-8-655 97 33
Email: sipri@sipri.org

The Stockholm International Peace Research Institute, SIPRI, has published a series of books as part of the Chemical and Biological Warfare (CBW) Project. Volume 1 was published in 1985 and the last, Volume 19, was published in 2001. The SIPRI CBW Studies series (the Scorpion series, a reference to toxins) covers a wide variety of issues related to the work of the CBW Project. The listing is presented on http://www.sipri.org/contents/publications/CBWstudies.html.

SIPRI Books in Scorpion Series
No. 19. The Evolution of Biological Disarmament
Nicholas A. Sims (2001)
Oxford University Press
ISBN 0-19-829578-2, paperback, 210 pages

No. 18. Biological and Toxin Weapons: Research, Development and Use from the Middle Ages to 1945
Erhard Geissler, John Ellis van Courtland Moon (Eds.) (1999)
Oxford University Press
ISBN 0-19-829579-0, paperback, 296 pages

No. 17. Chemical Weapons Destruction in Russia: Political, Legal and Technical Aspects
John Hart, Cynthia Miller (Eds.) (1998)
Oxford University Press
ISBN 0-19-829569-3, paperback, 176 pages

No. 16. The Challenge of Old Chemical Munitions and Toxic Armament Wastes
Thomas Stock, Karlheinz Lohs (Eds.) (1996)
Oxford University Press
ISBN 0-19-829190-6, paperback, 356 pages

No. 15. Control of Dual-Threat Agents: The Vaccines for Peace Programme
Erhard Geissler, John P. Woodall (Eds.) (1994)
Oxford University Press
ISBN 0-19-829172-8, paperback, 282 pages

No. 14. Verification under the Chemical Weapons Convention: On-Site Inspection in Chemical Industry Facilities
Trapp R (1993)
Oxford University Press
ISBN 0-19-829160-4, paperback, 132 pages

No. 13. Verification of Dual-use Chemicals under the Chemical Weapons Convention: The Case of Thiodiglycol
Lundin SJ (Ed.) (1991)
Oxford University Press
ISBN 0-19-829156-6, paperback, 156 pages

No. 12. Views on Possible Verification Measures for the Biological Weapons Convention
Lundin SJ (Ed.) (1991)
Oxford University Press
ISBN 0-19-829142-6, paperback, 140 pages

No. 11. National Implementation of the Future Chemical Weapons Convention
Thomas Stock, Ronald Sutherland (Eds.) (1990)
Oxford University Press
ISBN 0-19-827837-3, paperback, 186 pages

No. 10. Strengthening the Biological Weapons Convention by Confidence-Building Measures
Erhard Geissler (Ed.) (1990)
Oxford University Press
ISBN 0-19-829139-6, paperback, 220 pages

No. 9. Non-Production by Industry of Chemical-Warfare Agents: Technical Verification Under a Chemical Weapons Convention
SJ Lundin (Ed.) (1988)
Oxford University Press
ISBN 0-19-829129-9, paperback, 265 pages

No. 8. International Organization for Chemical Disarmament
Nicholas A. Sims (1987)

Oxford University Press
ISBN 0-19-829121-3, paperback, 158 pages

No. 7. Chemical Weapon Free Zones?
Ralf Trapp (Ed.) (1987)
Oxford University Press
ISBN 0-19-829113-2, paperback, 211 pages

No. 6. Chemical and Biological Warfare Developments: 1985
Julian Perry Robinson (1986)
Oxford University Press
ISBN 0-19-829110-8, paperback, 110 pages

No. 5. The Chemical Industry and the Projected Chemical Weapons Convention: Proceedings of a SIPRI/Pugwash Conference, Volume II
Oxford University Press
ISBN 0-19-829109-4, paperback, 233 pages

No. 4. The Chemical Industry and the Projected Chemical Weapons Convention: Proceedings of a SIPRI/Pugwash Conference, Volume I (1986)
Oxford University Press
ISBN 0-19-829107-8, paperback, 147 pages

No. 3. The Detoxification and Natural Degradation of Chemical Warfare Agents
Ralf Trapp (1985)
Taylor & Francis
ISBN 0-85066-309-1, paperback, 104 pages

No. 2. Chemical Warfare Arms Control: A Framework for Considering Policy Alternatives
Julian Perry Robinson (1985)
Taylor & Francis
ISBN 0-85066-308-3, paperback, 116 pages

No. 1. Effects of Chemical Warfare: A Selective Review and Bibliography of British State Papers
Andy Thomas (1985)
Taylor & Francis
ISBN 0-85066-307-5, paperback, 116 pages

Journals

Journals that publish articles in CBRN or NBC terrorism abound. Especially in the last few years, articles have been published in journals devoted to topics from military medicine to pediatric health. A quick search of the PubMed database for chemical terrorism lists 99 articles, only nine were published before September 2001. A similar search for bioterrorism lists 3818 articles, only 176 articles were published before September 2001.

Journal of Medical Chemical, Biological, and Radiological Defense (2002–)
Web: www.JMedCBRN.org

The *Journal of Medical Chemical, Biological, and Radiological Defense* is devoted to peer-reviewed articles in medical defense and specifically chemical, biological, and radiological defense. Articles feature descriptions of medical treatment and medical countermeasures, clinical studies, medical defense policy and doctrine, both for the military and civilian terrorism issues. The archives section includes hard-to-find technical reports, articles, and proceedings and upcoming scientific conferences in CBRN defense and terrorism issues.

Journal Articles

Since 2001 the number of articles discussing terrorism in general and CBRN terrorism specifically has increased dramatically as noted above. Many of the articles are reviews or surveys of preparedness, nevertheless, the articles listed provide a reasonable introduction to the topic of CBRN terrorism. The articles listed in this section are good introductory articles in well-known professional journals by credible authors. It is not an exclusive listing but it can serve as the beginning of any research in the area. Preference was given to articles with open access.

Chemical Terrorism

Neurological aspects of biological and chemical terrorism: a review for neurologists
Martin CO, Adams HP Jr (2003)
Arch. Neurol. 60(1): 21–25. Review.
Web: http://archneur.ama-assn.org/cgi/content/full/60/1/21

This article reviews four agents that have a history of military or terrorist use: cyanide poisons, organophosphate poisons, botulinum toxin, and anthrax.

Tokyo – protecting the health care worker during a chemical mass casualty event: an important issue of continuing relevance
Okumura S, Okumura T, Ishimatsu S, Miura K, Maekawa H, Naito T (2005)
Critical Care 9: 397–400; doi:10.1186/cc3062
Web: http://ccforum.com/content/9/4/397/abstract

And the related commentary

The problem of secondary contamination following chemical agent release
David Baker (2005)

SAMU 75, Hopital Necker – Enfants Malades, Paris, France and Chemical Hazards and Poisons Division, Health Protection Agency, Guy's and St Thomas's Trust, London, UK

Critical Care 9: 323–324 doi:10.1186/cc3509 at http://ccforum.com/content/9/4/323

This article and its companion commentary provide a good discussion of the importance of decontamination and the treatment of populations exposed in a chemical attack.

Chemical terrorism attacks: update on antidotes
Emerg. Med. Clin. North Am. 2007; 25(2): 567–595
Lawrence DT, Kirk, MA

Blue Ridge Poison Center, Division of Medical Toxicology, Department of Emergency Medicine, University of Virginia, P.O. Box 800744, Charlottesville, VA 22908-0774, USA.

There is well-founded concern that a chemical or radioactive agent will at some point be used as a weapon of terror. There are several antidotes that, if used correctly in a timely fashion, can help lessen the harm caused by these agents. This article is meant to introduce the clinician to several such agents, along with the antidotes useful in the management of exposure to these. It covers the indications, administration, and precautions for using these antidotes.

Antidotes for nerve agent poisoning: should we differentiate children from adults?
Baker MD (2007)
Curr. Opin. Pediatr. 19(2): 211–215
Division of Pediatric Emergency Medicine, Department of Pediatrics, University of Alabama Birmingham, Birmingham, Alabama, USA
Email: mbaker@peds.uab.edu

Chemical terrorism presents a threat to the civilian population, including children. Nerve agent antidotes are available in prepackaged autoinjectors that can be delivered rapidly following an exposure. This review examines the evidence supporting the use of nerve agent antidotes in children. It is an example of how military antidotes and treatments will need to be adapted for a civilian population with children, elderly, and mature adults, and immune-compromised individuals.

Biological Terrorism (Bioterrorism)

The Microbial Rosetta Stone Database: A compilation of global and emerging infectious microorganisms and bioterrorist threat agents
Ecker DJ, Sampath R, Willett P, et al (2005)
BMC Microbiology 5: 19
Full text available at http://www.biomedcentral.com/1471-2180/5/19

The Microbial Rosetta Stone database relates microorganism names, taxonomic classifications, diseases, specific detection and treatment protocols, and relevant literature. The database structure facilitates linkage to public genomic databases. This paper focuses on the information in the database for pathogens that impact global public health, emerging infectious organisms, and bioterrorist threat agents.

The Microbial Rosetta Stone is available at http://www.microbialrosettastone.com/. The database provides public access to up-to-date taxonomic classifications of organisms that cause human diseases, improves the consistency of nomenclature in disease reporting, and provides useful links between different public genomic and public health databases.

Occurrence and overlap of natural disasters, complex emergencies and epidemics during the past decade (1995–2004)
Paul B Spiegel, Phuoc Le, Mija-Tesse Ververs, Peter Salama (2007)
Conflict and Health 1: 2; doi:10.1186/1752-1505-1-2
Published 1 March 2007
Web: http://www.conflictandhealth.com/content/1/1/2/abstract

The fields of expertise of natural disasters and complex emergencies (CEs) are quite distinct, with different tools for mitigation and response as well as different types of competent organizations and qualified professionals who respond. However, natural disasters and CEs can occur concurrently in the same geographic location, and epidemics can occur during or following either event. Epidemics commonly occur during CEs. The data presented in this article do not support the often-repeated assertion that epidemics, especially large-scale epidemics, commonly occur following large-scale natural disasters. This observation has important policy and programmatic implications when preparing and responding to epidemics. There is an important and previously unrecognized overlap between natural disasters and CEs. Training and tools are needed to help bridge the gap between the different type of organizations and professionals who respond to natural disasters and CEs to ensure an integrated and coordinated response.

Agroterrorism: where are we in the ongoing war on terrorism?
Crutchley TM, Rodgers JB, Whiteside HP Jr, Vanier M, Terndrup TE (2007)
J. Food Prot. 70(3): 791–804
University of Alabama at Birmingham, Department of Nutrition Sciences, 1675 University Boulevard, Birmingham, Alabama 35294, USA.
Email: tcrutchley@uabmc.edu

Many of the characteristics of agricultural infrastructure that contribute to its high productivity and efficiency

also make it extremely vulnerable to a terrorist attack by a biological weapon. As a result of continuing criticism, many initiatives at all levels of the US government and within the private sector are directed to improve detection and response to an agroterrorist attack. This article discusses how outbreaks, such as the 1999 West Nile outbreak, the 2001 anthrax attacks, the 2003 monkeypox outbreak, and the 2004 *Escherichia coli* O157:H7 outbreak, have demonstrated the need for improvements in the areas of communication, emergency response and surveillance efforts, and education for all levels of government, the agricultural community, and the private sector.

Public Health Assessment of Potential Biological Terrorism Agents
Lisa D Rotz, Ali S Khan, Scott R Lillibridge, Stephen M Ostroff, James M Hughes (2002)
Centers for Disease Control and Prevention, Atlanta, Georgia
Emerg. Infect. Dis. 8.
Web: http://www.cdc.gov/ncidod/eid/vol8no2/01-0164.htm

This is one of the few classic papers in the field. Many biological agents can cause illness in humans, but not all are capable of affecting public health and medical infrastructures on a large scale. The Working Group on Civilian Biodefense, using an expert panel consensus-based process, identified several biological agents as potential high-impact agents against civilian populations using a method for assessing potential biological threat agents that would provide a reviewable, reproducible means for standardized evaluations of these threats. This report outlines the overall selection and prioritization process used to determine the biological agents for public health preparedness activities. The selection and prioritization was conducted in 1999, but remains the best documented prioritization of agents.

Radiological Terrorism

Vulnerability of populations and the urban health care systems to nuclear weapon attack – examples from four American cities
William C Bell, Cham E Dallas (2007)
Center for Mass Destruction Defense, College of Pharmacy, University of Georgia, Athens, GA 30602, USA
Intern. J. Health Geog. 6: 5; doi:10.1186/1476-072X-6-5
Web: http://www.ij-healthgeographics.com/content/6/1/5

This paper has quickly become one of the most cited papers in the field. The implications are beyond the radiological and nuclear examples given and apply equally well to chemical and biological attacks. The effects of 20 kiloton and 550 kiloton nuclear detonations on high-priority target cities are presented for New York City, Chicago, Washington DC, and Atlanta. Thermal, blast, and radiation effects are described, and affected populations are calculated using 2000 block level census data. Weapons of 100 Kts and up are primarily incendiary or radiation weapons, able to cause burns and start fires at distances greater than they can significantly damage buildings, and to poison populations through radiation injuries well downwind in the case of surface detonations. With weapons below 100 Kts, blast effects tend to be stronger than primary thermal effects from surface bursts. From the point of view of medical casualty treatment and administrative response, there is an ominous pattern where these fatalities and casualties geographically fall in relation to the location of hospital and administrative facilities. It is demonstrated that a staggering number of the main hospitals, trauma centers, and other medical assets are likely to be in the fatality plume, rendering them essentially inoperable in a crisis.

Radiological weapons: what type of threat?
Mapstone J, Brett S (2005)
Critical Care 9: 223–225
Web: http://ccforum.com/content/9/3/223

The risks of radiological weapons are discussed. Unless a hospital has a nuclear reactor nearby, it is unlikely that radiological incidents will feature high on the major incident plan. Recently, health protection agencies have again started to provide guidance on these issues, following a perceived heightened threat from terrorism. This article attempts to demystify the risks and describe the extra actions that should be considered at a hospital in order to effectively deal with the aftermath of such an attack.

Organizations

Applied Science and Analysis, ASA, Inc.
PO Box 6409
Kaneohe, HI 96744
Phone: 808-235-8010
Fax: 808-432-9670
Email: info@asanltr.com
Web: www.asanltr.com

ASA was started in 1983 to foster international exchange of information on chemical, biological, and radiological defense issues. ASA developed and publishes the ASA Newsletter devoted to issues in CBRN

defense and especially the exchange of information. ASA developed the Chemical Biological and Radiological Medical Treatment Symposium, CBMTS, series to discuss research, policy, innovations in the medical treatment of CBRN casualties, prevention of CBRN casualties, and crisis and consequence management of the after effects of CBRN releases.

Harvard-Sussex Program (HSP)
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Email: hspoffice@sussex.ac.uk
Web: http://www.sussex.ac.uk/

This program was started by a collaboration of Matthew Meselson at Harvard and Julian Perry Robinson at Sussex to instill the traditions, practice, and benefits of scholarship into the formation of public policy on issues involving biological and chemical weapons. University-based research and publication, other forms of international communication, constructive association with people in policy-shaping and policy-making circles, and training of young people are the means HSP uses. In addition, HSP maintains national and international frameworks for discourse, study and consensus-building that bring together scientists and other scholars with officials of governmental and intergovernmental bodies.

Motivating HSP is the urgency of concerns raised by biological and chemical weapons as potential instruments of terror, coercion and mass killing, whether in the hands of warring nations or of non-state entities. HSP therefore favors efforts to eliminate these weapons globally and to prevent the hostile exploitation of biotechnology. It supports efforts to maintain and enhance the moral, political, and legal constraints and prohibitions against the hostile use of disease. If the existing norms against CBW were to fail, biological and chemical weapons of the kinds developed during the years of the East–West Cold War could furnish relatively simple means for the attack of people, animals, and crops over large areas. Even more menacing, in the longer term, would be a world in which the dual-use nature of new biotechnology, now advancing very rapidly, were exploited for those purposes.

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US Department of Health and Human Services (HHS)
The US Department of Health and Human Services
200 Independence Avenue, S.W.
Washington, D.C. 20201
Phone: 202-619-0257 or 1-877-696-6775
Web: www.dhs.gov

HHS is the 'government's principal agency for protecting the health of all Americans and providing essential human services.' HHS is responsible for national health, has a website that lists major resources, including CBRN weapons and their characteristics and countermeasures, environmental disaster, and bioterrorism. Through the website there are links to other authoritative sources (http://www.hhs.gov/disasters/).

The family of agencies within the US DHHS that deal with health issues, including protection from CBRN terrorism, includes.
ATSDR—Agency for Toxic Substances & Disease Registry
CDC—Centers for Disease Control & Prevention
NIH—National Institutes of Health

Agency for Toxic Substances & Disease Registry
ATSDR
CDC-INFO
Public inquiries: 800-CDC-INFO or 800-232-4636
TTY 888-232-6348 24 Hours/Day
E-mail: cdcinfo@cdc.gov
CDC Emergency Response: 770-488-7100
www.atsdr.cdc.gov

The ATSDR serves the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances.

The US Centers for Disease Control and Prevention (CDC)
1600 Clifton Rd.
Atlanta, GA 30333, USA
Phone: 404 639-3311
Public inquiries: (404) 639-3534/(800) 311-3435
Web: www.cdc.gov

CDC's mission is 'to promote health and quality of life by preventing and controlling disease, injury, and disability.' CDC has an extensive website 'intended to increase the nation's ability to prepare for and respond to public health emergencies.' The most comprehensive website for CBRN terrorism is at http://www.bt.cdc.gov/. This site is a portal to information about individual

CBRN agents, agent effects and disease, training, monitoring, detecting, mitigating, decontaminating after an attack by CBRN agents.

US Department of Homeland Security (DHS)
Washington, D.C. 20528
Phone: 202-282-8000
Web: www.dhs.gov

DHS has as its mission securing the homeland. DHS is the organization in the US with prime responsibility for handling the results of CBRN terrorism on civilians. This includes managing national health emergencies in the event of pandemics, even if the origin is natural. In the event of a national emergency, there will be some overlap and integration of the HHS and DHS responsibilities. The DHS website is http://www.dhs.gov/index.shtm. Information from DHS can be found on at least two sources, www.whitehouse.gov, and directly for the citizen at www.ready.gov.

The best description of DHS is at http://www.whitehouse.gov/deptofhomeland/toc.html/. Two especially useful pages from www.whitehouse.gov are those for Emergency Preparedness and Response, http://www.whitehouse.gov/deptofhomeland/sect4.html, and Chemical, Biological, Radiological, and Nuclear Countermeasures, http://www.whitehouse.gov/deptofhomeland/sect5.html/.

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Web: http://www.who.int/

WHO has a website with guidance for public health response to deliberate chemical and biological agent releases, http://www.who.int/csr/delibepidemics/en/. This document and others on the WHO website, provide a broad overview of what may need to be taken into account in building public-health preparedness against deliberate releases of biological or chemical agents. It was prepared as a response to Member States requests for assistance. The new guidance, 2006, is an update to that provided in 2004 and first prepared in 1970 as *Health Aspects of Biological and Chemical Weapons*.

The section on information resources is particularly useful and is grouped into three categories: major texts and general sources: authoritative books or monographs covering several aspects of preparedness, task-specific information resources, such as threat and hazard identification, hazard evaluation and planning for hazard management, and hazard reduction and control, and, references to major websites hosting authoritative information that may be updated frequently (http://www.who.int/csr/delibepidemics/annex6.pdf).

Nuclear Threat Initiative (NTI)
Senator Sam Nunn and Ted Turner founded the Nuclear Threat Initiative (NTI) in January 2001. NTI's mission is to strengthen global security by reducing the risk of use and preventing the spread of chemical, biological, radiological, and nuclear weapons. NTI seeks to raise public awareness, serve as a catalyst for new thinking and take direct action to reduce these threats. They operate a website with information on CBR agents and weapons (http://www.nti.org).

The Biological and Chemical Weapons Nonproliferation and Response Program (BCWNRP)
The Henry L. Stimson Center
1111 19th Street
Twelfth Floor
Washington, DC 20036
Phone: 202.223.5956
Fax: 202.238.9604
Email: info@stimson.org
http://www.stimson.org/cbw/programhome.cfm

The BCWNRP examines the distinct issues associated with biological and chemical weapons, as well as the technologies and regulatory frameworks designed to minimize the risk that these agents pose to human security.

Chemical and biological weapons share a characteristic distinct from nuclear weapons: fairly easily acquired raw materials (for most pathogens or chemicals) that either have legitimate uses or occur naturally. The CBW project focuses on the history of biological and chemical weapons, measures to control their proliferation (including domestic laws and international regimes), and weapons destruction technologies. Technical reports examine the likelihood of terrorism involving chemical and biological weapons, as well as technologies and policies to prevent or counter their use.

Publications

Stewardship or Censorship? Balancing Biosecurity, The Public's Health, and The Benefits of Scientific Openness
Julie Fischer
April 2006

Speaking Data to Power: Science, Technology, and Health Expertise in the National Biological Security Policy Process
Report 52

Julie Fischer
October 2004

Inching Away from Armageddon: Destroying the U.S. Chemical Weapons Stockpile
Claudine McCarthy and Julie Fischer
May 2004

Compliance Through Science: US Pharmaceutical Industry Experts on a Strengthened Bioweapons Nonproliferation Regime
Report 48
A Collaborative Research Report of Experts from the US Pharmaceutical and Biotechnology Industries
September 2002

House of Cards: The Pivotal Importance of a Technically Sound BWC Monitoring Protocol
Report 37
Working Group: House of Cards
May 2001

Ataxia: The Chemical and Biological Terrorism Threat and the US Response
Report 35
Amy E Smithson and Leslie-Anne Levy
October 2000

Toxic Archipelago: Preventing Proliferation from the former Soviet Chemical and Biological Weapons Complexes
Report 32
Amy E Smithson
December 1999

Rudderless: The Chemical Weapons Convention At 1 1/2
Report 25
Amy E Smithson
September 1998

Biological Weapons Proliferation: Reasons for Concern, Courses of Action
Report 24
Marie Chevrier, Graham Pearson, Amy E Smithson, Jonathon Tucker, and Gillian Woollett
January 1998

The Battle to Obtain Ratification of the Chemical Weapons Convention
Occasional Paper 35
Michael Krepon, John Parachini, and Amy E Smithson
July 1997

Separating Fact from Fiction: The Australia Group and the Chemical Weapons Convention
Occasional Paper 34
Amy E Smithson
March 1997

The U.S. Senate and CWC Ratification: The Price of Inaction
Report 18
Sheila Buckley, John Glenn, H Martin Lancaster, Michael Moodie, and Amy E Smithson
October 1995

Chemical Weapons Disarmament in Russia: Problems and Prospects
Report 17
Major General Roland Lajoie, Vil Mirzayanov, and Amy E Smithson
October 1995

The U.S. Chemical Weapons Destruction Program: Views, Analysis, and Recommendations
Report 13
Michael Krepon, Amy E Smithson, and James Schear
September 1994

Implementing the Chemical Weapons Convention: Counsel from Industry
Report 10
Amy E Smithson
January 1994

The Chemical Weapons Convention Handbook
Elisa Harris, Don Mahley, and Amy E Smithson
September 1993

Administering the Chemical Weapons Convention: Lessons from the IAEA
Occasional Paper 14
Amy E Smithson
March 1993

Strengthening the Chemical Weapons Convention Through Aerial Inspections
Occasional Paper 4
Amy E Smithson and Michael Krepon
April 1991

Databases

There are several databases on the explicit use of CBRN agents as terrorist weapons, but most list the characteristics of the CBRN agents, toxicology, physical properties, effects, symptoms, etc.

HSP CBW Events Data-Base
Harvard-Sussex Program

HSP has a searchable database recording some 15 000 events during the past two decades that have been associated with CBW. It is a systematic record of events back to 1987 in and around the world of CBW, searchable via the text-retrieval application in which it

is held. The 'News Chronology' feature in The CBW Conventions Bulletin is drawn from it.

HSP also has collected a bibliographical database recording some 4500 publications on or around the subject of CBW. This is the HSP CBW Publications Data-Base, a continually updated register of substantial new publications in the field back to 1987 that is excerpted for the 'Recent Publications' feature of the Bulletin. It is held in EndNote, so as to facilitate searching and manipulation.

Educational Module on Chemical and Biological Weapons (CBW) Non-proliferation
Stockholm International Peace Research Institute (SIPRI)
Web: http://www.sipri.org/contents/webmaster/databases

The CBW module is designed to educate the interested layperson (at basic and intermediate levels, an advanced version is planned) in non-proliferation in general and CBW non-proliferation in particular. Case studies are on Iraq and Libya and understanding why and how each decided to develop and acquire CBW.

Monterey Proliferation Databases
Center for Nonproliferation Studies (CNS)
460 Pierce Street, Monterey, CA 93940, USA
CNS maintains the following proliferation databases on http://cns.miis.edu/dbinfo/about.htm/

ChemBio Weapons and WMD Terrorism Database
China WMD and Arms Control Database
HEU Reduction and Elimination Database
Inventory of International Nonproliferation Organizations and Regimes
NIS Trafficking Database
Nuclear and Missile Developments Database
Submarine Proliferation Database
WMD Country Profiles Database

Thanks to a grant from the Nuclear Threat Initiative (NTI), CNS has made its databases available to the public as part of the NTI Research Library on www.nti.org/

The CNS proliferation databases contain information compiled from hundreds of source publications, including United Nations and International Atomic Energy Agency documents, trade journals, government and defense publications, periodicals and electronic news sources, academic journals, US congressional testimony, conference proceedings, book chapters, correspondence from international advisors, unpublished papers, and Internet sources. These databases contain continually updated information about the global proliferation of weapons of mass destruction (nuclear, chemical, and biological) and their delivery systems.

Of particular interest is the ***ChemBio Weapons and WMD Terrorism News Archive***. The ChemBio Weapons and WMD Terrorism News Archive is compiled from the tri-weekly news service offered by the Washington office of the Center for Non-proliferation Studies at the Monterey Institute of International Studies. This news list serve archive consists of links to and key excerpts from articles, testimony, newspaper and magazine articles, government reports, speeches, and specialized news reporting services. Topics covered include CBW state programs, non-proliferation treaties and verification measures, destruction of CBW, incidents involving chemical, biological, radiological, and nuclear weapons (CBRN) including, threats, hoaxes, international contaminations, poisonings or agent release, threat assessment, national and international policies, and legislation.

Please contact the Monterey Terrorism Research and Education Program (MonTREP) for information about the WMD Terrorism Database and the Incident Response Database.

Other Resources

There are many websites wherein chemical and biological terrorism and the agents are described and characterized. Many of the sites are collections from the general public and interested historians, without any outside review. The websites noted here are only a sampling and, in general, are more reliable sources.

Applied Science and Analysis (ASA)
ASA Newsletter, ISSN 1057-9419
ASA,
Kaneohe, HI 96744
Email: info@asanltr.com
Web: www.asanltr.com

Available by subscription, with selected articles are on http://www.asanltr.com/. This newsletter is published by ASA every 2 months and is a primary source of information on CBRN internationally since 1987. The ASA Newsletter covers technical articles, contracts, equipment, history, and policy. The use of industrial chemicals as 'chemical weapons,' sometimes called eco-terrorism, has been addressed in this newsletter since 1992.

Stockholm International Peace Research Institute (SIPRI)
Signalistgatan 9

SE-169 70 Solna
Sweden
Phone: +46-8-655 97 00
Fax: +46-8-655 97 33
Email: sipri@sipri.org

SIPRI has published a six-volume set of CBW primers on one CD. This is available from SIPRI at http://www.sipri.org/contents/publications/cdrom.html/.

Volume I. The Rise of CB Weapons (1971)

A description of the main lines of development in the technology underlying CBW and in the constraints affecting use of chemical and biological weapons. The period covered is approximately 1914–45, although more recent developments in CW technology are also described. In addition, the volume includes an account of all instances known to SIPRI when CB weapons have been used in war, or when their use has been alleged; in this case the timespan is 1914–70.

Volume II. CB Weapons Today (1973)

A description of the present state of CBW technology and of national CBW programs and policies. It also includes a discussion of the attractions and liabilities of CB weapons, and of the consequences, intentional or unintentional, which might follow their use.

Volume III. CBW and the Law of War (1973)

A description of the legal limitations on the use of chemical and biological weapons. It comprises discussions of the field of application of the Geneva Protocol, particularly as regards non-lethal chemical weapons and anti-plant agents, of the existence, development, and scope of the prohibition of CBW provided by the customary law of war, and of the application to CBW of general principles of the law of war. It also reviews the juristic works in this field.

Volume IV. CB Disarmament Negotiations, 1920–1970 (1971)

A review of the activities of the League of Nations and the United Nations in extending and reinforcing the prohibitions concerning chemical and biological weapons, including a report of recent negotiations for international CB disarmament. The volume also contains an account of those instances when formal complaints of the use of CB weapons have been made to the two world organizations.

Volume V. Technical Aspects of Early Warning and Verification (1971)

A discussion of measures that might be adopted to prevent future CBW. The volume describes steps that might be taken to strengthen the legal prohibition of CBW, and the problems and possibilities, including those of verification, involved in the negotiation of CB disarmament.

Volume VI. The Prevention of CBW (1975)

A technical account of SIPRI research on methods of early warning and identification of biological warfare agents, together with a description of two experimental SIPRI projects on CB verification. The first project concerns the non-production of BW agents and involved visits to biological laboratories in several countries; the second concerns the non-production of organophosphorus CW agents and summarizes the results of a symposium.

CBW Bulletin of the Harvard-Sussex Program
Harvard Sussex Program
SPRU – Science and Technology Policy Research
Freeman Centre
University of Sussex
Brighton, East Sussex
BN1 9QE, UK
Phone: +44 (0)1273 678 172
Fax: +44 (0)1273 685 865
Email: hspoffice@sussex.ac.uk
Web: http://www.sussex.ac.uk

The CBW Conventions Bulletin, formerly The Chemical Weapons Convention Bulletin, is the quarterly journal of the Harvard Sussex Program, providing news, background, and comment on chemical and biological warfare issues. It is edited jointly by Matthew Meselson and Julian Perry Robinson, with the HSP Advisory Board serving as its Editorial Committee. The Bulletin offers its readers a News Chronology, which is a systematic account of events in and around the CBW world during the previous 3 months; a listing of notable Recent Publications in the field; a calendar of key scheduled forthcoming events in the CBW world; detailed reviews of the latest developments within the Organization for the Prohibition of Chemical Weapons (OPCW) in The Hague; and reports on the activities concerning the Biological Weapons Convention in Geneva. The journal also offers its readers editorial comment on matters of the moment as well as authoritative invited comment and comments, and there is an occasional Historical Note addressing an event of the past that has particular salience for the present. A selective book-reviews feature was inaugurated in the December 2005 issue.

CHAPTER

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Testing Methods and Toxicity Assessment (Including Alternatives)

YURI BRUINEN DE BRUIN, CHANTRA ESKES, INGRID LANGEZAAL, SANDRA COECKE, AGNIESZKA KINSNER-OVASKAINEN, AND PERTTI J. HAKKINEN

INTRODUCTION

Many sources exist that contain valuable information on toxicology testing methods comprising in vivo (use of whole animals) and in vitro (use of artificial environment outside of living organisms) testing methods. The information resources presented below relate to chemical substances and are collected to provide key guidance on available information on in vivo, in vitro, and other toxicological testing and assessment methods (e.g., in silico toxicological methods performed on computer or via computer simulation), on relevant databases, published literature, books and journals, teaching aids, and finally organizations, foundations, and testing laboratories involved in toxicity assessment. The current information is of relevance for research, applied sciences and policy implementation purposes, such as the implementation of the European Union's (EU's) chemicals policy REACH (Registration, Evaluation, Authorisation, and Restriction of CHemicals) or the GPSD (General Product Safety Directive). The provided information resources are recommended starting points when searching for information on testing methods, alternative testing methods and computational assessment methods. The latter methods are better described elsewhere in this book (Charles A. Pittinger, Use of Software Models to Predict Health and Environmental Hazards and Risks). The reader should take note, however, that the information provided is not a comprehensive listing given the ever-expanding number of Internet and Web resources that are becoming available.

Search Strategy on Information Resources and Selection Criteria

The search strategy and selection criteria used in the current work faced three challenges concerning (1) selection of a number of information resources facilitating a more focused search, (2) screening of the information resources based on predefined terms, and (3) setting up a mechanism to categorize the relevance of the information towards testing methods and toxicity assessment.

Selection of Information Resources

The first search criterion consisted of a selection of initial information resources most known to the authors to contain relevant information comprising cross reference database search options such as Alternatives to Animal Testing (ALTWEB), (U.S.) National Library of Medicine's Specialized Information Services databases and information resources (PUBMED, TOXNET, TOXLINE, IRIS, etc.), ScienceDirect, Scirus, European Commission and European Agencies websites, U.S. Environmental Protection Agency (EPA) websites, World Health Organization (WHO), Organisation for Economic

Co-operation and Development (OECD), Interagency Coordination Committee on the Validation of Alternative Methods (ICCVAM) and Japanese Center for the Validation of Alternative Methods (JaCVAM), but also the search portals 'British Library,' 'Library of Congress,' 'Google,' 'Google Book Search,' and 'Google Scholar Beta' together with 'Amazon.com' were used.

Screening of Information Resources

The second search criterion was to screen the above information resources by the use of one or a combination of the search terms 'Alternative testing,' 'Chemical substances,' 'Chemicals,' 'In-vitro,' 'In-vivo,' 'Journal,' 'Newsletter,' 'Review,' 'Testing methods,' 'Toxicity assessment,' 'Toxicity testing,' 'Toxicology,' 'Funds,' and/or 'Foundations.'

Selection Criteria

The selection criteria included a categorization of each information resource on its relevance to testing methods and toxicity assessment. The journals, newspapers, books, databases, funds, and organizations were selected on the basis of 'appearance and format' (e.g., article vs. review, multi source and information databases vs. literature database, traditional toxicity testing databases vs. alternative testing databases, etc.), 'date of reference,' 'accessibility,' 'quality of information,' and eventually on basis of 'frequency ranking.' The respective information resources presented in this chapter were among the most recent resources frequently used to publish relevant information on testing methods and toxicity assessment. The authors also used references cited in the selected information and selected articles or any known relevant information not retrieved with the above-mentioned strategies.

TOXICITY TESTING METHODS

Testing methods for toxicity assessment have a variety of uses ranging from research and development to more applied regulatory testing for the purpose, such as registering a new chemical substance. If traditionally they involved the use of experimental animals, there is a tendency today to make more and more use of alternatives that refine, reduce, or replace the animal testing. The following provides sources of information on testing methods for toxicity assessment based on the potential uses and needs, as well as on whether they involve traditional animal testing or alternative methods to animal testing.

Testing methods for regulatory purposes

Regulatory testing methods and guidelines for toxicity testing of chemical substances

This section focuses on the regulatory testing methods recommended for the toxicity assessment of chemical substances at international level by the OECD, at the European level by the regulations on chemical substances, and at the US level by the Environmental Protection Agency for the testing of toxic substances. Regulation for other specific types of products such as biocides and pesticides was not considered here.

OECD Guidelines for the Testing of Chemicals – Section 4: Human Health Effects

The OECD Guidelines for the Testing of Chemicals are a collection of the most relevant internationally agreed testing methods used to characterize potential hazards of new and existing chemical substance and chemical preparations/mixtures. They represent a basic set of tools that are primarily for use in regulatory safety testing and subsequent chemical product notification and chemical registration. They can also be used for a variety of other purposes including the selection/ranking of candidate chemical substances during the development of new chemical substances and products and in toxicology research. OECD Test Guidelines (TG) should not be confused with data requirements, which are the prerogative of national authorities. It is also not possible to devise 'standard' testing methods appropriate for all chemical substances/chemical products. Therefore, judgment must be exercised in each case to assess the suitability of a particular method.

Web: http://www.oecd.org/document/55/0,2340,en_2649_34377_2349687_1_1_1_1,00.html and http://www.oecd.org/document/12/0,2340,en_2649_34377_1898188_1_1_1_1,00.html.

OECD series on Principles of Good Laboratory Practice and Compliance Monitoring

The primary objective of the OECD Principles of GLP is to ensure the generation of high-quality and reliable test data related to the safety of industrial chemical substances and preparations in the framework of harmonizing testing procedures for the mutual acceptance of data.

Web: http://www.oecd.org/document/63/0,2340,en_2649_34381_2346175_1_1_1_1,00.html and http://miranda.sourceoecd.org/vl=1121627/cl=73/nw=1/rpsv/cw/vhosts/oecdjournals/1607310x/v1n6/contp1-1.htm.

Annex V to the EU Dangerous Substance Directive 67/548/EEC – Part B Methods for Determination of Toxicity

Annex V to the EU Dangerous Substances Directive contains testing methods for the determination of the toxicological properties recommended in the European Union for the notification of new chemical substances. These methods are based on recognized and recommended methods by competent international bodies, in particular the OECD, or are adopted from national standards or scientific consensus methods. Animal tests and studies shall be conducted in accordance with national regulations and shall take into account humane principles and international developments in the field of animal welfare. Testing methods in Annex V are regularly updated and new methods are introduced as required. This annex might be modified in view of the EU REACH regulation on chemicals entered into force on the 1st of June 2007 (see next paragraph).

Web: http://ecb.jrc.it/testing-methods/.

Registration, Evaluation, Authorisation, and Restriction of CHemicals (REACH) EU Regulation 1907/2006

The REACH regulation adopted in December 2006 establishes a new EU regulatory framework for the testing of chemicals. It requires toxicity testing to be conducted in accordance to test methods laid down in a Commission Regulation which is to be adopted by the Commission, or in the meanwhile in accordance with other international test methods recognized by the Commission as being appropriate, such as Annex V to the EU Dangerous Substance Directive.

Web: http://ecb.jrc.it/reach/, http://reach.jrc.it/, and http://echa.europa.eu/.

US Environmental Protection Agency (US EPA) – Office of Prevention, Pesticides and Toxic Substances Harmonized Test Guidelines – Series 870 Health Effects Test Guidelines

The harmonized test guidelines have been developed for testing of pesticides and toxic chemical substances, and the development of test data that must be submitted to the Agency for review under Federal regulations. The purpose is to minimize variations among the testing procedures that must be performed to meet US EPA's data requirements under the Toxic Substances Control Act (TSCA) and the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA).

Web: http://www.epa.gov/opptsfrs/publications/OPPTS_Harmonized/870_Health_Effects_Test_Guidelines/Series.

Validated Alternative Methods to Animal Testing

Validation is the process that establishes the scientific relevance and reliability of a testing method for a specific purpose. Formal endorsement of the scientific validity of an alternative testing method is a current requirement for inclusion of a new method into regulatory testing guidelines.

Validation Principles

OECD Guidance Document on the Validation and International Acceptance of New or Updated Testing Methods for Hazard Assessment

OECD Series on Testing and Assessment N. 34, ENV/JM/MONO (2005) 14, 96 pp. Paris, France: OECD.

The document outlines general principles, important considerations, illustrative examples, potential challenges, and the results of experience gained in the area of testing method validation.

Web: http://appli1.oecd.org/olis/2005doc.nsf/linkto/env-jm-mono(2005)14.

A Modular Approach to the ECVAM Principles on Test Validity

Hartung T, Bremer S, Casati S, et al (2004) ATLA 32: 467–472.

This article presents a new approach to structure the information required for evaluating the validation status of an alternative method.

Web: http://ecvam.jrc.it/index.htm.

The principles of weight of evidence validation of testing methods and testing strategies

Balls M, Amcoff P, Bremer S, et al ATLA 34: 1–19.

This workshop report presents the principles and elements for consideration for undertaking a retrospective validation of an alternative method.

Web: http://ecvam.jrc.it/index.htm.

Practical Aspects of the Validation of Toxicity Test Procedures. ECVAM Workshop Report 5

Balls M, Blaauboer BJ, Fentem JH, (1995) ATLA 23: 129–147.

This workshop report presents the principles for the validation of an alternative method to animal testing.

Web: http://ecvam.jrc.it/index.htm.

The Role of Prevalidation in the Development, Validation and Acceptance of Alternative Methods. ECVAM Prevalidation Task Force Report 1

Curren, Southee, Spielmann, Liebsch, Fentem, Balls (1995) ATLA 23: 211–217.

This workshop report presents a description of the prevalidation phase before an assay enters a formal validation study.

Web: http://ecvam.jrc.it/index.htm.

ICCVAM Guidelines for the Nomination and Submission of New, Revised, and Alternative Testing Methods

ICCVAM (2003)

NIH Publication No. 03-4508, 50 pp. Research Triangle Park, NC, USA: National Institute of Environmental Health Sciences (NIEHS)

This document provides practical guidance on information and data requirements, in support of a validation assessment. The guidance assures availability of sufficient information for evaluation of the validation status of testing methods.

Web: http://www.iccvam.niehs.nih.gov/methods/methods.htm.

Guidance on Good Cell Culture Practice – A report of the second ECVAM task force on Good Cell Culture Practice

Coecke S, Balls M, Bowe G, et al (2005) ATLA 33: 261–287

The maintenance of high standards is fundamental to all good scientific practice, and is essential for maximizing the reproducibility, reliability, credibility, acceptance, and proper application of any results produced. The Guidance on Good Cell Culture Practice (GCCP) promotes the maintenance of these standards and the reduction of uncertainty in the development and application of animal and human cell and tissue culture procedures and products by encouraging greater international harmonization, rationalization, and standardization of laboratory practices, quality control systems, safety procedures, recording and reporting, and compliance with laws, regulations, and ethical principles.

Web (for the task force reports): http://ecvam.jrc.it/index.htm.

Validated Alternative Methods to Animal Testing

Information on validated alternative methods can be found in the following internet sites of international bodies performing formal validation of alternatives to animal testing.

The European Centre for the Validation of Alternative Methods (ECVAM)

ECVAM is the European Centre responsible for the formal validation of alternative methods for toxicity testing. Formal validation is obtained through an official statement made by the ECVAM Scientific Advisory Committee (ESAC). Once validated, the alternative methods are proposed for inclusion in official guidelines. Formally validated alternatives included in the EU and OECD guidelines exist for the following endpoints: skin corrosion, phototoxicity, percutaneous absorption, skin sensitization, acute toxicity, and batch potency testing of erysipelas and tetanus vaccines. In addition, recently validated alternatives not yet included in the guidelines exist for the following endpoints: genotoxicity, pyrogenicity, acute aquatic toxicity, embryotoxicity, and prediction of acute neutropenia.

Web: http://ecvam.jrc.it/index.htm.

The US Interagency Coordinating Committee on the Validation of Alternative Methods (ICCVAM) and The National Toxicology Program Interagency Center for the Evaluation of Alternative Toxicological Methods (NICEATM)

ICCVAM's mission is to facilitate development, validation, and regulatory acceptance of new and revised regulatory alternative methods to animal testing. NICEATM administers the ICCVAM and provides scientific and operational support for ICCVAM-related activities. Alternative methods on the following endpoints were submitted to ICCVAM for review: dermal corrosivity and irritation, phototoxicity, acute toxicity, immunotoxicity, pyrogenicity, developmental toxicity, biologics and vaccines, ocular toxicity, and endocrine disruptors. Method-related guidelines exist for the following endpoints: acute toxicity, dermal sensitization and corrosivity, phototoxicity, developmental toxicity, and endocrine disruptors.

Web: http://iccvam.niehs.nih.gov/.

The Japanese Center for the Validation of Alternative Methods (JaCVAM)

JaCVAM supports validation, evaluation, and international communication of alternative methods to animal testing. It has current activities on alternative methods for the following endpoints: phototoxicity, skin sensitization, corrosivity, skin irritation, endocrine disruptors, and mutagenicity.

Web: http://wwwsoc.nii.ac.jp/jsaae/KOJIMA.pdf.

Other Recommended Methods

Besides the regulatory testing required by official regulations, the scientific committees and trade associations reported below have reported toxicological

testing methods that might be useful for specific industrial needs.

The Scientific Committee on Consumer Products (SCCP)

The SCCP is a European Commission-sponsored committee that addresses questions related to the safety of non-food consumer products for consideration by the members of the European Union. In particular, it has produced notes of guidance on the testing of cosmetic ingredients and their safety evaluation.

Web: http://ec.europa.eu/health/ph_risk/committees/04_sccp/docs/sccp_o_03j.pdf.

The European Cosmetic Toiletry and Perfumery Association (COLIPA)

COLIPA is the European Trade Association representing the interests of the cosmetic, toiletry, and perfumery industry. Amongst its activities, it contributes to product quality and consumer safety and promotes research into alternatives to animal testing. It has also developed guideline documents for the safety assessment of cosmetic products, skin tolerance of potential irritant cosmetic ingredients, percutaneous absorption/penetration assessment, and on human skin compatibility.

Web: http://www.colipa.com/site/index.cfm?SID=15588&L0=15604&OBJ=15832.

The European Centre for Ecotoxicology and Toxicology of Chemicals (ECETOC)

ECETOC is a non-profit association of companies with interests in the manufacture and use of chemical substances. It was established to provide a scientific forum through which the expertise of the European chemical industry could be harnessed to research, review, assess, and publish studies on the ecotoxicology and toxicology of chemical substances. It proposes a series of monographs on comprehensive reviews of generic topics or issues fundamental to the application of sound science in evaluating the hazards and risks of chemical substances to human health and the environment.

Web: http://www.ecetoc.org/Content/Default.asp.

SCIENTIFIC INFORMATION

Information related to alternative (in vitro) and traditional (in vivo) testing methods and toxicity assessment can be found from numerous resources. This section is an update of the previous chapter on Toxicology Testing Methods and Laboratories that was part of the 3rd edition of the Information Resources in Toxicology and currently presents a non-exhaustive overview of scientific literature published after 1990 (books, journals, and papers), internet databases, and newsletters that can be consulted to start searching for toxicology-related information.

RESOURCES

Books

Arnold DL, Grice HC, Krewski DR (1990)
Handbook of in Vivo Toxicity Testing
Academic Press, San Diego, CA.
ISBN: 0120633809.

Information on in vivo toxicity testing methodologies.

Atterwill CK, Goldfarb P, Purcell W (2000)
Approaches to High Throughput Toxicity Screening
Taylor & Francis, New York.

Integrated approach to in vitro toxicology and ADME screening using new technologies and discusses how they might be applied to the pre-clinical safety assessment and 'lead optimization' of new pharmaceutical products in drug discovery.

Barile FA (2007)
Principles of Toxicology Testing
CRC
ISBN-13: 978-0849390258.

Principles of animal toxicology testing with in vitro alternative methods to highlight the importance of both fields for interpretation of the significance and relevance of the other.

Boelsterli UA (2007)
Mechanistic Toxicology: The Molecular Basis of How Chemicals Disrupt Biological Targets, 2nd Edition
CRC.
ISBN-13: 978-0849372728.

Information on molecular biology and biochemistry with the characteristics of toxic effects induced by drugs, environmental chemicals, and other xenobiotics.

Bus JS, Costa LG, Hodgson E, Lawrence DA, Reed DJ (2007)
Current Protocols in Toxicology
John Wiley & Sons Inc.

Best practices collection of laboratory protocols for accurate, efficient assessments of toxicity in whole

organisms, organs and tissues, cells, and biochemical pathways.

Cronin MTD, Livingstone DA (2004)
Predicting Chemical Toxicity and Fate
Taylor & Francis
ISBN: 0415271800.

State of the art on prediction methods of toxicity and fate of chemical substances both to man and in the environment with a strong focus on Quantitative Structure–Activity Relationships (QSARs).

Derelanko MJ, Hollinger MA (2001)
Handbook of Toxicology, 2nd Edition
CRC.
ISBN-13: 978-0849303708.

Diverse assortment of basic information to design, conduct, and interpret toxicology studies and to perform risk assessments.

Ecobichon DJ (1997)
The Basis of Toxicity Testing
CRC.
ISBN: 0849385547.mailto:

Includes the principles and concepts behind various types of in vivo and in vitro toxicological studies; the design, conduct, and interpretation of studies; the latest developments in alternatives to animal studies; the types of studies required by regulatory agencies; and sections on various risk assessment-related topics.

Fan AM (1996)
Toxicology and Risk Assessment
Marcel Dekker
ISBN: 0824794907.

Fundamental principles and concepts of toxicology and risk assessment including sections on clinical testing, risk assessment of chemical substances and hazardous materials, the application of animal data to human health risk assessment, mathematical models, statistical approaches, environmental laws, information resources, and risk management.

Frazier JM, Frazier M (1992)
In vitro Toxicity Testing
Marcel Dekker
ISBN: 0824786149.

Potential application of in vitro procedures to identify and quantify the toxicological risk to target organs associated with the use of commercial products and therapeutic drugs.

Gad SC (2000)
In vitro Toxicology
Taylor & Francis
ISBN: 1560327693 2000.

Principles of in vitro toxicology and in vitro toxicity testing methods.

Gad SC (2001)
Regulatory Toxicology, 2nd Edition
CRC.
ISBN-13: 978-0415239196.

Safety and toxicity testing of chemical substances.

Gad SC (2007)
Animal Models in Toxicology
CRC/Taylor & Francis
ISBN: 9780824754075.

A practical guide to the common statistical problems encountered in toxicology and the methodologies that are available to solve them.

Harry S, Sidney K (1999)
Toxicity Assessment Alternatives
Humana Press
ISBN: 0896037878.

Information on toxicity assessment alternatives on developments on mechanically based alternatives, current trends and future projections, hazard assessment applications, and the validation of alternatives. Achieved and accepted alternatives to animal testing are explained by various scientific and regulatory communities, such as the use of transgenic models that reduce the time and cost of carcinogenicity testing, the use of tissue cultures for the assessment of endocrine-disrupting chemical substances, and the application of molecular modeling to explain chemical toxicity.

Hayes AW (2007)
Principles and Methods of Toxicology, 5th Edition
CRC
ISBN-13: 978-0849337789.

Fundamental principles and applied methods of toxicology.

Hodgson E (2004)
A Textbook of Modern Toxicology, 3rd Edition
Wiley-Interscience
ISBN-13: 978-0471265085.

A book on toxicology describing the physical and chemical study of all the known poisonous substances, as well as the methods of testing for them, their action on the living body, and the postmortem results they occasion.

Hood RD (1997)
Handbook of Developmental Toxicology

CRC.
ISBN: 0849301351.

Encompasses the study of toxicant effects on development, from conception through puberty.

Jacobson-Kram D, Keller KA (2006)
Toxicology Testing Handbook. Principles, Applications and Data Interpretation, 2nd Edition
Marcel Dekker.ISBN: 9780849338588 and ISBN 10: 0849338581.

Provides data on issues such as species selection, dose level and dosing regimens, animal models, routes of exposure, statistical evaluation, data interpretation, adherence to good laboratory practices, fulfillment of regulatory requirements including registering products in international markets, and provides guidance on how to evaluate the quality of a Contract Research Organization (CRO).

Jolles G, Cordier A (1992)
In vitro Methods in Toxicology
Academic Press
ISBN 0123881757.

This book covers general aspects of in vitro testing, target organ toxicity, reproductive toxicity and carcinogenesis, and deals with in vitro toxicity.

Klaassen CD (2001)
Casarett and Doull's Toxicology: The Basic Science of Poisons, 6th Edition
McGraw-Hill Professional
ISBN-13: 978-0071347211.

A book on modern toxicology, including the principles, concepts, mechanisms, and modes of thought that are the foundation of the discipline.

Klaassen CD, Watkins JB (2003)
Casarett & Doull's Essentials of Toxicology, 1st Edition
McGraw-Hill Professional
ISBN-13: 978-0071389143.

A book that introduces the science of toxicology.

Kram DJ (2001)
Toxicology Testing Handbook: Principles, Applications, and Data Interpretation, 1st Edition
Informa HealthcareISBN-10: 0824700732, ISBN-13: 978-0824700737.

Information on scientific research in the field of toxicity testing.

Lee CJ, Lee LH, Wu CL, Lee BR, Chen ML (2006)
Clinical Trials of Drugs and Biopharmaceuticals.
CRC.
ISBN: 0849321859.

Drugs development and approval and pre-clinical evaluations of pharmacological activity and safety.

Liansky S, Macmillan R, Dupus J (1996)
Alternatives to Animal Testing
CPL Press, Newbury, UK

This book contains the proceedings of a 1995 conference organized by the European Cosmetic, Toiletry and Perfumery Association (COLIPA). Includes the text of keynote addresses, roundtable discussions, and other presentations.

Marquardt H, Schäfer SG, McClellan RO (1999)
Toxicology, 1st Edition
Academic Press
ISBN-13: 978-0124732704.

An introduction to the science of toxicology.

Newman MC, Unger MA (2003)
Fundamentals of Ecotoxicology
CRC.
ISBN: 1566705983.

Information on the sources, transport, and fate of major classes of contaminants in terrestrial, freshwater, and marine systems.

O'Hare S, Atterwill CK (1995)
In vitro Toxicity Testing Protocols
Humana Press
ISBN: 0896032825.

A collection of proven, state-of-the-art methods that toxicologists can use in carrying out laboratory studies.

Riviere J (2006)
Biological Concepts and Techniques in Toxicology: An Integrated Approach
Taylor & Francis/CRC Press.
ISBN: 9780824729790 and ISBN: 10: 082472979X.

Describes the integration of new scientific concepts into routine toxicologic testing procedures, highlights new methods and concepts that may have a major impact on toxicology, presents an overview of the impact of hormesis on interpretation of dose–response relationships, discusses the use of biological data and test systems in toxicology, reviews current approaches to nanomaterials, forensics, and pharmaceutics, and reviews developments in toxicokinetics.

Salem H, Katz SA (1998)
Advances in Animal Alternatives for Safety and Efficacy Testing
CRC.
ISBN: 1560326239.

Presents up-to-date concepts and approaches to the theory and practice of alternatives to animal testing and promotes technology transfer.

Salem H, Katz SA (2003)
Alternative Toxicological Methods
CRC Press.
ISBN: 9780849315282 and ISBN 10: 084931528X.

Describes recent progress made in developing and validating replacement, reduction, and refinement alternatives to animal testing, and the use of genomics and proteomics, engineered tissue equivalents for screening ocular injury, and gene array techniques in skin biology.

Schiefer HB, Irvine DG, Buzik SC (1997)
Understanding Toxicology: Chemicals, Their Benefits and Risks
CRC.
ISBN-13: 978-0849326868.

A general overview of toxicology, presenting the facts and underlying principles needed by non-specialists for making decisions about potentially hazardous substances in everyday settings.

Stine KE, Brown TM (2006)
Principles of Toxicology, 2nd Edition
CRC
ISBN-13: 978-0849328565.

Comprehensive textbook introducing the science of toxicology at the undergraduate or graduate level.

Timbrell JA (2001)
Introduction to Toxicology, 3rd Edition
CRC.
ISBN-13: 978-0415247627.

This book introduces fundamental concepts of toxicology and builds upon these using topical and historical examples.

Winder C, Stacey NH (2004)
Occupational Toxicology
Taylor & Francis
ISBN: 0748409181.

Basic tenets of the science of toxicology that underpin the application of toxicological information to the workplace.

Woolley A (2003)
A Guide to Practical Toxicology: Evaluation, Prediction and Risk, 1st Edition
CRC.
ISBN-13: 978-0748409235.

Background information on toxicological method or process.

Journals

ALTEX

Official journal of the Middle European Society for Alternatives to Testing in Animals (MEGAT).

Archives of Toxicology

ATLA (Alternatives to Laboratory Animals)

Basic & Clinical Pharmacology & Toxicology

Cell Biology and Toxicology

Critical Reviews in Toxicology

Ecotoxicology and Environmental Safety

Environmental Health Perspectives (EHP)

The journal of the (U.S.) National Institute of Environmental Health Sciences.

Environmental Toxicology and Chemistry

Experimental and Toxicologic Pathology

Food and Chemical Toxicology

Human and Experimental Toxicology

International Agency for Research on Cancer (IARC) Scientific Publications

The Institute for Laboratory Animal Research (ILAR) Journal and e-Journal

Inhalation Toxicology

The International Journal of Laboratory Animal Science and Welfare

International Journal of Toxicology

Journal of Applied Toxicology

Journal of Biochemical Toxicology

Journal of Pharmacological and Toxicological Methods

Journal of Toxicology and Environmental Health

Mutation Research – Genetic Toxicology and Environmental Mutagenesis

Neurotoxicology

Neurotoxicology and Teratology

Regulatory Toxicology and Pharmacology

Reproductive Toxicology

Reviews on Environmental Health

Toxicological and Environmental Chemistry

Toxicological Sciences

Toxicology and Applied Pharmacology

Toxicology in Vitro

Toxicology Letters

Toxicology Mechanisms and Methods

Special Issues, Supplements and Review Articles

Alternatives to Laboratory Animals (ATLA) (2005), Volume 33, Supplement 1, July 2005. ***Alternative (Non-Animal) Methods for Cosmetics Testing: Current Status and Future Prospects***

This supplement is a report prepared in the context of the 7th Amendment of the Cosmetics Directive for Establishing the Timetable for Phasing Out Animal Testing and deals with safety and testing data requirements and practices for various toxicological endpoint.

Alternatives to Laboratory Animals (ATLA) (2006), Volume 34, Supplement 1, March 2006.

This supplement deals with various toxicity endpoint testing requirements in the frame of REACH.

Environmental Health Perspectives Supplements (1998), Volume 106, Number S2, April 1998. ***Alternative Testing Methodologies; Human Health Effects of Dioxins and Furans***

This supplement contains about 43 papers providing information on toxicity testing, alternative testing methods including organ toxicity, and ecotoxicity.

Review Articles

Bakand S, Winder C, Khalil C, Hayes A (2005) Toxicity assessment of industrial chemicals and airborne contaminants: transition from *in vivo* to *in vitro* testing methods: a review. Inhal. Toxicol. 17(13): 775–787.

Baker VA (2001) Endocrine disrupters – testing strategies to assess human hazard. Toxicol. In Vitro 15(4–5): 413–419.

Bhogal N, Grindon C, Combes R, Balls M (2005) Toxicity testing: creating a revolution based on new technologies. Trends Biotechnol. 23(6): 299–307.

Bremer S, Hartung T (2004) The use of embryonic stem cells for regulatory developmental toxicity testing *in vitro* – the current status of test development. Curr. Pharm. Des. 10(22): 2733–2747.

Coecke S, Eskes C, Gartlon J, et al (2006) The value of alternative testing for neurotoxicity in the context of regulatory needs. Env. Tox. Pharmacol. 21(2): 153–167.

Combes RD (2004) Peer review of validation studies: an assessment of the role of the OECD by reference to the validation of the uterotrophic assay for endocrine disruptors. Altern. Lab. Anim. 32(2): 111–117.

Cooper RL, Lamb JC, Barlow SM, et al (2006) A tiered approach to life stages testing for agricultural chemical safety assessment. Crit. Rev. Toxicol. 36(1): 69–98.

Doe JE, Boobis AR, Blacker A, et al (2006) A tiered approach to systemic toxicity testing for agricultural chemical safety assessment. Crit. Rev. Toxicol. 36(1): 37–68.

ECVAM Workshop Reports. A series of reports that review the status on specific topics related to alternative methods and make recommendations about the best way forward, to promote the integration of in vitro tests and other alternative methods in the regulatory process. Available online: http://www.ecvam/index.htm.

Grindon C, Combes R, Cronin MT, Roberts DW, Garrod J (2006) A review of the status of alternative approaches to animal testing and the development of integrated testing strategies for assessing the toxicity of chemicals under REACH – a summary of a DEFRA-funded project conducted by Liverpool John Moores University and FRAME. Altern. Lab. Anim. 34(Suppl 1): 149–158.

Hasspieler BM, Haffner GD, Adeli K (1996) *In vitro* toxicological methods for environmental health testing. Rev. Environ. Health 11(4): 213–227.

Hayashi Y (2005) Designing *in vitro* assay systems for hazard characterization. basic strategies and related technical issues. Exp. Toxicol. Pathol. 57(Suppl 1): 227–232.

Hofer T, Gerner I, Gundert-Remy U, et al (2004) Animal testing and alternative approaches for the human health risk assessment under the proposed new European Chemicals Regulation. Arch. Toxicol. 78(10): 549–564.

Hoffmann S, Hartung T (2006) Toward an evidence-based toxicology. Human Exp. Toxicol. 25: 497–513.

Holme JA, Dybing E (2002) The use of *in vitro* methods for hazard characterization of chemicals. Toxicol. Lett. 127(1–3): 135–141.

Hutchinson TH (2002) Reproductive and developmental effects of endocrine disrupters in invertebrates: *in vitro* and *in vivo* approaches. Toxicol. Lett. 131(1–2): 75–81.

Knight DJ, Breheny D (2002) Alternatives to animal testing in the safety evaluation of products. Altern. Lab. Anim. 30(1): 7–22.

Louekari K (2004) Status and prospects of *in vitro* tests in risk assessment. Altern. Lab. Anim. 32(4): 431–435.

Louekari K, Sihvonen K, Kuittinen M, Somnes V (2006) *In vitro* tests within the REACH information strategies. Altern. Lab. Anim. 34(4): 377–386.

Meyer O (2003) Testing and assessment strategies, including alternative and new approaches. Toxicol. Lett. 140–141: 21–30.

Nohynek GJ, Fautz R, Benech-Kieffer F, Toutain H (2004) Toxicity and human health risk of hair dyes. Food Chem. Toxicol. 42(4): 517–543.

Raunio H, Taavitsainen P, Honkakoski P, Juvonen R, Pelkonen O (2004) *In vitro* methods in the prediction of kinetics of drugs: focus on drug metabolism. Altern. Lab. Anim. 32(4): 425–430.

Seagrave J, McDonald JD, Mauderly JL (2005) *In vitro* versus *in vivo* exposure to combustion emissions. Exp. Toxicol. Pathol. 57(Suppl 1): 233–238.

Stokes WS (2002) Humane endpoints for laboratory animals used in regulatory testing. ILAR J. 43(Suppl): S31–S38.

Stitzel KA (2002) Tiered testing strategies – acute local toxicity. ILAR J. 43(Suppl): S21–S26.

Databases

Multi Source and Information Databases

DIMDI-Medical Knowledge Online

Provides information in all fields of the life sciences to the interested public.

Web: https://gripsdb.dimdi.de/websearch/servlet/Gate?accessid=bfrAnimaltBasicEn#__DEFANCHOR.

Entrez

Cross-database search page linked to 31 information resources on bibliographies, toxicology, nucleotide sequences, protein sequences, macromolecular structures, whole genomes, etc.

Web: http://www.ncbi.nlm.nih.gov/gquery/gquery.fcgi.

ESIS (European chemical Substances Information System)

Portal to database containing information about chemical substances such as physical and chemical properties, Classification and Labeling, Risk and Safety Phrases and Risk Assessment.

Web: http://ecb.jrc.it/esis/.

MDL Discovery Knowledge

Reference works, literature links, and the world's most comprehensive collection of bioactivity, chemical sourcing, synthetic methodology, metabolism, toxicology, and Environment, Health, and Safety (EH&S) databases.

Web: http://www.mdli.com/products/knowledge/index.jsp.

Multi-Database Search

Search all factual chemical databases.

Web: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?Multi.

(U.S.) National Library of Medicine

The world's largest medical library providing access to multiple major databases materials and information and research services in all areas of biomedicine and health care.

Web: http://www.nlm.nih.gov/.

Includes:
TOXNET (free online)

Network of databases on toxicology, hazardous chemical substances, and environmental health. National Library of Medicine, Specialized Information Services cluster of databases on toxicology, hazardous chemical substances, and related areas.

Web: http://toxnet.nlm.nih.gov/.

Literature Search Databases

AGRICOLA (AGRICultural OnLine Access) (free online)

Information on animal science, veterinary science, farming practices, housing and husbandry practices, alternative farming systems and other animal agriculture literature.

Web: http://agricola.nal.usda.gov/.

ALTBIB

Bibliography on alternatives to the use of live vertebrates in biomedical research and testing.

Web: http://toxnet.nlm.nih.gov/altbib.html.
Alternative Farming http://www.awionline.org/farm/Altfrm.htm (free online)

Published and online information on factory farming and humane alternatives.

Web: http://www.awionline.org/farm/Altfrm.htm.

ANZCCART

Information for animal carers, animal ethics committee members, and scientists as well as other interested parties.

Web: http://www.adelaide.edu.au/ANZCCART/.

ASFA (Aquatic Sciences and Fisheries Abstracts)

Dissemination of information on aquatic sciences and fisheries to the world community, bearing in mind the special interests of developing countries in this field.

Web: http://www.fao.org/fi/website/FIRetrieveAction.do?dom=org&xml=asfa_prog.xml.

CAB (fee based)

Information on life sciences, animal science, animal health, animal production, molecular biology, genetics, biotechnology, breeding, and beyond.

Web: http://www.cabi-publishing.org/AbstractDatabases.asp?SubjectArea=&Subject=&Section=dc&PID=125.

EMBASE (fee based)

A comprehensive international database on pharmacological and biomedical literature.

Web: http://www.embase.com/.

Environmental Enrichment for Primates (free online)

An annotated database on environmental enrichment and refinement of husbandry for non-human primates.

Web: http://www.awionline.org/lab_animals/biblio/enrich.htm/.

InterNICHE (free online)

A library of multimedia CD-ROMs, videos, and models focusing on animal use and alternatives within the biological sciences.

Web: http://www.interniche.org/alt_loan.html#disc.

PrimateLit Database (free online)

Bibliographic access to the scientific literature on non-human primates for the research and educational communities.

Web: http://www.awionline.org/lab_animals/LAREF/enriop.htm.

PubMed/MEDLINE (free online)

Database with millions of references, primarily from MEDLINE, to journal articles in life sciences with a concentration on biomedicine.

Web: http://www.ncbi.nlm.nih.gov/entrez/query.fcgi.

SCIRUS (free online)

Offers a comprehensive science-specific search engine on the Internet, designed for scientists and researchers. It provides access to scientific, scholarly, technical, and medical data, as well as the latest reports, peer-reviewed articles, patents, pre prints, and journals that other search engines miss.

Web: http://www.scirus.com/srsapp/advanced/index.jsp.

ScienceDirect (partially free)

An advanced web delivery systems for scientific, technical and medical information.

Web: http://www.sciencedirect.com/.

SCOPUS (fee based)

Scopus is the largest abstract and citation database of research literature and quality web sources.

Web: http://www.scopus.com/scopus/home.url.

TEXTBASE (free online)

A collection of information on current textbooks within the field of laboratory animal science.

Web: http://oslovet.veths.no/fag.aspx?fag=58&mnu=databases_2.

Thomson Scientific

Information on academic, government, corporate, and pharma R&D.

Web: http://scientific.thomson.com/.

Toxicology Literature Online (TOXLINE)

References from toxicology literature.

Web: http://www.toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?TOXLINE.

Traditional Testing Methods Databases

ECOTOX (free online)

Provides single chemical toxicity information for aquatic and terrestrial life.

Web: http://cfpub.epa.gov/ecotox/.

ECOTOX

Database with information on single chemical toxicity for aquatic life, terrestrial plants and wildlife.

Web: http://cfpub.epa.gov/ecotox/.

Haz-Map

Information on hazardous chemical substances and occupational diseases.

Web: http://hazmap.nlm.nih.gov/.

ILAR – Animal Models and Strains Database (free online)

Search engine for information on animal models or strains of animals used for research.

Web: http://dels.nas.edu/ilar_n/ilarhome/search_amsst.shtml.

Individual Animal Pathology Database

Search for chronic studies collected in the NTP's Toxicology Database Management System and Carcinogenesis Bioassay Data System.

Web: https://ntp-apps.niehs.nih.gov/iacf/demo/tdms-menu.cfm.

Jackson Laboratory Resources (free online)

The site provides access to a variety of mouse strain and genetic resource databases, including the Mice Database, Mouse Genome Informatics, and International Mouse Strains Resources.

Web: http://www.jax.org/resources/index.html.

National Center for Research Resources (NCRR)

Provides information on unique technologies, instrumentation, facilities, animal models, genetic stocks, and biomaterials.

Web: http://www.ncrr.nih.gov/.

NIH Model Organisms for Biomedical Research (free online)

Information about national and international activities and major resources that are being developed to facilitate biomedical research using the animal models, such as mice, rats, frogs, zebra-fish, fruit fly, round worm, amoebae, fungus, yeast, and plants.

Web: http://www.nih.gov/science/models/.

Registry of Toxic Effects of Chemical Substances (RTECS)

A compendium of toxicity data extracted from the open scientific literature on primary irritation, mutagenic effects, reproductive effects, carcinogenic effects, acute toxicity, and other multiple dose toxicity.

Web: http://www.cdc.gov/niosh/rtecs/default.html.

Zebra Fish Information Network (ZFIN)

ZFIN serves as the zebra fish model organism database providing resources for the laboratory use of zebra fish, developing and supporting integrated zebra fish genetics, maintaining the definitive reference data on zebra fish research information, facilitating the use of zebra fish as a model for human biology and serving the needs of the research community.

Web: http://zfin.org/cgi-bin/webdriver?MIval=aa-ZDB_home.apg.

Alternative testing methods databases

Alternatives to Animal Testing on the Web (Altweb)

Internet information platform on alternatives to animals in testing and education and research comprising technical information such as databases, Internet search engine, network of experts, etc.

Web: http://altweb.jhsph.edu.

AnimAlt-ZEBET

Provides information on alternatives to animal experiments on the Internet.

Web: http://www.bfr.bund.de/cd/1508.

DB-ALM

ECVAM database service on alternative methods to animal experimentation containing literature, in vitro methods, QSAR models, and more.

Web: http://ecvam-dbalm.jrc.cec.eu.int/.

InVitroDerm

Alternatives to skin irritation and corrosion testing in animals.

Web: http://www.invitroderm.com/.

INVITTOX (free online)

Listing of protocols presenting up-to-date technical information on the performance of in vitro techniques and methodologies currently in use and under development with critical assessment comments on their applications, advantages, and drawbacks.

Web: http://www.invittox.com/.

Animal welfare databases

AltWeb – Humane Endpoints Database (free online)

This database is designed to help investigators find the earliest 'endpoint' that is compatible with the scientific objectives of their research.

Web: http://apps1.jhsph.edu/altweb/humane/.

AltWeb Pain Management (Anesthesia/Analgesia) Database (free online)

Information on anesthesia and analgesia for laboratory animals and available drugs and their side effects.

Web: http://apps1.jhsph.edu/altweb/aadb/aadb_search.cfm.

Practical Enrichment Options Database (free online)

This Animal Welfare Institute database disseminates enrichment ideas and practical tips from the 'Laboratory Animals Refinement and Enrichment Forum' and from other published information.

Web: http://www.awionline.org/lab_animals/LAREF/enriop.htm.

Refinement of Housing and Handling Conditions and Environmental Enrichment for Animals kept in Laboratories (free online)

Two databases on refinement and enrichment for non-primate and primate animals kept in laboratories disseminating reference material on all aspects of refinement of housing and handling conditions and environmental enrichment for all animals kept in research, testing, and teaching institutions.

Web: http://www.awionline.org/lab_animals/biblio/laball.htm.

Wildlife Information Network (WIN) (free online)

To provide information on the health and management of free-ranging and captive animals and emerging infectious diseases to wildlife professionals and decision-makers worldwide.

Web: http://www.wildlifeinformation.org/.

Other Databases (ongoing projects, education and training)

Alternatives in Education Database (free online)

Information on alternatives to the use of animals in education.

Web: http://avar.org/alted/.

Computer Retrieval of Information on Scientific Projects (CRISP) (free online)

Database of federally funded biomedical research projects conducted at universities, hospitals, and other research institutions. It provides information on human diseases, therapeutic interventions, clinical trials, and preclinical research.

Web: http://crisp.cit.nih.gov/.

DoD Biomedical Research Database (free online)

Information on research, testing and training related to infectious diseases, biological hazards, toxicology, medical chemical defense, medical biological defense, clinical medicine, clinical surgery, physical protection, training, and graduate medical education.

Web: http://www.dtic.mil/biosys/org/brd/index.htm.

ERIC Education Resources Information Center

Bibliographic records of education literature plus a growing collection of full text.

Web: http://www.eric.ed.gov/.

EURCA Alternatives Database (free online)

Detailed descriptions of alternatives (focusing on alternatives in education), along with reviews and comments on their use and suitability, based upon the 3Rs concept.

Web: http://www.eurca.org/index.asp.

European Resource Centre for Alternatives in Higher Education EURCA

Promotion of the use of alternatives to using animals in higher education.

Web: http://www.eurca.org/.

GenBank (free online)

Genetic sequence database that is an annotated collection of all publicly available DNA sequences.

Web: http://www.ncbi.nlm.nih.gov/Genbank/index.html.

Individual Studies Database

Search tool on toxicological studies by chemical name.

Web: http://ntp-apps.niehs.nih.gov/ntp_tox/index.cfm.

Intute (free online)

A service providing access to web resources for education and research, evaluated and selected by a network of subject specialists.

Web: http://www.intute.ac.uk/healthandlifesciences/.

MedWeb

A catalog of biomedical and health-related websites.

Web: http://www.medweb.emory.edu/MedWeb/.

N-CLASS Database

Database on environmental hazard classification.

Web: http://apps.kemi.se/nclass/default.asp.

NORINA (free online)

Information on over 3800 audiovisual aids that may be used as alternatives or supplements to the use of animals in teaching.

Web: http://oslovet.veths.no/fag.aspx?fag = 57.

Porcine Immunology and Nutrition Database (PIN) (free online)

Database focusing on immunologically related genes.

Web: http://www.ba.ars.usda.gov/nrfl/nutri-immun-db/n3rfl_query1.html.

U.S. Food and Drug Administration

Portal to information on food, drugs, medical devices, biologics, animal feed and drugs, cosmetics, radiation-emitting products.

Web: http://www.fda.gov/default.htm.

Zoological Record (fee based)

World's oldest continuing database of animal biology.

Web: http://scientific.thomson.com/products/zr/.

Newsletters

Adis Newsletters

The Adis Newsletters database contains all the news and full-text articles from the following three newsletter publications: Inpharma® (INP); ReactionsTM (REA); and Pharmacoeconomics & Outcomes NewsTM (PON). These three newsletters bring together the most important developments in drugs and drug therapy from the world's biomedical literature, major meetings, and symposia.

Web: http://library.dialog.com/bluesheets/html/bl0428.html.

AltNews

Information about research, technology, grants, corporate–scientific collaborations, government rulings, seminars, databases, educational resources, and issues and debates in the alternatives community.

Web: http://altweb.jhsph.edu/index.htm.

Animal Welfare Information Center (AWIC)

Information about animal welfare and the reduction of testing animals.

Web: http://awic.nal.usda.gov/nal_display/index.php?info_center=3&tax_level=1&tax_subject=190.

European Commission, Joint Research Centre, European Centre for the Validation and Evaluation of Alternative Methods (ECVAM) Newsletter

Reports the scientific and technical aspects of the work carried out and co-ordinated by the ECVAM in support of European legislation on the development of alternative methods.

Web: http://ecvam.jrc.it/.

European Commission, Joint Research Centre, European Chemicals Bureau (ECB) Newsletter

Reports the scientific and technical aspects of the work carried out and co-ordinated by the ECB in support of European legislation on chemical substances control.

Web: http://ecb.jrc.it/newsletter/.

The Society of Toxicology Communiqué

Published online four times annually (Spring, Summer/Fall, Winter, and Special Issue) on toxicological issues.

Web: http://www.toxicology.org/ai/pub/communique.asp.

Organizations

The following organizations are involved in the field of toxicology and toxicity testing, and include non-/governmental organizations, fund-providing organizations, foundations, associations, federations, and testing laboratories.

Governmental

Animal Welfare Information Center (AWIC)
U.S. Department of Agriculture
Web: http://awic.nal.usda.gov.

Centre for Documentation and Evaluation of Alternatives to Animal Experiments (ZEBET)
Web: http://www.bfr.bund.de/cd/1591.

European Chemicals Agency (ECHA)
Web: http://echa.europa.eu/.

European Commission, Joint Research Centre (JRC)
Web: http://www.jrc.cec.eu.int/

European Chemicals Bureau (ECB)
Web: http://ecb.jrc.it.

European Centre for the Validation of Alternative Methods (ECVAM)
Web: http://ecvam.jrc.it/index.htm.

Physical and Chemical Exposure Unit (PCE)
Web: http://web.jrc.ec.europa.eu/pce/.

(U.S.) Interagency Coordinating Committee on the Validation of Alternative Methods (ICCVAM) and The National Toxicology Program Interagency Center for the Evaluation of Alternative Toxicological Methods (NICEATM)
Web: http://iccvam.niehs.nih.gov/home.htm.

Organization for Economic Co-operation and Development (OECD)
Web: http://www.oecd.org/.

(U.S.) National Institute of Environmental Health Sciences (NIEHS)
Web: http://www.niehs.nih.gov.

(U.S.) National Toxicology Program
Web: http://ntp.niehs.nih.gov/index.cfm.

United Nations
Web: http://www.un.org/:

United Nations – Economic Commission for Europe – Globally Harmonized System of Classification and Labeling of Chemicals (GHS)
Web: http://www.oecd.org/topic/0,2686,en_2649_34371_1_1_1_1_37407,00.html.

United Nations Environment Program (UNEP)
Web: http://www.unep.org/.

World Health Organization (WHO)
Web: http://www.who.int/about/en/.

Non-Governmental Organizations (NGOs)

American College of Laboratory Animal Medicine (ACLAM)
Web: http://www.aclam.org.

American Type Culture Collection (ATCC)
Web: http://www.lgcpromochem-atcc.com/about/LGCATCCPart.cfm.

Armed Forces Institute of Pathology (AFIP)
Web: http://www.afip.org.

European consensus-platform for alternatives (ECOPA)
The parties concerned, i.e. animal welfare, industry, academia and governmental institutions.
Web: http://www.ecopa.eu/.

European Society of Toxicology in Vitro (ESTIV)
Web: http://www.estiv.org/.

FRAME (Fund for the Replacement of Animals in Medical Experiments)
Web: http://www.frame.org.uk/index.htm.

Industrial in Vitro Toxicology Group (IIVTG)mailto:
Web: http://www.ivtip.org/links.html.

Institute for in Vitro Sciences, Inc. (IIVS)
Web: http://www.iivs.org.

International Institute for the Advancement of Medicine (IIAM)
Web: http://www.iiam.org.

Johns Hopkins Center for Alternatives to Animal Testing (CAAT)
Web: http://caat.jhsph.edu/index.htm.

LASA (Laboratory Animal Science Association)
Web: http://www.lasa.co.uk.

National Anti-Vivisection Society
Web: http://www.navs.org.

Netherlands Centre for Alternatives to Animal Use (NCA)
Web: http://www.nca-nl.org/.

Scientific Group on Methodologies for the Safety Evaluation of Chemicals (SGOMSEC)
Web: http://www.icsu-scope.org/projects/complete/sgomsec.htm.

Society for in Vitro Biology (SIVB) (formerly the Tissue Culture Association)
Web: http://www.sivb.org.

Society of Toxicology (SOT)
Web: http://www.toxicology.org.

The International Council for Laboratory Animal Science (ICLAS)
Web: http://www.iclas.org.

The National Centre for the Replacement, Refinement and Reduction of Animals in Research (NC3Rs)
Web: http://www.nc3rs.org.uk.

The Norwegian Reference Centre for Laboratory Animal Science and Alternatives
Web: http://oslovet.veths.no/dokument.aspx?dokument=80.

Tufts University Center for Animals and Public Policy
Web: http://www.tufts.edu/vet/cfa/about_mission.html.

University of California Center for Animal Alternatives
Web: http://www.vetmed.ucdavis.edu/Animal_Alternatives/main.htm.

U.S. National Academy of Sciences (NAS), Institute for Laboratory Animal Research (ILAR)
Web: http://dels.nas.edu/ilar_n/ilarhome.

Industry Organizations

American Chemistry Council (ACC)
Web: http://www.americanchemistry.com/s_acc/sec_about.asp?CID=6&DID=9.

ECETOC European Centre for Ecotoxicology and Toxicology of Chemicals
Web: http://www.ecetoc.org/.

EFPIA European Federation of Pharmaceutical Industries and Associations
Web: http://www.efpia.org/.

European Chemical Industry Council (CEFIC)
Web: http://www.cefic.org/.

In vitro toxicology industrial platform (IVTIP)
Web: http://www.ivtip.org/.

Funds/Foundations

3R Research Foundation
Web: http://www.forschung3r.ch.

Alternatives Research & Development Foundation
Web: http://www.ardf-online.org.

American Fund for Alternatives to Animal Research (AFAAR)
c/o Dr. Ethel Thurston
175 West 12th St, New York, NY 10011

Dr Hawden Trust
Web: http://www.drhadwentrust.org.uk/.

Erna-Graff-Stiftung für Tierschutz
Web: http://www.erna-graff-stiftung.de/cms/stiftung/index.php.

European Science Foundation
Web: http://www.esf.org.

European Science Foundation
Web: http://www.esf.org.

FFVFF Stiftung/Fonds für versuchstierfreie Forschung
Web: http://www.ffvff.ch/.

FISEA Fondation Internationale pour la Substitution de l'Expérimentation Animale
Web: http://www.fisea.lu/index.php?pg=story&lg=en.

Regina Bauer Frankenberg Foundation for Animal Welfare
c/o JP Morgan
Chase Bank, New York, NY 10036.

Stiftung Tier im Recht
Web: http://www.tierimrecht.org/.

The Hildegard Doerenkamp–Gerhard Zbinden Foundation
Web: http://www.doerenkamp.ch/en/default.html?id=49.

Associations/Federations

American Association for Laboratory Animal Science (AALAS)
Web: http://www.aalas.org/index.aspx.

Association for Assessment and Accreditation of Laboratory Animal Care (AAALAC)
Web: http://www.aaalac.org/about/index.cfm.

Biosciences Federation
Web: http://www.bsf.ac.uk/asg/asghome.htm.

European Partnership For Alternative Approaches To Animal Testing (EPAA)
Web: http://ec.europa.eu/enterprise/epaa/index_en.htm.

Federation of European Toxicologists & European Societies of Toxicology (EUROTOX)
Web: http://www.eurotox.com/index.html.

Federation of European Laboratory Animal Science Associations (FELASA)
Web: http://www.felasa.eu/index.htm.

The Laboratory Animal Breeders' Association (LABA)
Web: http://www.laba-uk.com.

Animal Welfare Organizations

Center for Laboratory Animal Welfare
Web: http://www.mspca.org/site/pp.asp?c=gtIUK4OSG&b=126332.

Doris Day Animal League
Web: http://www.ddal.org.

Eurogroup for Animal Welfare
Web: http://www.eurogroupanimalwelfare.org/.

European Coalition to End Animal Experiments (ECEAE)
Web: http://www.eceae.org/english/index.html.

People for the Ethical Treatment of Animals (PETA)
Web: http://www.peta-online.org.

The Animal Welfare Institute
Web: http://www.animalwelfare.com.

The Humane Society of the United States (HSUS)
Web: http://www.hsus.org.

The Scientists Center for Animal Welfare (SCAW)
Web: http://www.scaw.com.

Universities Federation for Animal Welfare (UFAW)
Web: http://www.ufaw.org.uk.

Testing Laboratories

The New Chemicals Database of the European Commission's European Chemicals Bureau can be used to identify the testing laboratories that are most frequently used for testing of toxicological properties of chemical substances. Laboratories can be selected on basis of the quantity of substances tested (i.e. more than 764 times (May 2007)), and accessibility of the contract laboratories to the general public. The following

presents a few search engines that are useful tools to find testing laboratories all over the world.

Search Engines for Testing Laboratories

American Society for Testing and Materials (ASTM)

An on-line full text search for services and locations of testing laboratories.

Web: http://www.astm.org/labs.

ContractLaboratory.com

An online search engine to find laboratories for all chemical research and testing.

Web: http://www.contractlaboratory.com.

Michigan Environmental Laboratory Directory

An online search engine helping the general public find laboratories that offer environmental and drinking water laboratory testing services to meet their needs.

Web: http://www.deq.state.mi.us/labs/.

Websites (discussion forums, testing method resource center, and expert commentaries)

AltTox
Web: http://www.AltTox.org

AltTox.org's goal is to advance non-animal methods of toxicity testing through online discussion and information exchange. The website is designed to encourage the exchange of technical and policy information on in vitro and in silico methods, with the target audience including industry, government, academia, non-governmental organizations, and the public. AltTox includes:

- AltTox.org Forums as online discussion forums covering a range of topics within four major categories: Toxicity Endpoints & Tests, Emerging Technologies, Programs & Policies, and Overarching Challenges & Opportunities.
- Toxicity Testing Resource Center (TTRC) providing a comprehensive source of information on non-animal methods of toxicity testing.
- 'Way Forward' invited expert commentaries.

Also being planned for AltTox are online workshops and virtual meetings. AltTox is being developed and supported through a collaboration of the Procter & Gamble Company (P&G) and the Humane Society of the United States (HSUS). AltTox content will be overseen by an editorial board of subject matter experts who will also serve as forum moderators.

Acknowledgments

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CHAPTER

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Veterinary Toxicology

ROBERT H POPPENGA AND WAYNE SPOO

INTRODUCTION

Veterinary toxicology has grown into a multifaceted discipline that utilizes many diverse sources of toxicologic information. Veterinary toxicologists can be involved in basic toxicology research, clinical toxicology, regulatory toxicology, chemical risk assessment and chemical food safety in private, academic, clinical, government, and commercial settings, among others. Like many areas of science, veterinary toxicology information is being generated at rates much higher than most professionals can access it and incorporate its principles into practice. Veterinary toxicologists need access to a wide variety of information sources to remain abreast of current toxicologic information and to make sound clinical choices. The internet has provided the veterinary toxicologist with a valuable tool to access both historical and cutting-edge research information in a timely and cost-effective manner.

The diverse information needs of veterinary toxicologists can be illustrated by using veterinary clinical toxicology as an example. Veterinary clinical toxicologists are concerned with exposure assessment of many animal species to a bewildering array of potentially toxic chemicals (both naturally occurring and synthetic), investigation of animal deaths believed to be associated with toxicant exposure, selection of appropriate samples and tests to assist in reaching a diagnosis and the interpretation of analytical data derived from such testing. Also, they serve as an information resource for a diverse clientele seeking toxicity information to be used in a preventative fashion. For example, it is not unusual for veterinary toxicologists to receive inquiries concerning the potential toxicity of a plant found in the environment of an animal. Unfortunately, in many situations, there is little toxicity information available for a given toxicant that is specific for the species of animal involved. As a result, veterinary clinical toxicologists often integrate toxicity data from multiple sources to make informed 'weight of evidence' judgments about the potential hazard associated with the presence of a toxicant in the environment or the clinical relevance of a toxicant exposure. We list some of the more important and easily assessable sources below.

RESOURCES

Books

Adams HR (Ed.) (2001)
Veterinary Pharmacology and Therapeutics, 8th Edition
Blackwell Publishing, Ames, IA

Provides a comprehensive resource on the basic and applied principles of veterinary pharmacology and therapeutics. Focuses on basic mechanisms of representative drugs from the important classes of therapeutic agents. Emphasizes pharmacodynamics and pharmacokinetics as well as their clinical application.

Beyer WN, Heinx GH, Redmon-Norwood AW (Eds.) (1996)
Environmental Contaminants in Wildlife: Interpreting Tissue Concentrations
Lewis Publishers, Boca Raton, FL

A multi-authored textbook that provides practical information relating environmental contaminant

concentrations in tissues of wildlife to adverse health effects. Environmental contaminants discussed include organochlorine insecticides, polychlorinated biphenyls, dioxins, polycyclic aromatic hydrocarbons, lead, mercury, cadmium, selenium, and fluoride. The species discussed include terrestrial and marine mammals and birds, fish, and aquatic invertebrates. Contains extensive references for each topic.

Boothe DM (2001)
Small Animal Clinical Pharmacology and Therapeutics
W.B. Saunders Co., Philadephia, PA

A multi-authored introductory textbook of veterinary clinical pharmacology with a focus on dogs and cats. Sections include an introduction to drug use in small animals, major drug categories such as antimicrobials, anthelmintics, anti-inflammatories, corticosteroids, chemotherapeutic agents, immunomodulators, and biologic response modifiers, and use of drugs based upon affected organ systems.

Burrows GE, Tyrl RJ (2001)
Toxic Plants of North America
Iowa State University Press, Ames, IA

A definitive guide to toxic plants of veterinary significance in North America. Chapters are organized based upon plant families which are further divided by plant genera. For each genus there is extensive discussion of taxonomy and morphology, distribution and habitat, disease problems, disease genesis, clinical signs, pathology, and treatment. Extensive reference lists for each plant genera.

Campbell A, Chapman M (2000)
Handbook of Poisoning in Dogs and Cats
Blackwell Science Ltd., Oxford, UK

An introductory textbook of veterinary toxicology organized in a toxicant specific format and based upon calls received by the Veterinary Poisons Information Service in London. For each toxicant its source, clinical presentation, incidence of intoxication, toxicity, mechanisms of toxicity, kinetics and metabolism, laboratory diagnosis, postmortem findings, and treatment are discussed.

Cheeke PR (1998)
Natural Toxicants in Feeds, Forages, and Poisonous Plants, 2nd Edition
Interstate Publishers, Inc., Danville, IL

A good introduction to naturally occurring toxins in animal feeds and forages and in plants poisonous for livestock. Discusses mycotoxins, the effects of plant toxins on specific organ systems, toxins resulting from animal feed processing and naturally occurring carcinogens.

Fairbrother A, Locke LN, Hoff GL (Eds.) (1996)
Noninfectious Disease of Widlife, 2nd Edition
Iowa State University Press, Ames, IA

A multi-authored textbook that discusses a number of toxicants that impact wild animal populations such as mycotoxins, endrocrine disruptors, cholinesterase-inhibiting and organochlorine pesticides, PCBs and dioxins, cyanide, lead, mercury, selenium, and petroleum.

Fowler ME (1993)
Veterinary Zootoxicology
CRC Press, Boca Raton, FL

Provides facts, techniques, methodologies, and regimens for the more effective clinical management of animals poisoned or envenomated by other animals.

Gardner SC, Oberdörster E (Eds.) (2006)
Toxicology of Reptiles
CRC Taylor and Francis, Boca Raton, FL

A multi-authored textbook that provides an introduction to and current knowledge of reptile toxicology. Chapters discuss global threats to reptile populations, tools for assessing contaminant exposures and effects, contaminant effects on important organ systems and development. References for each chapter are up-to-date and extensive.

Gfeller RW, Messonnier SP (2004)
Small Animal Toxicology and Poisonings, 2nd Edition
Mosby, St. Louis, MO

An introductory textbook of clinical veterinary toxicology with a focus on dogs and cats. Toxicants are listed alphabetically and cover sources, mechanisms of action, clinical findings, and treatment. The target audience is emergency and critical care veterinarians. Suggested readings are provided for each toxicant but extensive references are not provided.

Gupta RC (Ed.) (2007)
Veterinary Toxicology: Basic and Clinical Principles
Elsevier, Academic Press, New York

A comprehensive book directed at not only veterinarians but also other health professionals addressing the issue of animal and human toxicology. Chapters address the diagnoses of poisoning from plants, animals, and chemicals. Other topics include target organ toxicity, radiation, FDA regulatory issues, and ethics in veterinary toxicology.

Humphreys D (1988)
Veterinary Toxicology, 3rd Edition
Bailliere Tindall, Philadelphia, PA

Compendium of information regarding agents used in veterinary practice. The agent groupings include minerals and inorganics, toxic gases and vapors, drugs, pesticides, poisonous plants, mycotoxins, venomous bites and stings, and radioactive materials.

Joint FAO/WHO Expert Committee on Food Additives
Residues of Some Veterinary Drugs in Animals and Foods: Monographs
Food and Agriculture Organization of the United Nations, Rome

Published periodically with the *FAO Food and Nutrition Paper* series. Summarizes the safety data on selected veterinary drug residues. Each monograph covers biological data of the drug, metabolism studies, and evaluations. Extensive bibliographies are included.

Joint FAO/WHO Expert Committee on Food Additives
Toxicological Evaluation of Certain Veterinary Drug Residues in Food
World Health Organization, Geneva

Published periodically within the *WHO Food Additives* series. Summarizes the safety data on selected veterinary drug residues. Each monograph covers biological data of the drug, toxicological studies, and evaluations. Extensive bibliographies are included.

Jubb KVE, Kennedy PC, Palmer N (1993)
Pathology of Domestic Animals (Vol. 1, 2 and 3)
Academic Press, San Diego, CA

A comprehensive, three-volume textbook of domestic animal pathology organized on an organ system basis. Covers degenerative, congenital, inflammatory, infectious, nutritional, neoplastic, traumatic, and toxicant-induced diseases.

Kahn CM (Ed.) (2005)
The Merck Veterinary Manual, 9th Edition
Merck and Company, Whitehouse Station, NJ

This veterinary medical textbook provides broad coverage of animal diseases and includes fairly extensive coverage of animal intoxications in a separate section of the manual. Multiple authors contribute to the information. No references are provided. The information is also accessible online at: http://www.merckvetmanual.com/mvm/index.jsp/.

Knight AP, Walker RG (2001)
A Guide to Plant Poisoning of Animals in North America
Teton NewMedia, Jackson, WY

A concise textbook of plants poisonous to North American animals. Plants are discussed on an organ system basis. The focus of the book is on the clinical problems associated with plant ingestion. Pictures of the plants and maps of their distribution are provided.

Lorgue G, Lechenet J, Riviere A, et al (1996)
Clinical Veterinary Toxicology
Blackwell, Oxford, UK

English-language edition of an original French publication, providing succinct advice on the management of animal poisoning.

Messonnier G (1997)
Handbook of Small Animal Toxicology and Poisonings
Mosby, St. Louis, MO

A portable handbook providing practitioners with ready access to information on all aspects of toxicoses and poisonings of dogs and cats, including patient assessment and management details.

Moats WA, Medina MB (Eds.) (1996)
Veterinary Drug Residues
American Chemical Society, Washington, DC

Covers drug residues in animal tissues because they may be toxic in food products, they may produce pharmacologic effects in consumers, or they may cause allergic reactions in sensitive individuals. The book points out the need to adhere to prescribed dosages and withdrawal times and warns against the use of unauthorized materials. A total of 18 chapters develop the topic in detail.

Murphy MJ (1996)
A Field Guide to Common Animal Poisons
Iowa State University Press, Ames, IA

A quick reference for veterinary practitioners and students. Discusses the prevalence of animal exposure to toxins, and provides treatment regimens, toxin summaries, selected bibliographies, additional sources of information, and indices of toxins.

Osweiler GD (1996)
Toxicology
Williams & Wilkins, Baltimore, MD

Presents an outline for independent study for the practicing veterinarian. The basic sections include the general principles of toxicology, how toxicants affect major body systems at the clinical level, and specific agents. The format of this book makes it useful to general toxicologists as well.

Osweiler GD, Carson TL, Buck WB, Van Gelder GA (1985)
Clinical and Diagnostic Veterinary Toxicology, 3rd Edition
Kendall/Hunt, Dubuque, IA

An older but still useful introductory textbook of basic and clinical veterinary toxicology. Directed toward the veterinary student for the purpose of discussing clinical and diagnostic areas. Following the presentation of basic toxicologic concepts, metals, feed-related toxicants, industry-related toxicants, antibacterials, fungicides, herbicides, insecticides, toxic gases, household and commercial products, biotoxins, and plant-related toxins are discussed.

Peterson ME, Talcott PA (Eds.) (2006)
Small Animal Toxicology, 2nd Edition
Elsevier Saunders, St. Louis, MO

A multi-authored comprehensive textbook of clinical veterinary toxicology with a focus on dogs and cats, although other species such as reptiles and birds are considered. General chapters cover toxicologic concepts, obtaining a clinical history, patient management, diagnosis of intoxications, adverse drug reactions, use of human poison control centers, and disaster management. Specific toxicants are covered in separate chapters. Reference lists are extensive.

Plumb DC (2005)
Veterinary Drug Handbook, 5th Edition
PharmaVet Inc., Stockholm, WI (worldwide print distribution by Blackwell Publishing Professional, Ames, IA)

A one-volume veterinary compendium including both drugs approved for veterinary species and non-approved drugs routinely used. The book includes adverse effects, warnings, overdosage, acute toxicity, and drug reactions.

Plumlee KH (Ed.) (2004)
Clinical Veterinary Toxicology
Mosby, St. Louis, MO

A multi-authored, comprehensive introductory textbook of veterinary toxicology covering the principles of toxicology, manifestations of toxicoses and specific toxicants of importance to veterinary medicine.

Roder JD (2001)
Veterinary Toxicology
Butterworth-Heinemann, Woburn, MA

An introductory textbook of veterinary toxicology providing an overview of veterinary toxicology, clinical presentations, and diagnosis of common veterinary toxicants according to affected organ systems, the pathophysiologic aspects of selected toxicant mechanisms and therapeutic approaches to the intoxicated patient. Limited references are provided.

Sundlof SF, Riviere JE, Craigmill AL, (Eds.) (1996)
Handbook of Comparative Pharmacokinetics and Residues of Veterinary Therapeutic Drugs
CRC Press, Boca Raton, FL

Data are presented on antimicrobial drugs, therapeutic agents, pesticides, growth promoters, and environmental contaminants. Information includes physicochemical constants and chemical structures, legal tissue tolerances, and pharmacokinetic parameters derived from the literature analysis.

Feed Additive Compendium 2006
Miller Publishing Company, Minnetonka, MN

Contains a complete listing of animal drugs approved by the FDA for inclusion in animal feeds along with inclusion rates. Regulatory issues related to inclusion of drugs in livestock feeds are discussed. Updated annually.

Journals

Clinical Toxicology (2005–)
Taylor and Francis, Philadephia, PA

The official journal of the American Academy of Clinical Toxicology and the European Association of Poisons Centres. Articles focus on human clinical toxicology but most of the articles are relevant to veterinary toxicology as well. It is a continuation of the *Journal of Toxicology Clinical Toxicology* (1982–2004).

Journal of Medical Toxicology (2005–)
University of Pennsylvania Press, Philadelphia, PA

The official journal of the American College of Medical Toxicology. Articles focus on the diagnosis, management, and prevention of poisoning/toxicity and other adverse health effects resulting from medications, chemicals, occupational and environmental substances, and biological hazards. The journal publishes original articles, illustrative cases, review articles, and other special features.

Journal of Toxicologic Pathology (1978–)
Taylor and Francis, Philadelphia, PA

The official journal of the Society of Toxicologic Pathologists. Articles focus on the multidisciplinary elements that constitute toxicologic pathology, including spontaneous and experimentally induced morphological and functional changes, environmental exposures, case reports, and risk assessment and investigative techniques. The journal publishes original articles, symposia papers, brief communications, current topic reviews, current issues, and fast-track articles.

Journal of Veterinary Diagnostic Investigation (1988–)
Allen Press, Lawrence, KS
Web: http://jvdi.org/

Articles pertain to all aspects of veterinary diagnostic science. The major disciplines are anatomical pathology, bacteriology/mycology, clinical pathology, epidemiology, immunology, laboratory information management, molecular biology, parasitology, public health, toxicology, and virology.

Veterinary and Human Toxicology (1977–2005)
Comparative Toxicology Laboratories, Kansas State University, Manhattan, KS

This journal published review and original research articles pertaining to human and veterinary toxicology.

Journal Articles

Carson TL (2000) Current knowledge of water quality and safety for livestock. Vet. Clin. North Am. Food Anim. Pract. 16(3): 455–464.

Cornell J, Weathers P, Pokras M, et al (1995) Poisonous plant identification: A comparison of databases designed for veterinary use. Vet. Hum. Toxicol. 37(5): 482–485.

Fleischli MA, Franson JC, Thomas NJ, et al (2004) Avian mortality events in the United States caused by anticholinesterase pesticides: a retrospective summary of National Wildlife Health Center records from 1980 to 2000. Arch. Environ. Contam. Toxicol. 46(4): 542–550.

Hoff B, Boermans HJ, Baird JD, et al (1998) Retrospective study of toxic metal analyses requested at a veterinary diagnostic toxicology laboratory in Ontario (1990–1995). Can. Vet. J. 39(1): 39–43.

Hovda LR, Hooser SB (2002) Toxicology of newer pesticides for use in dogs and cats. Vet. Clin. North Am. Small Anim. Pract. 32(2): 454–468.

Hungerford LL, Trammel HL, Clark JM, et al (1995) The potential utility of animal poisoning data to identify human exposure to environmental toxins. Vet. Hum. Toxicol. 37(2): 158–162.

Galey FD (2000) Diagnostic toxicology for the food animal practitioner. Vet. Clin. North Am. Food Anim. Pract. 16(3): 409–422.

Gwaltney-Brant SM, Rumbeiha WK (2002) Newer antidotal therapies. Vet. Clin. North Am. Small Anim. Pract. 32(2): 311–322.

Montforts MH (1999) Validaton of the exposure assessment for veterinary medicinal products. Sci. Tot. Environ. 225: 119–122.

Panter KE, James LF, Gardnes DR, et al (1999) Lupines, poison-hemlock and *Nicotiana* spp.: toxicity and teratogenicity in livestock. J. Nat. Toxins, 8(1): 117–134.

Petterino C, Paolo B (2001) Toxicology of various anticoagulant rodenticides to animals. Vet. Hum. Toxicol. 43(6): 353–360.

Plumlee KH, Galey FD (1994) Neurotoxic mycotoxins: a review of fungal toxins that cause neurologic disease in large animals. J. Vet. Int. Med. 8(1): 49–54.

Plumlee KH (2002) Plant hazards. Vet. Clin. North Am. Small Anim. Pract. 32(2): 383–396.

Poppenga RH (2000) Current environmental threats to animal health and productivity. Vet. Clin. North Am. Food Anim. Pract. 16(3): 544–558.

Poppenga RH (2002) Herbal medicine: potential for intoxication and interactions with conventional drugs. Clin. Tech. Small Anim. Pract. 17(1): 6–18.

Post LO, Keller WC (2000) Current status of food animal antidotes. Vet. Clin. North Am. Food Anim. Pract. 16(3): 445–454.

Volmer PA, Meerdinck GL (2002) Diagnostic toxicology for the small animal practitioner. Vet. Clin. North Am. Small Anim. Pract. 32(2): 357–366.

Organizations

American Academy of Veterinary and Comparative Toxicology
c/o Dr. Michelle Mostrom
North Dakota State University
182 Van Es Hall, PO Box 5406
Fargo, ND 58105
Phone: 701-231-7529
Fax: 701-231-7514
Email: michelle.mostrom@ndsu.nodak.edu

Organization that serves as an umbrella for veterinary toxicologists and veterinary forensic chemists. Provides educational programs to its members.

American Association of Veterinary and Laboratory Diagnosticians
AAVLD Secretary/Treasurer
c/o Dr. Alex Ardans
PO Box 1770
Davis, CA 95617
Phone: 530-752-9719
Fax: 30-752-5680
Email: areitz@cahfs.ucdavis.edu
Web: http://www.aavld.org/mc/page.do

The American Association of Veterinary Laboratory Diagnosticians (AAVLD) is a not-for-profit professional organization which seeks to: disseminate information relating to the diagnosis of animal diseases, coordinate diagnostic activities of regulatory, research and service laboratories, establish uniform diagnostic techniques, improve existing diagnostic techniques, and develop new diagnostic techniques.

American Board of Veterinary Toxicology
c/o Dr. Birgit Puschner
California Animal Health and Food Safety Laboratory
W. Health Science Drive
Davis, CA 95616
Phone: 530-752-6322
Fax: 530-752-3361
Web: http://www.abvt.org

Organization that certifies, by examination, veterinarians with training in veterinary toxicology.

American College of Toxicology
9650 Rockville Pike
Bethesda, Maryland 20814
Phone: (301) 634-7840
Fax: (301) 634-7852
Email: ekagan@actox.org /clemire@actox.org
Web: http://www.actox.org

The mission of the American College of Toxicology is to educate and lead professionals in industry, government, and related areas of toxicology by actively promoting the exchange of information and perspectives on the current status of safety assessment and the application of new developments in toxicology.

American Society for the Prevention of Cruelty to Animals National Animal Poison Control Center
Dana B. Farbman, CVT, Senior Manager, Client and Professional Relations
ASPCA Animal Poison Control Center
1717 South Philo Road, Suite #36
Urbana, IL 61802
Phone: 217-337-5030
Fax: 217-344-3586 (fax)
Email: napcc@aspca.org
Web: http://www.aspca.org/site/PageServer?pagename=pro_apcc

The ASPCA Animal Poison Control Center is dedicated to helping animals exposed to potentially hazardous substances by providing 24-hour veterinary diagnostic and treatment recommendations. The center conducts toxicology educational programs and non-traditional research.

The International Association of Forensic Toxicologists
Alain G. Verstraete, MD, Secretary
Laboratory of Clinical Biology-Toxicology
Ghent University Hospital
De Pintelaan 185-B-9000 Gent, Belgium
Phone: 32-9-240-3407
Fax: 32-9-240-4985
Email: alain.verstraete@ugent.be

An international association whose members are actively engaged in analytical toxicology or allied areas. The aims of the association are to promote cooperation and coordination of efforts among members and to encourage research in forensic toxicology. Its website has a compendium of therapeutic and toxic plasma drug and chemical concentrations, an archive of their bulletin and case notes and reviews.

Society of Toxicology
1821 Michael Faraday Drive, Suite 300
Reston VA 20190
Phone : (703) 438-3115
Fax : (703) 438-3113
Email : sothq@toxicology.org
Web: http://www.toxicology.org

The mission of the Society of Toxicology is to advance science to enhance human, animal, and environmental health through understanding of toxicology.

Databases

The internet is replete with information related to veterinary toxicology and is a rich resource for obtaining information quickly. Internet sources of information related to veterinary toxicology are too numerous to list, however some of the more important and reliable sites are listed below.

ATSDR Toxicology Profiles
Agency for Toxic Substances and Disease Registry
Department of Health and Human Services
Web: http://www.atsdr.cdc.gov/

By Congressional mandate, the Agency for Toxic Substances and Disease Registry (ATSDR) produces 'toxicological profiles' for hazardous substances found at National Priorities List (NPL) sites. These hazardous substances are ranked based on frequency of occurrence at NPL sites, toxicity, and potential for human exposure.

EXTOXNET
A cooperative effort of University of California-Davis, Oregon State University,

Michigan State University, Cornell University, and the University of Idaho.
Primary files are maintained and archived at Oregon State University.
Web: http://extoxnet.orst.edu/

The EXTOXNET InfoBase provides a variety of information about pesticides. Pesticide Information Profiles (PIPs) provide information on specific pesticides; Toxicology Information Briefs (TIBs) contain a discussion of certain concepts in toxicology and environmental chemistry. Other topic areas include: Toxicology Issues of Concern (TICs), Factsheets, News about Toxicology Issues, Newsletters, Resources for Toxicology Information, and Technical Information.

FishBase

A global information system covering just about everything on all known fish species. FishBase contains information for research scientists, fisheries managers, zoologists, and veterinarians.
Web: http://www.fishbase.org/search.php

Hazardous Substances Data Bank (HSDB)

Online database covering the toxicology of potentially hazardous chemicals.
Web: http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB

Poisonous Plant Database
U.S. Food and Drug Administration, Center for Food Safety and Nutrition
Web: http://www.cfsan.fda.gov/~djw/plantox.html

This database contains references to the scientific literature describing studies of the toxic properties and effects of plants and plant parts.

PubMed
U.S. National Library of Medicine, National Institutes of Health
Web: http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?DB=pubmed

PubMed is a database that includes over 16 million citations from MEDLINE and other life science journals for biomedical articles back to the 1950s. PubMed includes links to full-text articles and other related resources.

SCIRUS

Comprehensive science-specific search engine designed for scientists and researchers. It provides access to scientific, scholarly, technical, and medical data, as well as the latest reports, peer-reviewed articles, patents, preprints, and journals that other search engines miss. SCIRUS indexes and searches special sources such as ScienceDirect (access to full-text journals published by Elsevier Science), BioMed Cental (an independent online publishing house providing free access to the peer-reviewed biological and medical research it publishes), as well as other databases such as PubMed, the NASA Technical Reports databases and various other databases.
Web: http://www.scirus.com/srsapp/advanced/index.jsp

Toxicology Information for Veterinarians
A website sponsored by the Sir James Dunn Animal Welfare Center of the Atlantic Veterinary College.
Web: http://www.upei.ca/~toxinfo/news.htm

The website is part of an Atlantic Veterinary College, Animal Welfare Center-funded project to improve the care of poisoned animals throughout Atlantic Canada by providing veterinarians with reliable toxicologic information. It has sources of toxicologic information pertaining to animals, advice on sample collection for toxicologic analyses, and toxic dose calculations.

TOXNET
U.S. National Library of Medicine, National Institutes of Health
Web: http://toxnet.nlm.nih.gov

Contains databases on toxicology, hazardous chemicals, environmental health, and toxic releases.

USDA National Agricultural Library

USDA NAL lists a number of databases on biomedical research, biological science, animal science, veterinary medicine, fish and wildlife research, toxicology and specialized alternative methods.
Web: http://awic.nal.usda.gov/nal_display/index.php?info_center=3&tax_level=2&tax_subject=184&topic_id=1115&placement_default=0#T

Veterinary Gateway of Intute

Veterinary Gateway is a free online service providing access to the very best Web resources for education and research. The service is created by a network of UK universities and partners. Subject specialists select and evaluate the websites their database and write descriptions of the resources. The database contains over 110 000 records.
Web: http://www.intute.ac.uk/

Other Resources

Canadian Poisonous Plants Information System
Web: http://www.cbif.gc.ca/pls/pp/poison

The website presents data on plants that cause poisoning in livestock, pets, and humans. The plants include native, introduced, and cultivated outdoor plants as well as indoor plants that are found in Canada. Some food and herbal plants are also included that may cause potential poisoning problems.

Cornell Poisonous Plants
Web: http://www.ansci.cornell.edu/plants/

This is a website that includes plant images, pictures of affected animals and presentations concerning the botany, chemistry, toxicology, diagnosis, and prevention of poisoning of animals by plants and other natural flora.

Current Awareness in Clinical Toxicology

This is a monthly bibliography of recent toxicology-related articles in the scientific literature. It is a members-only benefit of the American Academy of Clinical Toxicology and is produced for the American Academy of Clinical Toxicology.

Food Animal Residue Avoidance Databank (FARAD)
Web: http://www.farad.org

FARAD is a computer-based decision support system designed to provide livestock producers, Extension specialists, and veterinarians with practical information on how to avoid drug, pesticide, and environmental contaminant residue problems.

Indiana Plants Poisonous to Livestock and Pets

Searchable database of poisonous plants produced by the Cooperative Extension Service, Purdue University.
Web: http://www.vet.purdue.edu/depts/addl/toxic/cover1.htm

VETTOX listserv
Restricted to members; moderator: Raisbeck@uwyo.edu/.

An online discussion group of veterinary toxicologists, chemists, and other veterinary health professionals.

Other poisonous plant databases
Web: http://vein.library.usyd.edu.au/links/toxicology.html#plantsus
Web: http://vein.library.usyd.edu.au/links/toxicology.html#plantsoz

PART

III

Other Resources Categorization

CHAPTER

62

Organizations

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INTRODUCTION

The organizations listed in this chapter are government agencies, professional societies, trade associations, research institutes, non-governmental organizations (NGOs), centers or departments of universities, and others involved with toxicology and human health and environmental risk assessment activities. They are primarily based in the United States, but select organizations from other countries have also been listed if judged to be of worldwide interest. Further information on organizations in countries outside the U.S. is available in the country chapters of this book. It is beyond the scope of this book to include all the relevant organizations within U.S. state, regional, and local jurisdictions.

Overlaps in jurisdiction exist among agencies with toxicology and related disciplines in their missions. For instance, a given chemical may be subjected to different regulatory requirements depending on its use (e.g., food additive, manufacturing solvent, or chemical emulsion) or on its classification (e.g., analytical reagent, stored as a bulk stock chemical, or chemical or toxic waste). This has led to some regulatory confusion among agencies and the industries they regulate, and has contributed to the public's lack of understanding about the science and policies related to chemicals and other materials in the environment. These complex and sometimes controversial issues are addressed by various interagency coordinating groups and councils, as listed under 'Special groups' at the end of this chapter.

The non-governmental organizations, typically designated as non-profit organizations, fall into two major categories: (i) special interest groups with a goal of providing information and perspectives to the public, policy- and decision makers, and elected officials, and (ii) public interest groups that attempt to serve as advocates and resources of information on issues. These organizations include professional associations and societies, independent and trade associations, accrediting and certifying boards, and private research and policy groups.

Individual industrial, consulting, and other for-profit toxicology-related organizations are generally not included in this chapter. However, many of the trade associations listed serve specific manufacturing and business interests, e.g., specific types of chemicals and consumer products.

Private industries are important sources of data and information related to toxicology and related disciplines of environmental and occupational medicine and health, with their websites often providing access to a wide range of information. For example, the Right-to-Know laws, Toxics Release Inventory (TRI) and emergency preparedness, and ISO 14000 environmental management standards have led to new sources data and information such as material safety data sheets (MSDSs), environmental auditing reports, and specific requirements for disclosure of environmental information in corporate annual reports and other documents. In upcoming years, compliance of companies with the European Union's Registration, Evaluation, Authorisation, and Restriction of Substances (REACH) legislation is expected to lead to large amounts of chemical- and product-related information being shared between companies, with government agencies, which will become accessible via websites such as the European Chemicals Agency (ECHA, www.echa.europa.eu/). Legislation similar to REACH is being

considered for other countries, e.g., the U.S. EPA's Chemical Assessment and Management Program (ChAMP, www.epa.gov/champ/) and will lead to additional important web-based sources of chemical-related information.

Adding to the complexity of seeking information on the regulatory and policy aspects of toxicology are the activities of state, county, and municipal agencies and departments in the United States. These agencies provide additional levels of regulatory compliance and support basic and applied scientific and technical research. For example, the Toxics Use Reduction Institute (TURI) at the University of Massachusetts Lowell has been a leader establishing chemical use policy and working with business to reduce the use of hazardous chemicals (www.turi.org). As mentioned earlier, it is beyond the scope of this book to provide a detailed inventory of environmental and health agencies for each state, territory, county, and municipality as has been provided for the federal government. However, the following major resources can be used to find local agencies:

- Association of State and Territorial Health Officials (ASTHO) (http://www.astho.org/)
- Environmental Council of the States (ECOS) (http://www.ecos.org/)
- National Association of Clean Air Agencies (http://www.4cleanair.org/index.asp.)
- National Association of Counties (NACo) (http://www.naco.org/)
- National Association of County and City Health Officials (NACCHO) (http://www.naccho.org/)
- National Conference of Local Environmental Health Administrators (NCLEHA) (http://www.ncleha.org/)
- National League of Cities (NLC) (http://www.nlc.org/).

The State and Local Government on the Net Directory (http://www.statelocalgov.net/) provides one-stop access to the official websites of thousands of state agencies and city and county governments.

EPA's American Indian Tribal Portal (http://www.epa.gov/tribalportal) offers links to many American Indian Organizations. The U.S. Department of Health and Human Service's (DHHS) Indian Health Service (http://www.epa.gov/tribalporta) is useful for finding links to organizations concerned with American Indian Health.

GuideStar (http://www.guidestar.com) is a good source for information about non-profit organizations.

Some sources to consider for locating additional organizations are:

DIRLINE
Web: http://dirline.nlm.nih.gov

From the U.S. National Library of Medicine (NLM), DIRLINE is an online database containing location and descriptive information about a wide variety of information resources such as organizations, research resources, projects, and databases concerned with health and biomedicine, toxicology included.

Gale Directory Library
Web: http://www.gale.cengage.com/Directory Library

Offers titles such as the *Encyclopedia of Associations*, the *Consulting and Consulting Organizations Directory*, and the *Encyclopedia of Governmental Advisory Organizations*.

LISTING OF ORGANIZATIONS

Academy of Toxicological Sciences (ATS)
Web: http://www.acadtoxsci.org/

The Academy of Toxicological Sciences (ATS) has certified toxicologists since 1981. The certification shows recognition from their peers about their expertise and sound scientific judgment, and these toxicologists are awarded the title of Fellow. The ATS vision is to be recognized as the leading international organization that certifies toxicologists based on their education, professional experience, demonstrated achievement, proven ability, and scientific expertise.

Agency for Toxic Substances and Disease Registry (ATSDR)
Web: http://www.atsdr.cdc.gov

ATSDR is an agency of the Centers for Disease Control and Prevention of the U.S. Department of Health and Human Services, with the mission of preventing exposure and adverse human health effects and diminished quality of life associated with exposure to hazardous substances from waste sites, unplanned releases, and other sources of pollution present in the environment. Functions include public health assessments of waste sites, health consultations concerning specific hazardous substances, health surveillance and registries, response to emergency release of hazardous substances, applied research in support of public health assessments, information development and dissemination, and education and training concerning hazardous substances. ATSDR develops toxicological profiles (http://www.atsdr.cdc.gov/toxpro2.html) for hazardous substances found at National Priority List sites and for the Department of Defense and the Department of Energy for substances related to federal sites. Within these documents, ATSDR develops minimal risk values (MRLs; see http://www.atsdr.cdc.

gov/mrls.html). Also available is ATSDR's ToxFAQs™ (http://www.atsdr.cdc.gov/toxfaq.html), a series of summaries about hazardous substances and their health effects. Information for this series is excerpted from the ATSDR Toxicological Profiles and Public Health Statements. The ATSDR Science Corner (http://www.atsdr.cdc.gov/cx.html) is a user-friendly gateway to environmental health information and resources.

Air and Waste Management Association (AWMA)
Web: http://www.awma.org

AWMA is a non-profit, technical and educational association with over 8000 members in over 65 countries. AWMA's vision is to be the premier international environmental organization promoting global responsibility. Members include toxicologists and others in industry, academia, government agencies, and elsewhere. It provides networking among government agencies at federal, state, county, and municipal levels and interactions among government agencies, industries, businesses, and academics. Publications include newsletters, a journal (*Journal of the Air & Waste Management Association*), and a publications catalog.

Alliance for Risk Assessment (ARA)
Web: http://allianceforrisk.org

The Alliance for Risk Assessment (ARA) is a collaboration of organizations that fosters the development of technical chemical risk assessment products and services, through a collaborative effort of specialists and organizations dedicated to protecting public health by improving the process and efficiency of risk assessment, and to increasing the capacity for developing risk values to meet growing demand. The ARA coordinates with Federal and State Agencies whenever possible, to ensure the best use of available resources, and to avoid duplication of effort.

American Academy of Clinical Toxicology (AACT)
Web: http://clintox.org

Members include physicians and others interested in clinical toxicology. AACT promotes the study of health effects of poisons on humans and animals, and unites into one group scientists and clinicians whose research, clinical, and academic experience focus on clinical toxicology. It fosters a better understanding of the principles and practice of clinical toxicology, and encourages development of new therapies and treatment in clinical toxicology. AACT facilitates information exchange among individual members and organizations interested in clinical toxicology, and defines the position of clinical toxicologists on toxicology-related issues. *Clinical Toxicology* is the official journal of the AACT, the European Association of Poisons Centres and Clinical Toxicologists, and the American Association of Poison Control Centers.

American Academy of Environmental Medicine (AAEM)
(Formerly the Society for Clinical Ecology)
Web: http://www.aaemonline.org/

Founded in 1965, this association of physicians and others interested in the clinical aspect of environmental medicine promotes an understanding of environmental illness and methods of controlling environmental illness. Produces educational aids such as tapes and audiovisual presentations and provides database searches and member information. Publications include a newsletter and the *Journal of Nutritional and Environmental Medicine*.

American Academy of Forensic Sciences (AAFS)
Web: http://www.aafs.org

The nearly 6000 members of AAFS are divided into ten sections spanning the forensic enterprise, and include physicians, attorneys, dentists, toxicologists, physical anthropologists, document examiners, psychiatrists, physicists, engineers, criminalists, educators, and others. Each AFFS section provides opportunities for professional development, personal contacts, awards, and recognition, and many sections publish periodic newsletters and mailings. Other AAFS publications include the *Journal of Forensic Sciences*.

American Association for Clinical Chemistry (AACC)
(Formerly the American Association of Clinical Chemists)
Web: http://www.aacc.org

AACC's members include clinical laboratory professionals, physicians, research scientists and other individuals involved with clinical chemistry and clinical laboratory science disciplines. It sponsors many scientific meetings each year and conducts an extensive government affairs program. AACC produces six periodicals and is also a major publisher of clinical laboratory science and practice books. The periodicals include *Clinical Chemistry* (AAC's flagship journal), *Clinical Laboratory News*, *Clinical & Forensic Toxicology News* (*CFT News*), and *AACC eNews.*

American Association for Laboratory Animal Science (AALAS)
Web: http://www.aalas.org

Non-profit organization whose mission is to serve society through education and the advancement of responsible laboratory animal care and use. Offers a certification program, training materials, and publishes

Comparative Medicine, the *Journal of the American Association for Laboratory Animal Science (JAALAS), TechTalk,* and *AALAS in Action.*

American Association of Occupational Health Nurses (AAOHN)
Web: http://www.aaohn.org

An organization of registered professional nurses employed in a variety of public and private settings that addresses occupational and environmental health matters. Provides a certification process for demonstrating specialty skills in occupational health nursing.

American Association of Poison Control Centers (AAPCC)
Web: http://www.aapcc.org

AAPCC member poison centers maintain a 24-hour Poison Help hotline. It is continuously staffed by pharmacists, physicians, nurses, and poison information providers who are toxicology specialists. The Poison Help hotline provides immediate access to poison exposure management instructions and information on potential poisons. AAPCC member poison centers provide educational outreach through the 1-800-222-1222 phone line to prevent poison emergencies. The general public may use the number to ask questions about the proper handling and ventilation related to household products, bites and stings, plants, over-the-counter and prescription medications, drugs, alcohol, hydrocarbons, carbon monoxide, and other types of potentially toxic fumes and gases. AAPCC maintains the only poison information and surveillance database in the United States. It offers real-time monitoring of unusual poisoning patterns, chemical exposures, and other potential public health hazards. AAPCC provides a network of toxicology experts ready to speak on more than 20 subject area specialties, including chemical and biological weapons, 'pharming' (the misuse of prescription drugs), carbon monoxide, and childhood poisoning. Media are invited to request expert interviews.

American Board of Clinical Metal Toxicology (ABCMT)
Web: http://abcmt.org/

Formerly the American Board of Chelation Therapy, The American Board of Clinical Metal Toxicology is dedicated to establishing and maintaining guidelines and standards for the practice of clinical metal toxicology and to the assurance of a superior level of competence on the part of physicians treating patients with this spectrum of expanding global afflictions. These standards are reflected in certification by the American Board of Clinical Metal Toxicology and by the requirement for periodic recertification.

American Board of Environmental Medicine (ABEM)
Web: http://www.americanboardofenvironmental-medicine.org/

The Board's mission is to establish and maintain the educational and testing criteria for board certification to ensure optimal standard and quality of the environmental physician.

American Board of Forensic Toxicology (ABFT)
Web: http://www.abft.org/

Forensic toxicology encompasses the measurement of alcohol, drugs, and other toxic substances in biological specimens and interpretation of such results in a medicolegal context. The purpose of the American Board of Forensic Toxicology is to establish and enhance voluntary standards for the practice of forensic toxicology and for the examination and recognition of scientists and laboratories providing forensic toxicology services.

American Board for Occupational Health Nurses Inc. (ABOHN)
Web: http://www.abohn.org/

The American Board for Occupational Health Nurses (ABOHN) was established as an independent nursing specialty certification board in 1972. ABOHN was formed to develop and conduct a program of certification for qualified occupational health nurses. ABOHN is a charter member of the American Board of Nursing Specialties (ABNS), a national approval body for nursing specialty certification programs.

American Board of Toxicology Inc. (ABT)
Web: http://www.abtox.org/

Members include toxicologists certified by this organization. The ABT was formed in 1979 to enhance the science of toxicology by establishing standards for professional practice by certification of individuals in general toxicology. The purposes for which the Board is organized are to encourage the study of the science of toxicology, to stimulate its advancement by establishing standards for professional practice, to prepare and administer procedures including tests for the implementation of such standards, and to confer recognition by certificates or otherwise upon those members of the profession who, measured against such standards, demonstrate competence.

American Board of Veterinary Toxicology (ABVT)
Web: http://www.abvt.org

The American Board of Veterinary Toxicology (ABVT) is an internationally recognized certifying body for veterinarians demonstrating broad knowledge and expertise in many aspects of toxicology. The Board is a

specialty organization of the American Veterinary Medical Association, established in 1967. The combination of veterinary training and expertise in toxicology has made Diplomates of ABVT unique and highly effective in a variety of careers. ABVT Diplomates play important roles in ensuring animal, human, and environmental health around the world.

American Chemistry Council (ACC)
(Formerly the Chemical Manufacturers Association)
Web: http://www.americanchemistry.com/

ACC is a trade association representing the U.S. chemical industry. Since 1988, members have improved their environmental, health, safety, and security performance through the Responsible Care initiative. Participation in Responsible Care, a global initiative, is mandatory for ACC member companies, all of which have made CEO-level commitments to uphold these program elements. Includes divisions on plastics, chlorine chemistry, and chemical products and technology. Publishes *American Chemistry* magazine.

American Chemical Society (ACS)
Web: http://www.acs.org

The American Chemical Society (ACS) is the world's largest scientific society and one of the world's leading sources of authoritative scientific information. A nonprofit organization, chartered by Congress, ACS is at the forefront of the evolving worldwide chemical enterprise and the premier professional home for chemists, chemical engineers, and related professions around the globe. Publisher of numerous journals including: *Chemical and Engineering News, Chemical Research in Toxicology, Environmental Science and Technology,* and *Nano Letters*. Includes a technical division on Chemical Toxicology (http://web.mit.edu/toxms/www/index.html). The mission of the ACS Green Chemistry Institute (http://www.acs.org/greenchemistry) is to advance the implementation of green chemistry principles into all aspects of the chemical enterprise.

American College of Laboratory Animal Medicine (ACLAM)
Web: http://www.aclam.org

The American College of Laboratory Animal Medicine (ACLAM) advances the humane care and responsible use of laboratory animals through certification of veterinary specialists, professional development, education, and research. Establishes standards of education, training, experience, and expertise necessary to become qualified as a specialist and recognizes that achievement through board certification.

American College of Medical Toxicology (ACMT)
Web: http://www.acmt.net

Medical toxicology is a medical subspecialty focusing on the diagnosis, management, and prevention of poisoning/toxicity and other adverse health effects due to medications, chemicals, occupational and environmental toxins, and biological agents, and is officially recognized as a medical subspecialty by the American Board of Medical Specialties. The American College of Medical Toxicology is a professional, non-profit association of physicians with recognized expertise in medical toxicology. The College is dedicated to advancing the science and practice of medical toxicology through a variety of activities.

American College of Occupational and Environmental Medicine (ACOEM)
Web: http://www.acoem.org

Founded in 1916, ACOEM is the nation's largest medical society dedicated to promoting the health of workers through preventive medicine, clinical care, research, and education. The College also conducts continuing education courses such as Basic Curriculum in Occupational Medicine and offers training in Drug/Alcohol Testing, Impairment and Disability Evaluation, and Board Review in Occupational Medicine.

American College of Toxicology (ACT)
Web: http://www.actox.org

The mission of the American College of Toxicology is to educate and lead professionals in industry, government, and related areas of toxicology by actively promoting the exchange of information and perspectives on the current status of safety assessment and the application of new developments in toxicology. ACT maintains an outstanding collection of toxicology-related links to its website. The ACT newsletter is available on the website, as are announcements of upcoming meetings. Publications include a newsletter and journal (*International Journal of Toxicology*, formerly the *Journal of American College of Toxicology*).

American College of Veterinary Pathologists
Web: http://www.acvp.org/about/

The American College of Veterinary Pathologists (ACVP) is an organization of board-certified scientists that has been setting the standard for veterinary pathology since 1949. By promoting excellence in veterinary pathology, ACVP improves and protects human and animal health for the betterment of society.

American Conference of Governmental Industrial Hygienists (ACGIH)
Web: http://www.acgih.org

ACGIH is a member-based organization and community of professionals that advances worker health and safety through education and the development and

dissemination of scientific and technical knowledge. Members include individuals interested in industrial hygiene and in exchanging ideas and promoting standards and techniques in industrial health. Publishes *Journal of Occupational and Environmental Hygiene*, and numerous other documents including the annual *Threshold Limit Values and Biological Exposure Indices*. Sponsors or co-sponsors many meetings and offers relevant courses related to industrial hygiene.

American Council on Science and Health (ACSH)
Web: http://www.acsh.org/

The American Council on Science and Health (ACSH) is a consumer education consortium concerned with issues related to food, nutrition, chemicals, pharmaceuticals, lifestyle, the environment, and health. ACSH is an independent, non-profit, tax-exempt organization.

American Industrial Hygiene Association (AIHA)
Web: http://www.aiha.org

AIHA is one of the largest international associations serving the needs of occupational and environmental health professionals practicing industrial hygiene in industry, government, labor, academic institutions, and independent organizations. It works in conjunction with the American Board of Industrial Hygiene to promote certification of hygienists; administers comprehensive education programs; and operates laboratory accreditation programs.

American Public Health Association (APHA)
Web: http://www.apha.org

The American Public Health Association is the oldest, largest, and most diverse organization of public health professionals in the world and has been working to improve public health since 1872. The Association aims to protect all Americans and their communities from preventable, serious health threats and strives to assure community-based health promotion and disease prevention activities and preventive health services are universally accessible in the United States. Publishes the peer-reviewed *American Journal of Public Health* and the newspaper *The Nation's Health*.

American Society for Clinical Pharmacology and Therapeutics (ASCPT)
Web: http://www.ascpt.org

The American Society for Clinical Pharmacology and Therapeutics (ASCPT) consists of professionals whose primary interest is to promote and advance the science of human pharmacology and therapeutics. The Society is the largest scientific and professional organization serving the discipline of Clinical Pharmacology. Publishes *Clinical Pharmacology and Therapeutics*.

American Society for Pharmacology and Experimental Therapeutics (ASPET)
Web: http://www.aspet.org

The American Society for Pharmacology and Experimental Therapeutics (ASPET) is a scientific society whose members conduct basic and clinical pharmacological research in academia, industry, and the government. Its members research efforts help develop new medicines and therapeutic agents to fight existing and emerging diseases. Publishes journals such as *Drug Metabolism and Disposition*, *the Journal of Pharmacology* and *Experimental Therapeutics,* and *Molecular Pharmacology*. Their Division for Toxicology serves members with interests in all aspects of toxicology.

American Type Culture Collection (ATCC)
Web: http://www.atcc.org/

ATCC is a private, non-profit biological resource center (BRC) and research organization whose mission focuses on the acquisition, authentication, production, preservation, development, and distribution of standard reference microorganisms, cell lines, and other materials for research in the life sciences.

(U.S.) Army Center for Health Promotion & Preventive Medicine
Web: http://chppm-www.apgea.army.mil

The mission of this center is to provide worldwide technical support for implementing preventive medicine, public health, and health promotion/wellness services into all aspects of America's Army and the Army Community anticipating and rapidly responding to operational needs and adaptable to a changing world environment.

Association of Environmental Health and Sciences (AEHS)
Web: http://www.aehs.com

AEHS was created to facilitate communication and foster cooperation among professionals concerned with the challenge of soil protection and cleanup. AEHS provides a network to exchange information across disciplines and affiliations sharing a common interest in the broadly defined area of soils and health.

Association of Government Toxicologists (AGT)
Web: http://www.agovtox.org

The AGT was founded in 1983 to promote and facilitate the acquisition and utilization of knowledge in toxicology and to provide opportunities for government toxicologists to meet and exchange ideas. Persons who are employed by the federal government and who are qualified in toxicology or a related field

are eligible to be full members. Persons who were once employed by the federal government, who are employed by a state government in a non-academic position, or who are full-time federal government contractors and who are qualified in toxicology or a related field are eligible to be associate members.

Association International de la Savonnerie, de la Detergence et des Produits d'Entretien
(Association for Soaps, Detergents and Maintenance Products, AISE)
Web: http://www.aise-net.org/

AISE is the official representative body of the soaps, detergents, and maintenance products industry in Europe. It supports the objectives and implementation of European legislation aimed at harmonizing and specifying standards to ensure the protection of consumers, customers, people at work, and the environment. The industry has also developed and participated in several voluntary safety-related initiatives to ensure the safety of its products.

Association of Occupational and Environmental Clinics (AOEC)
Web: http://www.aoec.org/

Established in 1987 to improve the practice of occupational and environmental health through information sharing and collaborative research. The chief long-term goal of AOEC is to facilitate the prevention and treatment of occupational and environmental illnesses and injuries through collaborative reporting and investigation of health problems. Publications include a newsletter.

Association of State and Territorial Health Officials (ASTHO)
Web: http://www.astho.org

Provides services and programs to coordinate broad health-related functions and activities at the local community level. ASTHO's Environmental Health Project is working with CDC's National Center for Environmental Health (NCEH) to enhance environmental health services within state public health agencies. Works with other national organizations dealing with health issues, such as the National Association of County and City Health Officials.

British Industrial Biological Research Association (BIBRA)
Web: http://www.bibra-information.co.uk/

A well-regarded British consulting firm addressing the majority of the problems experienced both by company managers with responsibility for toxicological safety, and toxicologists themselves, including everything to do with REACH legislation. They have developed an extensive toxicity databank, ToxLook, and TRACE, a bibliographic database in chemical toxicology, and publish the monthly *Toxicology and Regulatory News*.

Canadian Centre for Occupational Health and Safety (CCOHS)
Web: http://www.ccohs.ca

CCOHS is a Canadian federal government agency based in Hamilton, Ontario, which serves to support the vision of eliminating all Canadian work-related illnesses and injuries. CCOHS offers a variety of products and services, including OSH Works for online management of health and safety programs; courses offered online and on site; MSDS services; legislation services; webinars and conferences. Among their databases, some offered free, and some by subscription, are MSDS (and its French version FTSS), CHEMINFO, CHEMpendium, RTECS, ILO Encyclopedia of Occupational Health and Safety, and ChemIndex.. CCOHS, in cooperation with the International Program on Chemical Safety (IPCS) also offers the INCHEM suite of databases at http://www.inchem.org/.

Canadian Network of Toxicology Centres (CNTC)
Web: http://www.uoguelph.ca/cntc/

The CNTC is a national network of collaborating government and academic researchers. The goals include promoting communication among CNTC member scientists and the public and educating Canadians about toxicology.

Center for Health, Environment, and Justice (CHEJ)
Web: http://www.chej.org/

CHEJ, formerly the Citizens Clearinghouse for Hazardous Waste (CCHW), was founded in 1981 by Lois Gibbs, the leader of the campaign at Love Canal. This national group works to build healthy communities, with social justice, economic well-being, and democratic governance. They believe this can happen when individuals from communities have the power to play an integral role in promoting human health and environmental integrity. They have produced a wide variety of publications dealing with issues such as cancer clusters, asthma, brownfields, MTBE, indoor air pollution, poisoned schools, pesticides, and drinking water.

Center for Science in the Public Interest (CSPI)
Web: http://www.cspinet.org

A strong advocate for nutrition and health, food safety, alcohol policy, and sound science. CSPI carved out a niche as a voice of the American public on

nutrition, food safety, health, and other issues during a boom of consumer and environmental protection awareness in the early 1970s. CSPI has sought to educate the public, advocate government policies that are consistent with scientific evidence on health and environmental issues, and counter industry's influence on public opinion and public policies. Publisher of the *Nutrition Action Healthletter*.

Centers for Disease Control and Prevention, U.S. (CDC)
Web: http://www.cdc.gov

CDC's stated mission is to 'to promote health and quality of life by preventing and controlling disease, injury, and disability.' They have strong programs in environmental health (including toxic substances), emergency preparedness and response, and worker safety and health, among others. Publishes the *National Report on Human Exposure to Environmental Chemicals*. CDC's National Center for Environmental Health plans, directs, and coordinates a national program to maintain and improve the health of the American people by promoting a healthy environment and by preventing premature death and avoidable illness and disability caused by non-infectious, non-occupational environmental and related factors. Its Agency for Toxic Substances and Disease Registry (see above) is a major purveyor of information related to toxicology.

Chemical Industry Institute of Toxicology (CIIT)
(See The Hamner Institutes for Health Sciences)

Chemical Safety and Hazard Investigation Board, U.S.
Web: http://www.chemsafety.gov

The CSB is an independent federal agency charged with investigating industrial chemical accidents. It conducts root cause investigations of chemical accidents at fixed industrial facilities. The agency does not issue fines or citations, but does make recommendations to plants, regulatory agencies such as the Occupational Safety and Health Administration (OSHA) and the Environmental Protection Agency (EPA), industry organizations, and labor groups. Congress designed the CSB to be non-regulatory and independent of other agencies so that its investigations might, where appropriate, review the effectiveness of regulations and regulatory enforcement.

Children's Environmental Health Network (CEHN)
Web: http://www.cehn.org

CEHN is a national multi-disciplinary organization whose mission is to protect the fetus and the child from environmental health hazards and promote a healthy environment. To achieve this mission, CEHN works to promote the development of sound public health and child-focused national policy, stimulate prevention-oriented research, educate health professionals, policy makers and community members in preventive strategies, and elevate public awareness of environmental hazards to children.

Consumer Product Safety Commission, U.S. (CPSC)
Web: http://www.cpsc.gov

The U.S. Consumer Product Safety Commission is charged with protecting the public from unreasonable risks of serious injury or death from more than 15 000 types of consumer products under the agency's jurisdiction. The CPSC is committed to protecting consumers and families from products that pose a fire, electrical, chemical, or mechanical hazard or can injure children. CPSC's National Electronic Injury Surveillance System (NEISS) is a national probability sample of hospitals in the U.S. and its territories. Patient information is collected from each NEISS hospital for every emergency visit involving an injury associated with consumer products. From this sample, the total number of product-related injuries treated in hospital emergency rooms nationwide can be estimated.

Cosmetic Ingredient Review (CIR)
Web: http://www.cir-safety.org/

The Cosmetic Ingredient Review (CIR) was established in 1976 by the Cosmetic, Toiletry & Fragrance Association (CTFA) with support of the U.S. Food & Drug Administration and the Consumer Federation of America. Although funded by CTFA, CIR and the review process are independent from CTFA and the cosmetics industry. The Cosmetic Ingredient Review thoroughly reviews and assesses the safety of ingredients used in cosmetics in an open, unbiased, and expert manner, and publishes the results in the open, peer-reviewed scientific literature.

Cosmetic, Toiletry, and Fragrance Association (CTFA)
(See Personal Care Products Council)

(U.S.) Council on Environmental Quality (CEQ)
Web: http://www.whitehouse.gov/ceq/

The Council on Environmental Quality coordinates federal environmental efforts and works closely with agencies and other White House offices in the development of environmental policies and initiatives. In addition, CEQ reports annually to the President on the state of the environment; oversees federal agency implementation of the environmental impact assessment process; and acts as a referee when agencies disagree over the adequacy of such assessments.

CropLife International
Web: www.croplife.org

CropLife International is a global federation representing the plant science industry. They address international developments in the area of crop protection (pesticides), agbiotechnology (GMOs) and sustainable agriculture. CropLife America (http://www.croplifeamerica.org/) is the nation's largest trade organization for agriculture and pest management. They are the voice of the industry that ensures the safe and responsible use of pesticides in order to provide a safe, affordable, and abundant food supply.

U.S. Department of Agriculture (USDA)
(See also National Agricultural Library)
Web: http://www.usda.gov

USDA provides leadership on food, agriculture, natural resources, and related issues based on sound public policy, the best available science, and efficient management. Their Food Safety and Inspection Service (FSIS) is the public health agency responsible for ensuring that the nation's commercial supply of meat, poultry, and egg products is safe, wholesome, and correctly labeled and packaged, as required by the Federal Meat Inspection Act, the Poultry Products Inspection Act, and the Egg Products Inspection Act.

(U.S.) Department of Defense (DoD)
Web: http://www.defenselink.mil/

The U.S. Defense Department is involved in a fair number of projects involving toxicology and environmental health. A few examples of programs associated with or related to the DoD are – the Defense Department's Chemical, Biological, Radiological and Nuclear Defense Information Analysis Center (http://www.cbrniac.apgea.army.mil/); the Veterans Health Administration (http://www.1.va.gov/health/index.asp); Armed Forces Institute of Pathology (AFIP) (http://www.afip.org) (see above); the Army Environmental Command (http://aec.army.mil/usaec/); the Army's Edgewood Chemical Biological Center (http://www.edgewood.army.mil/); the Army's Research Institute of Environmental Medicine (http://www.usariem.army.mil/); the Navy's risk communication program (http://www-nehc.med.navy.mil/); the Air Force Center for Engineering and the Environment (http://www.afcee.brooks.af.mil/); and the Coast Guard's National Response Center (http://www.nrc.uscg.mil/nrchp.html).

(U.S.) Department of Energy (DOE)
Web: http://www.doe.gov

The Department of Energy's overarching mission is to advance the national, economic, and energy security of the United States; to promote scientific and technological innovation in support of that mission; and to ensure the environmental cleanup of the national nuclear weapons complex. DOE is charged with cleaning up contaminated sites and disposing of radioactive waste left behind as a byproduct of nuclear weapons production, nuclear-powered naval vessels, and commercial nuclear energy production. DOE must mitigate the risks and hazards posed by the legacy of nuclear weapons production and research. In addition, they must deal with the environmental legacy of the Cold War.

(U.S.) Department of Health and Human Services (DHHS)
(Also see other DHHS listings)
Web: http://www.hhs.gov

DHHS is the United States government's principal agency for protecting the health of all Americans and providing essential human services, especially for those who are least able to help themselves. Toxicology and environmental health-related activities are dispersed throughout many operating divisions of the Department, such as the National Institutes of Health (http://www.nih.gov), the Food and Drug Administration (http://www.fda.gov), and the Centers for Disease Control and Prevention (http://www.cdc.gov).

(U.S.) Department of Housing and Urban Development (HUD), Office of Healthy Homes and Lead Hazard Control (OHHLHC)
Web: http://www.hud.gov/offices/lead/index.cfm

The Office of Healthy Homes and Lead Hazard Control (OHHLHC) was established under the HUD to eliminate lead-based paint hazards in privately owned and low-income houses. The OHHLHC funds state and local governments to develop cost-effective ways to reduce lead-based paint hazards. Furthermore, the office enforces HUD's lead-based paint regulations, provides public outreach and technical assistance, and conducts technical studies to help protect children and their families from health and safety hazards in the home.

(U.S.) Department of Interior
Web: http://www.doi.gov

The Mission of the DOI is to protect and provide access to the US natural and cultural heritage and honor trust responsibilities to Indian Tribes and commitments to island communities. The DOI Interior has established five goals: (1) Resource Protection; (2) Resource Use; (3) Recreation; (4) Serving Communities; (5) Management Excellence. These broad goals also include dealing with effects of chemicals and toxic threats to plants and animals. The Fish and Wildlife Service (FWS) (http://www.fws.gov) is responsible for

the conservation and protection of fish and wildlife and their respective habitats, including the effects of pesticides, chemical contaminant, and other toxic threats to these resources. The U.S. Geological Survey (USGS) (http://www.usgs.gov) provides comprehensive geographic and cartographic services, including the production of resources and delivery of services to analyze chemicals in the environment, groundwater and aquifer protection, the movement of chemical contaminants through waters and soils.

(U.S.) Department of Justice, Environment and Natural Resources Division
Web: http://www.usdoj.gov/enrd/

Nearly one-half of the Division's lawyers bring cases against those who violate the nation's civil and criminal pollution-control laws. Others defend environmental challenges to government programs and activities and represent the United States in matters concerning the stewardship of the nation's natural resources and public lands.

(U.S.) Department of Transportation (DOT)
Web: http://www.dot.gov

The DOT's stated mission is 'to serve the United States by ensuring a fast, safe, efficient, accessible and convenient transportation system that meets our vital national interests and enhances the quality of life of the American people, today and into the future.' Its Pipeline and Hazardous Materials Safety Administration concerns itself with pipeline and hazardous materials failures (http://www.phmsa.dot.gov/).

Ecological and Toxicological Association of the Dyes and Organic Pigments Manufacturers
Web: http://www.etad.com/

ETAD represents manufacturers of synthetic organic colorants and strives towards minimizing possible impacts on health and the environment by economical means and encourages harmonization of health and environmental regulations in key geographical areas. It also promotes responsible environmental and health risk management measures during manufacture, transport, use, and disposal of synthetic organic colorant products. ETAD maintains a literature references database (http://www1.etad.com/index.htm) that offers member companies ready access to information resources in ETAD's areas of interest.

Environmental Defense Fund (EDF)
Web: http://www.edf.org

EDF covers a broad range of regional, national, and environmental issues. It is dedicated to protecting the environmental rights (e.g., clean air and water, healthy, nourishing food, and a flourishing ecosystem) of all people. EDF was the original creator of the popular website scorecard.org. In November 2005, EDF transferred ownership of Scorecard to Green Media Toolshed (GMT), a non-profit organization.

Environmental Health Research Foundation (EHRF)
Web: http://www.biomonitoringinfo.org/

The Environmental Health Research Foundation (EHRF) is a non-profit, non-partisan scientific research foundation seeking to improve the analysis and communication of health and environmental science.

Environmental Law Institute (ELI)
Web: http://www.eli.org

ELI has played a pivotal role in shaping the fields of environmental law, policy, and management within the U.S. and abroad. ELI is an internationally recognized, not-for-profit, research and education center. It provides training courses and seminars, research programs, and policy recommendations. ELI advances innovation and solutions to environmental challenges via several publications such as 'Environmental Law Reporter®,' 'The Environmental Forum,' 'National Wetlands Newsletter,' and books on environmental law and policy.

Environmental Mutagen Society (EMS)
Web: http://www.ems-us.org

The EMS has been the primary scientific society that has fostered research on the basic mechanisms of mutagenesis as well as on the application of this knowledge in the field of genetic toxicology. The EMS is affiliated with the International Association of Environmental Mutagen Societies (IAEMS; http://www.iaems.net/). The membership is composed of a unique mix of academic, government, and industrial scientists and policy makers. In addition, the EMS publishes a peer-reviewed journal *Environmental and Molecular Mutagenesis*.

Environmental & Occupational Health Sciences Institute (EOHSI)
Web: http://eohsi.rutgers.edu

A joint institute of the Robert Wood Johnson Medical School and Rutgers University, EOHSI develops environmental and occupational health education materials for schools, the workplace, and community, including videos and teaching guides, fact sheets, and newsletters. EOHSI is an international resource for basic and clinical research in environmental health sciences and exposure assessment and promotes environmental health education and public policy.

(U.S.) Environmental Protection Agency (EPA)
Web: http://www.epa.gov

Founded in 1970, the mission of the US EPA is to protect human health and environment. Of particular relevance to toxicology and risk assessment are: The National Center for Environmental Assessment (NCEA; http://cfpub.epa.gov/ncea/), and the Office of Pollution Prevention and Toxics (OPPT) (http://www.epa.gov/oppt/) which manages programs under the Toxic Substances Control Act (TSCA) and the Pollution Prevention Act (PPA) of 1990. It also manages a variety of environmental stewardship programs that encourage companies to reduce and prevent pollution. EPA's numerous databases are described in the Databases section of this book. They include the Integrated Risk Information System and the Toxics Release Inventory. The EPA National Library Network (http://www.epa.gov/libraries/) provides access to information about the environment and related scientific, technical, management, and policy information.

Environmental Research Foundation
Web: http://www.rachel.org/

The Environmental Research Foundation was founded in 1980. It supports grassroots activists working on toxics and social justice issues through the publication of *Rachel's News* and the *Precaution Reporter*. They work to prevent harm to the environment and human health and providing resources to environmental justice (EJ) community groups to better protect their local communities. Their mission is justice and sustainable prosperity for all people.

ERASM (Environmental Risk Assessment and Management)
Web: http://www.erasm.org/

This joint platform of the European detergent and surfactants producers represented by their associations AISE (Association Internationale de la Savonnerie, de la Détergence et des Produits d'Entretien) and CESIO (Comité Européen des Agents Surface et de leurs Intermédiaires Organiques), initiates and co-ordinates joint industry activities for improving and enlarging the basis for and the knowledge about the risk assessment of detergent-based surfactants in environmental compartments.

Environmental Working Group
Web: http://www.ewg.org/

The mission of the Environmental Working Group (EWG) is to use the power of public information to protect public health and the environment. EWG specializes in providing useful resources (like Skin Deep and the Shoppers' Guide to Pesticides in Produce) to consumers while simultaneously pushing for national policy change.

Environment Canada
Web: http://www.ec.gc.ca

Environment Canada (EC) is the federal government environmental agency in Canada that is mandated to preserve and enhance the quality of the natural environment; conserve Canada's renewable resources; conserve and protect Canada's water resources; forecast weather and environmental change; enforce rules relating to boundary waters; and coordinate environmental policies and programs for the federal government.

European Association of Poisons Centres and Clinical Toxicologists (EAPCCT)
Web: http://www.eapcct.org

Members include clinical toxicologists and others. The purpose is to improve interactions between clinical toxicologists and poison information specialists. Publishes a newsletter and the journal *Clinical Toxicology*. 'EAPCCT unites clinical toxicologists in poisons centers, universities, hospitals, or in government agencies and encourage research into all aspects of poisoning … it facilitates the collection, exchange and dissemination of relevant information among individual members, poisons centres and organisations interested in clinical toxicology. It also promotes training and set standards for the practice of, clinical toxicology and encourages professional standards in poisons centres and in the management of poisoned patients. Collaboration with international and integrational organizations such as World Health Organization (WHO) and European communities forms the basis of this organization's project works.'

European Centre for Ecotoxicology and Toxicology of Chemicals (ECETOC)
Web: http://www.ecetoc.org/

ECETOC is a scientific, non-profit-making, non-commercial trade association with a mission to act as an independent, credible, peer-reviewed technical resource to all concerned with the identification of research needs and provision of scientific rationale for the assessment of health effects and environmental impact, and thereby to justify industry's licence and freedom to operate. Publishes Joint Assessment of Commodity Chemicals (JACC) reports and other useful publications, and convenes task forces to investigate toxicological issues.

European Chemical Industry Council (CEFIC)
Web: http://www.cefic.be

CEFIC is both the forum and the voice of the European chemical industry. Members are chemical federations

and manufacturers, and it represents, directly or indirectly, chemical companies that account for nearly a third of world chemical production. It has numerous working groups related to chemical safety and the regulation of chemicals, and sponsors research related to toxicology and other risk assessment.

European Chemicals Agency (ECHA)
Web: http://ec.europa.eu/echa/home_en.html

The ECHA is managing the Registration, Evaluation, Authorisation and restriction of CHemicals (REACH) legislation processes for existing and new chemical substances to ensure consistency across the European Union. These REACH processes are designed to provide additional information on chemicals, to ensure their safe use, and to ensure competitiveness of the European industry.

European Commission (EC)
Web: http://www.europa.eu.int

Since the Seveso accident in northern Italy in 1977 contaminated a large area with a highly toxic dioxin, increasingly stringent measures have been taken by the European Commission to reduce the risks arising from the manufacture and disposal of chemical substances. Begun in 1986, the European Inventory of Existing Chemical Substances (EINECS) has similar objectives to those of the Toxic Substances Control Act (TSCA) of the United States. EINECS lists all marketed chemical products in the EU, enabling them to be subject to a general procedure for notification, evaluation, and control. The European Commission also maintains the Environmental Chemicals Data and Information Network (ECDIN) databank (http://ecdin.etomep.net). Searchable by chemical name of CAS number, ECDIN 'is designed as an instrument which will enable people engaged in environmental management and research to obtain reliable information on chemical products.'

European Commission, Joint Research Centre (JRC)
Web: http://ec.europa.eu/dgs/jrc/

The Joint Research Centre is a research-based policy support organization and an integral part of the European Commission. The JRC provides the scientific advice and technical know-how to support a wide range of EU policies. Its Institute for Health and Consumer Protection (IHCP) provides scientific support for the development and implementation of EU policies related to health and consumer protection. The IHCP carries out research to improve the understanding of potential health risks posed by chemicals, biocides, genetically modified organisms, contaminants released from food contact materials and consumer products. Of special interest are its Institute for Environment and Sustainability and Institute for Health and Consumer Protection. The latter supports work related to Chemicals (REACH) and biocides, modified organisms, cosmetics and animal welfare, consumer products, and food and food-contact materials. JRC's European Centre for the Validation of Alternative Methods (ECVM) promotes the scientific and regulatory acceptance of non-animal tests which are of importance to biomedical sciences, through research, test development and validation and the establishment of a specialized database service.

European Environmental Mutagen Society (EEMS)
Web: http://www.eems-eu.org/eems/default.csp

Members include industry and university laboratories and research centers. Promotes research in genetic toxicology and environmental mutagenesis. Affiliated with the Environmental Mutagen Society and International Association of Environmental Mutagen Societies. Publishes a journal entitled, *European Journal of Genetic and Molecular Toxicology*, a newsletter and other documents.

European Food Safety Authority (EFSA)
Web: http://www.efsa.europa.eu

EFSA's goals is to have a global presence and a recognized agency for risk assessment on food and feed safety, animal health and welfare, nutrition, plant protection and plant health. In the European food safety system, risk assessment is independent of risk management. EFSA as the risk assessor of the food science, produces scientifically valid opinions and advice to provide a sound foundation for European policies and legislation and supports the European Commission, European Parliament, and EU Member States in having effective and timely risk management decisions.

European Science Foundation (ESF)
Web: http://www.esf.org

Working on behalf of its principal stakeholders – the member organizations and thereby Europe's scientific community – ESF considers hundreds of research proposals for programs and awards each year; publishes a wide range of position papers and briefings; and organizes workshops, conferences, and symposia as key elements of its role in ensuring that the voice of European science is heard on major policy and other issues affecting Europe's scientific community.

European Society of Toxicologic Pathology (ESTP)
Web: http://www.eurotoxpath.org

ESTP's goals are to organize scientific annual meetings, obtain more visibility by authorities/agencies, actively promote toxicologic pathology, contribute to guidelines by comments and proposals, participate in scientific working groups (e.g. historical tumor control data), offer training courses in toxicological pathology and related fields, and collaborate with the other Societies of Toxicological Pathology. It publishes a journal entitled *Experimental and Toxicologic Pathology*.

European Society of Toxicology in Vitro (ESTIV)
Web: http://www.estiv.org/

ESTIV aims to promote in vitro toxicology, both scientifically and educationally, in all countries of Europe. Organizes INVITOX congress and publishes the journal *Toxicology In Vitro*.

EUROTOX (Federation of European Toxicologists & European Societies of Toxicology)
Web: http://www.eurotox.com/

EUROTOX aims to foster toxicology, both scientifically and educationally, in all countries of Europe. To this, EUROTOX organizes an annual scientific congress, workshops, and postgraduate training courses. Specific activities are organized by the EUROTOX Specialty Sections. EUROTOX is actively harmonizing toxicology education and training, having established the European Register of Toxicologists in 1994.

EXtension TOXicology NETwork (EXTOXNET)
Web: http://extoxnet.orst.edu/

This network is a cooperative effort among various universities (University of California at Davis, Oregon State University, Michigan State University, and Cornell University) to stimulate dialog on toxicology issues and to make toxicology information available. Various types of pesticide toxicology and environmental chemistry information are available, including discussions of toxicological issues of concern (TICs), toxicology newsletters, other resources for toxicology information, toxicology fact sheets, Pesticide Information Profiles, and Toxicology Information.

(U.S.) Federal Bureau of Investigation (FBI), FBI Laboratory Services
Web: http://www.fbi.gov/hq/lab/labhome.htm

FBI Laboratory personnel provide forensic examinations, technical support, expert witness testimony, and training, to federal, state, and local law enforcement agencies. Operational Response activities include Chemical Biological Sciences, Explosives, Evidence Response Team, and Hazardous Material Response.

(U.S.) Federal Emergency Management Agency (FEMA)
Web: http://www.fema.gov

On March 1, 2003, the Federal Emergency Management Agency (FEMA) became part of the U.S. Department of Homeland Security (DHS). The primary mission of the Federal Emergency Management Agency is to reduce the loss of life and property and protect the Nation from all hazards, including natural disasters, acts of terrorism, and other man-made disasters, by leading and supporting the Nation in a risk-based, comprehensive emergency management system of preparedness, protection, response, recovery, and mitigation.

Federation of American Societies for Experimental Biology (FASEB)
Web: http://www.faseb.org

The Federation of American Societies for Experimental Biology (FASEB) advances biological science through collaborative advocacy for research policies that promote scientific progress and education and lead to improvements in human health. Among the member societies are the American Physiological Society, American Society for Biochemistry and Molecular Biology, American Society for Pharmacology and Experimental Therapeutics, American Society for Investigative Pathology, and the American Society for Cell Biology.

Flavor and Extract Manufacturers Association of the United States (FEMA)
Web: http://www.femaflavor.org/

FEMA furthers the business interests of its members through a sound scientific program designed to promote the safe use of flavors, and fosters a global environment in which the flavor industry can create, innovate, and compete. Members include companies manufacturing and selling food flavors and extracts. The Expert Panel of the Flavor and Extract Manufacturers Association (FEMA) has served as the primary body for the safety evaluation of food flavorings for the flavor industry, and the public through its 'generally recognized as safe' (GRAS) assessment of flavoring substances.

Food and Agriculture Organization of the United Nations (FAO)
Web: http://www.fao.org

The FAO of the United Nations leads international efforts to defeat hunger by serving both developed

and developing countries. It also acts as a neutral forum where all UN member nations meet to negotiate agreements and debate policy. Further, it serves as a source of knowledge and information which helps developing countries and countries in transition modernize and improve agriculture, forestry, and fisheries practices and ensure good nutrition for all. FAO also undertakes reviews of hazards of food and food additives. FAO's Food Quality and Standards Service (AGNS) is committed to the enhancement of food safety and quality along the food chain at international, regional and national levels, with the aim of protecting consumers and promoting the production and trade of safe, quality food.

(U.S.) Food and Drug Administration (FDA)
Web: http://www.fda.gov

The FDA is responsible for protecting the public health by assuring the safety, efficacy, and security of human and veterinary drugs, biological products, medical devices, our nation's food supply, cosmetics, and products that emit radiation. The FDA is also responsible for advancing the public health by helping to speed innovations that make medicines and foods more effective, safer, and more affordable; and helping the public get the accurate, science-based information they need to use medicines and foods to improve their health.

The following centers operate under FDA.

Center for Drug Evaluation and Research (http://www.fda.gov/cder/)
The Center for Biologics Evaluation and Research (http://www.fda.gov/cber/)
The Center for Food Safety and Applied Nutrition (http://www.cfsan.fda.gov/)
The Center for Devices and Radiological Health (http://www.fda.gov/cdrh/)
The National Center for Toxicological Research (http://www.fda.gov/nctr)

(U.S.) Food and Drug Administration (FDA), National Center for Toxicological Research (NCTR)
Web: http://www.fda.gov/nctr

NCTR conducts peer-reviewed scientific research and provides expert technical advice and training that enable FDA to make sound science-based regulatory decisions and improve the health of the American people. The research is focused towards FDA's goals: (1) to understand critical biological events in the expression of toxicity and (2) to develop and characterize methods, and incorporate new technologies to improve the assessment of human exposure, susceptibility, and risk.

(U.S.) FDA Center for Food Safety and Applied Nutrition
Web: http://www.cfsan.fda.gov/list.html

The Center for Food Safety and Applied Nutrition (CFSAN) maintains a comprehensive intramural research program that provides the cornerstone for regulatory decisions, enforcement activities, and the development, implementation, or evaluation of CFSAN policies. Research knowledge plays a major role in reducing levels of foodborne illness in the United States and helps to ensure food safety and food defense, the safety of cosmetic products, and enhance the ability of consumers to make sound nutrition choices.

Friends of the Earth (FoE)
Web: http://www.foe.org

FoE is an environmental advocacy group with international affiliates worldwide. Topics addressed include toxic chemicals, nuclear hazards, groundwater contamination, pesticides, environmental policy development.

Genetic Toxicology Association (GTA)
Web: http://www.gta-us.org/

GTA's primary purpose is to promote the development of the science of genetic toxicology and to foster the exchange and dissemination of information concerning the field.

Green Media Toolshed
Web: http://www.greenmediatoolshed.org/

Makes available SCORECARD, which provides information on pollution problems and toxic chemicals.

Greenfacts
Web: http://greenfacts.org/

Greenfact's mission is to bring and share complex scientific consensus reports on health and the environment to non-specialists. Their objective is to become the preferred online source of scientific information for journalists, decision makers, stakeholders, teachers, and concerned individuals. They publish reports and digests in the field of emerging toxicological and environmental sciences areas (e.g., nanotoxicology, climate change, etc.)

Greenpeace
Web: http://www.greenpeace.org/international

Greenpeace is an independent global campaigning organization that acts to change attitudes and behavior, to protect and conserve the environment and to promote peace.

Hamner Institutes for Health Sciences
Web: http://www.thehamner.org

An independent non-profit toxicology research institute whose members include chemical, pharmaceutical, and other corporations. Activities include research related to human risk assessments of chemicals, e.g., development and validation of testing methods, development of data used in risk assessments, and the doctoral and postdoctoral training of toxicologists. Publishes a newsletter and other information-sharing documents, and also publishes its original research in peer-reviewed journals and elsewhere. Chemical Industry Institute of Toxicology (CIIT) and Institute for Translational Biomedical Sciences (ITBS) are two institutes under Hamner Institutes.

Harvard Center for Risk Analysis (HCRA)
Web: http://www.hcra.harvard.edu/

HCRA's research is focused broadly on developing risk, economic, and decision analysis methods that are well-grounded in the natural and social sciences. They use these methods to provide insights useful for informing real-world decisions. Their work draws on diverse disciplines including epidemiology, toxicology, environmental science and engineering, decision theory, cognitive psychology, applied mathematics, statistics, and economics. Areas of practical application include risks from air pollutants such as particulate matter, ozone, and mercury; conventional and toxic water and waste pollutants; and emerging issues such as nanomaterials and low-level pharmaceuticals in the environment.

Health Canada
Web: http://www.hc-sc.gc.ca

Health Canada is the federal government department responsible for helping Canadians maintain and improve their health, making Canada's population among the healthiest in the world based on longevity, lifestyle choices, and effective use of the Canada's public healthcare system. Health Canada conducts ongoing consultations with Canadians to determine how to best meet their long-term healthcare needs. Further, it communicates information about disease prevention to protect Canadians from avoidable risks. Additionally, it encourages Canadians to take an active role in their health, such as increasing their level of physical activity and eating well. The Health Canada website has relevant information related to environmental public health, health risk assessments, toxicology, air quality (indoor and outdoors), and water quality.

Health Effects Institute (HEI)
Web: http://healtheffects.org

HEI is a non-profit corporation chartered in 1980 as an independent research organization to provide high-quality, impartial, and relevant science on the health effects of air pollution. Typically, HEI receives half of its core funds from the US Environmental Protection Agency and half from the worldwide motor vehicle industry.

HERA (Human and Environmental Risk Assessments)
Web: http://www.heraproject.com/

A voluntary industry program to carry out human and environmental risk assessments on ingredients of household cleaning products.

In Vitro Testing Industrial Platform (IVTIP)
Web: http://www.ivtip.org

IVTIP is a forum of European companies with an active interest in in vitro testing to be used in regulatory/safety testing or to be used in the compound discovery and development process. They are also supportive of applying, where possible, the principle of the 3Rs: replacing, reducing, and refining animal testing. Their members represent companies in the chemical, cosmetics, and pharmaceutical sector.

INFOTERRA
Web: http://www.unep.org/infoterra/

INFOTERRA is the global environmental information exchange network of the United Nations Environment Programme. The network operates through a system of government-designated national focal points. An INFOTERRA national focal point is essentially a national environmental information centre usually located in the ministry or agency responsible for environmental protection. The primary function of each centre is to provide a national environmental information service.

Institute for Children's Environmental Health
Web: http://www.iceh.org/

The Institute for Children's Environmental Health (ICEH), founded in 1999, is a non-profit educational organization working to ensure a healthy, just, and sustainable future for all children. ICEH's primary mission is to foster collaborative initiatives to reduce and ultimately eliminate environmental exposures that can undermine the health of current and future generations.

Institute for Risk Research (IRR) and Network for Environmental Risk Assessment and Management (IRR-NERAM)
Web: http://www.irr-neram.ca/

IRR and NERAM are networks of expertise in risk management for the environment (NERAM) and risk in general (IRR). Both networks are funded by partners in industry and government as well as from research contracts, and sale of publications. All work done is peer-reviewed and published to ensure that all activities are

fully independent and of the highest quality. According to opportunities for support, the two networks sponsor conferences, workshops, and in-house research.

International Academy of Oral Medicine and Toxicology (IAOMT)
Web: www.iaomt.org

The IAOMT is a network of dental, medical, and research professionals who seek to raise the standards of scientific biocompatibility in the dental practice with information from the latest interdisciplinary research.

International Academy of Toxicologic Pathology (IATP)
Web: http://www.iatpfellows.org/

The purpose of the International Academy of Toxicologic Pathology (IATP) is to recognize and accredit highly accomplished toxicologic pathologists to ensure the competence and experience of professional practitioners whose work affects the public welfare throughout the world.

International Agency for Research on Cancer (IARC)
Web: http://www.iarc.fr

IARC's mission is to coordinate and conduct research on the causes of human cancer, the mechanisms of carcinogenesis, and to develop scientific strategies for cancer control. The Agency is involved in both epidemiological and laboratory research and disseminates scientific information through publications, meetings, courses, and fellowships.

International Association of Environmental Mutagen Societies (IAEMS)
Web: http://www.iaems.net/

The International Association of Environmental Mutagen Societies (IAEMS) is a global organization composed of 11 regional Environmental Mutagen Societies around the world. The IAEMS helps to sponsor a variety of international conferences.

International Association of Forensic Toxicologists (TIAFT)
Web: http://www.tiaft.org/

The aims of the association are to promote cooperation and coordination of efforts among members and to encourage research in forensic toxicology. The members come from the police force, medical examiners and coroners' laboratories, horseracing and sports doping laboratories, hospitals, departments of legal medicine, pharmacology, pharmacy, and toxicology.

International Association of Therapeutic Drug Monitoring and Clinical Toxicology (IATDMCT)
Web: http://www.iatdmct.org

IATDMCT's aims include promotion of knowledge and understanding of clinical drug analysis and interpretation of results, and encouragement of the effective application of therapeutic drug monitoring and clinical toxicology.

International Council of Chemical Associations (ICCA)
Web: http://www.icca-chem.org

The International Council of Chemical Associations (http://www.icca-chem.org/) is the global voice of the chemical industry, representing chemical manufacturers and producers. ICCA promotes and coordinates Responsible Care® and other voluntary chemical industry initiatives and has a central role in the exchange of information within the international industry and in the development of position statements on matters of policy. It is also the main channel of communication between the industry and various international organizations that are concerned with health, environment, and trade-related issues.

(The) International Council On Nanotechnology (ICON)
Web: http://icon.rice.edu

The ICON is managed by Rice University's Center for Biological and Environmental Nanotechnology. It promotes effective nanotechnology stewardship through risk assessment, research, and communication. The ICON Environmental, Health and Safety (EHS) Database is part of the Virtual Journal format and contains summaries (abstracts) and citations for research.

International Dose–Response Society Environmental Health Sciences Program
Web: www.dose-response.org

The International Dose–Response Society is dedicated to the enhancement, exchange, and dissemination of ongoing global research in hormesis, a dose–response phenomenon characterized by low-dose stimulation and high-dose inhibition.

Intergovernmental Forum on Chemical Safety (IFCS)
Web: http://www.who.int/ifcs/en

Concerned with the sound management of chemicals, the IFCS is a unique, over-arching mechanism to develop and promote strategies and partnerships among national governments, intergovernmental and non-governmental organizations. It contributes to the implementation of the Strategic Approach to International Chemicals Management (SAICM) and the

work of other chemicals-related international organizations and institutions.

International Fragrance Association (IFRA)
Web: http://www.ifraorg.org

Research and development, scientific findings, health and safety concerns as well as environmental protection are at the heart of IFRA's concerns. Together with the industry's scientific arm the Research Institute for Fragrance Materials (RIFM), IFRA ensures that the establishment of usage standards for fragrance materials is put into practice according to available scientific recommendations, and that all member companies comply with those Standards.

International Labour Organization (ILO)
Web: http://www.ilo.org

ILO's main aims are to promote rights at work, encourage decent employment opportunities, enhance social protection and strengthen dialog in handling work-related issues. ILO's SAFEWORK component is concerned with such areas of action as hazardous work, chemical safety, occupational safety and health, and drugs and alcohol. The International Occupational Safety and Health Information Centre (CIS) (http://www.ilo.org/public/english/protection/safework/cis/) is the knowledge management arm of SAFEWORK. CIS publishes the ILO Encyclopedia and the International Chemical Safety Cards, among other documents.

International Life Sciences Institute (ILSI)
Web: http://www.ilsi.org

ILSI is a non-profit scientific research and educational foundation sponsored by various food, chemical, pharmaceutical, and other companies. Headquarters are in Washington, DC with offices (branches) around the world. Issues covered include those in toxicology, animal pathology, risk assessment, water quality, the environment, food safety, and nutrition. Offices worldwide focus on issues of regional and country-specific importance. Includes the ILSI Health and Environmental Sciences Institute focusing on environmental issues. Publishes numerous books and other documents.

International Maritime Organization (IMO)
Web: http://www.imo.org

IMO's main task has been to develop and maintain a comprehensive regulatory framework for shipping and its remit today includes safety, environmental concerns, legal matters, technical co-operation, maritime security, and the efficiency of shipping. Has developed the International Maritime Dangerous Goods (IMDG) Code.

International Neurotoxicology Association
Web: http://www.neurotoxicology.org

Promotes research and awareness in the areas of neurotoxicology, and organizes international conferences in the broad areas of neurotoxicology.

International Programme on Chemical Safety (IPCS)
Web: http://www.who.ch/pcs

IPCS is a joint program of the World Health Organization, the International Labour Organisation, and the United Nations Environment Program. IPCS' major activities involve: Evaluation of chemical risk to human health (involving preparation and publication of chemicals assessments, development and harmonization of scientifically sound methods for chemicals assessment, and evaluating the safety of food components, constituents, additives and residues of pesticides and veterinary drugs); poisons information, prevention, and management; chemicals incidents and emergencies; and capacity building.

International Radiation Protection Association (IRPA)
Web: http://www.irpa.net/

IRPA is the worldwide association for members of affiliated national or regional associate societies. The purpose of IRPA is 'to provide a medium whereby those engaged in radiation protection activities in all countries may communicate more readily with each other and through this process advance radiation protection in many parts of the world.'

International Society for Environmental Epidemiology (ISEE)
Web: http://www.iseepi.org

Topics addressed by ISEE members include environmental exposures (e.g. air pollution, hazardous waste, metals, pesticides, radiation), health effects (e.g. cancer, cardiovascular disease, neurologic effects, reproductive effects), methodology (e.g. biomarkers, ecologic investigations, experimental design, exposure/dose assessment, meta-analysis, risk assessment, statistics), environment–gene interactions, and ethics and law.

International Society of Exposure Analysis (ISEA)
Web: http://www.iseaweb.org

The ISEA was established in 1989 to foster and advance the science of exposure analysis related to environmental contaminants, both for human populations and ecosystems. The membership promotes communication among all disciplines involved in exposure analysis, recommends exposure analysis approaches to address substantive or methodological concerns, and works to

strengthen the impact of exposure assessment on environmental policy. ISEA is considering changing its name to the International Society of Exposure Science (ISES).

International Society of Regulatory Toxicology and Pharmacology (ISRTP)
Web: http://www.isrtp.org/

The purpose of the ISRTP is to provide an open public forum for policymakers and scientists promoting sound toxicologic and pharmacologic science as a basis for regulation affecting human safety and health, and the environment.

International Society for the Study of Xenobiotics (ISSX)
Web: http://www.issx.org

The International Society for the Study of Xenobiotics (ISSX) is a scientific organization for researchers interested in the metabolism and disposition of xenobiotics. Facilitates and encourages the assembly, acquaintanceship, and association of scientists engaged in research in xenobiotic metabolism and in other related disciplines. Hosts an international meeting and workshops throughout the world.

International Society on Toxinology (IST)
Web: http://www.toxinology.org/

The International Society on Toxinology was founded in 1962 by a group of scientists and clinicians interested in advancing the science of toxinology. The purpose of the Society is to advance knowledge on the properties of toxins and antitoxins and to bring together scholars interested in these substances through a common Society. Publishes the journal, *Toxicon*.

International Union of Pure and Applied Chemistry (IUPAC)
Web: http://www.iupac.org

IUPAC serves to advance the worldwide aspects of the chemical sciences and to contribute to the application of chemistry in the service of mankind. As a scientific, international, non-governmental, and objective body, IUPAC addresses many global issues involving the chemical sciences, including toxicology and risk assessment.

International Union of Toxicology (IUTOX)
Web: http://www.iutox.org

IUTOX views itself as the voice of toxicology on the global stage, and the organization seeking to increase the knowledge base of toxicological issues facing humankind and to extend this knowledge to developing societies and nations. The mission of IUTOX is to foster international scientific cooperation among toxicologists, to promote global acquisition, dissemination, and utilization of knowledge in the science of toxicology, and to ensure continued training and development of toxicologists worldwide. IUTOX, as of January 2008, has 51 affiliated societies representing all six continents and over 20 000 toxicologists from industry, academia, and government as members.

Johns Hopkins University Center for Alternatives to Animal Testing (CAAT)
Web: http://caat.jhsph.edu/

Members include individuals and organizations interested in the development and validation of in vitro alternatives to the use of whole animals in toxicology. Mission includes fostering the development of scientifically acceptable in vitro and other alternatives for use in the development and safety evaluation of commercial and therapeutic products. Mission further includes catalyzing the validation of alternative methods and encouraging their use, where appropriate, while continuing to ensure the health of the public and to disseminate scientifically correct information about alternatives, their uses, advantages, and limitations.

(U.S.) National Academies
Web: http://www.nas.edu

The National Academies perform public service by bringing together committees of experts in all areas of scientific and technological endeavor. These experts serve pro bono to address critical national issues and give advice to the federal government and the public. Four organizations comprise the Academies: the National Academy of Sciences, the National Academy of Engineering, the Institute of Medicine, and the National Research Council. The Board on Environmental Studies and Toxicology (BEST) (http://dels.nas.edu/best/) is the National Academies' principal study unit for environmental pollution problems affecting human health, human impacts on the environment, and the assessment and management of related risks to human health and the environment.

(U.S.) National Agricultural Library (NAL), Department of Agriculture
Web: http://www.nal.usda.gov

The National Agricultural Library houses one of the world's largest and most accessible agricultural information collections and serves as the nexus for a national network of state land-grant and U.S. Department of Agriculture field libraries. The Food Safety Information Center would be of particular interest to toxicologists.

National Animal Poison Control Center (NAPCC)
Web: www.aspca.org/apcc

The ASPCA Animal Poison Control Center is dedicated to helping animals exposed to potentially hazardous substances by providing 24-hour veterinary

diagnostic and treatment recommendations. The center is committed to protecting and improving the lives of animals through toxicology educational programs and non-traditional research.

National Environmental Health Association (NEHA)
Web: http://www.neha.org

A professional society, whose mission is 'to advance the environmental health and protection professional for the purpose of providing a healthful environment for all.' NEHA produces the Annual Educational Conference (AEC) & Exhibition, and a number of technical workshops each year. In addition, it publishes the peer-reviewed *Journal of Environmental Health*, and offers environmental publications through its online bookstore.

National Institute for Chemical Studies (NICS)
Web: http://www.nicsinfo.org/

NICS helps communities manage safety, health, and environmental risks associated with the manufacture, storage, transportation, and disposal of chemicals.

(U.S.) National Institutes of Health (NIH)
(Also see other NIH listings)
Web: http://www.nih.gov

The NIH is a part of the U.S. Department of Health and Human Services. It is the primary Federal agency for conducting and supporting medical research. Composed of 27 Institutes and Centers, the NIH provides leadership and financial support to researchers in every state and throughout the world. The NIH institutes most closely related to the topics of toxicology and environmental health toxicology and environmental health research play some role in the activities of virtually every NIH institute, particularly the National Cancer Institute, the National Institute of Environmental Health Sciences, and the National Library of Medicine.

(U.S.) National Institutes of Health (NIH), National Cancer Institute (NCI)
Web: http://www.cancer.gov

The NCI, established under the National Cancer Institute Act of 1937, is the Federal Government's principal agency for cancer research and training. The National Cancer Act of 1971 broadened the scope and responsibilities of the NCI and created the National Cancer Program. Over the years, legislative amendments have maintained the NCI authorities and responsibilities and added new information dissemination mandates as well as a requirement to assess the incorporation of state-of-the-art cancer treatments into clinical practice. Among NCI's many laboratories are those devoted to human carcinogenesis, and comparative carcinogenesis.

(U.S.) National Institutes of Health, National Institute of Child Health and Human Development (NICHD)
Web: http://www.nichd.nih.gov

The NICHD, established by Congress in 1962, conducts and supports research on topics related to the health of children, adults, families, and populations. Its Developmental Biology, Genetics, and Teratology Branch conducts research on the genetic and teratogenic aspects of environmental factors on development.

(U.S.) National Institutes of Health, National Institute of Environmental Health Sciences (NIEHS)
Web: http://www.niehs.nih.gov

The mission of the NIEHS is to reduce the burden of human illness and disability by understanding how the environment influences the development and progression of human disease. The internal research arm of the NIEHS contributes to the understanding of biological and chemical processes, of the role of environmental agents in human disease and dysfunction, and the identification of the effect of environmental influences on the underlying mechanisms that lead to complex diseases. Its clinical research program seeks to use environmental exposures to strengthen the evidence that a given exposure is toxic, determine how such exposures affect disease etiology and progression, and identify molecular targets to determine susceptibility and develop health interventions. NIEHS also funds external environmental health sciences research. The National Toxicology Program is an interagency program housed at NIEHS whose mission is to evaluate agents of public health concern by developing and applying tools of modern toxicology and molecular biology. NIEHS offers a number of databases relevant to toxicology, including Chemical Effects in Biological Systems (CEBS).

(U.S.) National Institutes of Health (NIH), National Library Of Medicine (NLM), Division of Specialized Information Services (SIS)
Web: http://sis.nlm.nih.gov

The NLM, part of the National Institute of Health, provides extensive information and data management support and medical library and computer-based reference services for health professionals, libraries, researchers, educators, officials, managers, and administrators. NLM's Division of Specialized Information Services (SIS, http://sis.nlm.nih.gov/) creates information resources and services in toxicology, environmental health, chemistry, HIV/AIDS, and disaster management. SIS' Toxicology and Environmental Health Information Program (TEHIP) creates, organizes, and disseminates toxicology and environmental

health information, through an extensive set of free databases and other online products.

(U.S.) National Institute for Occupational Safety and Health (NIOSH)
Web: http://www.cdc.gov/niosh

NIOSH is in the U.S. Department of Health and Human Services and is an agency established to help assure safe and healthful working conditions for working men and women by providing research, information, education, and training in the field of occupational safety and health. NIOSH develops recommendations for occupational safety and health standards, conducts and funds research, develops information on safe levels of exposure to toxic materials and harmful physical agents and substances, and undertakes responsibilities under the Federal Mine Safety and Health Amendments Act of 1977.

(U.S.) National Oceanic and Atmospheric Administration (NOAA)
Web: http://www.noaa.gov

NOAA's broad activities range from alerting the public to daily weather forecasts and severe storm warnings to climate monitoring, fisheries management, coastal restoration, and supporting marine commerce. NOAA's Office of Response and Restoration provides scientific and technical support to prepare for and respond to oil and chemical releases.

National Pest Management Association, Inc.
Web: http://www.pestworld.org

The NPMA is a not-for-profit organization committed to the protection of public health, food, and property. The NPMA website is designed to serve as a comprehensive resource about bugs, rodents, pest control, and the professional pest management industry. The intended audience includes consumers, media, educators, and pest control professionals, and the website provides access to NPMA-led 'Pest World' blogs and podcasts. A companion website (www.pestworldforkids.org) is designed for teachers and students, and another website, (www.NPMApestworld.org) provides NPMA members with access to additional information.

National Pesticide Information Center (NPIC)
Web: http://npic.orst.edu

NPIC provides objective, science-based information about pesticides and pesticide-related topics to enable people to make informed decisions about pesticides and their use. NPIC is a cooperative agreement between Oregon State University and the U.S. Environmental Protection Agency.

National Registry of Environmental Professionals (NREP)
Web: http://www.nrep.org

NREP's mission is to promote legal and professional recognition of individuals possessing education, training, and experience as environmental managers, engineers, technologists, scientists, and technicians. Its professional affiliations include the Council on Licensure Enforcement and Regulation, International Association of Emergency Managers, World Safety Organization, and many other organizations including professional societies and colleges/universities. NREP holds workshops and provides a registry listing service for individuals in the environmental field who meet the minimum educational and training requirements.

National Research Council (NRC)
Web: http://sites.nationalacademies.org/nrc/index.htm

The NRC functions under the auspices of the National Academy of Sciences (NAS), the National Academy of Engineering (NAE), and the Institute of Medicine (IOM). The NAS, NAE, IOM, and NRC are known together as the National Academies. NRC's mission is to improve government decision making and public policy, increase public education and understanding, and promote the acquisition and dissemination of science, engineering, technology, and health knowledge. The core services involve collecting, analyzing, and sharing information and knowledge. The NRC develops consensus studies (comprehensive reports on major policy issues), conducts expert meetings and workshops, provides program and research management at the request of state and federal agencies, and administers several postdoctoral fellowship programs.

Natural Resources Information Council (NRIC)
Web: http://www.nric.info/

The NRIC facilitates the exchange of information among natural resource managers, information specialists, and librarians specializing in natural resources. Its members are from public (government organizations and academia) and private (non-governmental and consulting) organizations. The NRIC holds conferences and publishes a newsletter.

National Safety Council (NSC)
Web: http://www.nsc.org/

The NSC promotes safety in the workplace, in transportation, and in homes and communities. The National Safety Council serves as the nation's leading resource on industry trends, professional development, and strategies for advancing safety and health

programs and practices. The Council is active in converting injury research and trends information into injury prevention education, training, consultation, and advocacy leadership.

National Science Foundation (NSF)
Web: http://www.nsf.gov

The NSF is an independent federal agency created by Congress in 1950 'to promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense…'. They fulfill their mission chiefly by issuing limited-term grants – currently about 10 000 new awards per year, with an average duration of 3 years – to fund specific research proposals that have been judged the most promising by a rigorous and objective merit-review system. Most of these awards go to individuals or small groups of investigators. Others provide funding for research centers, instruments and facilities that allow scientists, engineers and students to work at the outermost frontiers of knowledge.

National Technical Information Service (NTIS)
Web: http://www.ntis.gov

The NTIS is a U.S. Department of Commerce program that claims to be the largest central resource for government-funded scientific, technical, engineering, and business-related information. It provides for public sale reports of U.S. government-sponsored scientific, technical, engineering, and business-related information covering over 350 subject areas. The NTIS Database has over two million bibliographic records, and includes research sponsored by the U.S. and select foreign governments. The database includes research reports, computer products, software, video cassettes, audio cassettes, etc.

National Transportation Safety Board (NTSB)
Web: http://www.ntsb.gov

The NTSB is an independent U.S. Federal government agency promoting transportation safety through independent investigations and making recommendations aimed at preventing future accidents. It investigates every civil aviation accident in the U.S., and significant accidents in other modes of transportation such as in highway transportation, some railroad and marine accidents, and releases of hazardous materials in all forms of transportation.

National Wildlife Federation (NWF)
Web: http://www.nwf.org

The NWF is a collection of state and territorial conservation organizations with the mission 'to inspire Americans to protect wildlife for our children's future.' It has several regional field offices and numerous affiliated wildlife organizations. It issues news releases, factsheets, and reports, and the website provides access to several NWF-related blogs and NWF's online *Conservation Directory* which includes information about thousands of environmental groups around the world.

Natural Resources Defense Council (NRDC)
Web: http://www.nrdc.org

The NRDC was established in 1970 as a non-profit organization to provide legal assistance related to the preservation and conservation of natural resources. NRDC claims to be the nation's most effective environmental action group, combining the grassroots power of over one million members and online activists with the expertise of several hundred lawyers, scientists, and other professionals. NRDC has several offices in the U.S. and one in Beijing, People's Republic of China. As of mid-2008, NRDC's main priorities included: (a) curbing global warming, (b) moving America beyond oil, (c) saving wildlands across the Americas, (d) reviving our oceans, (e) stemming the tide of toxic chemicals, and (f) speeding up the greening of China. The NRDC website provides access to press releases, an e-newsletter, a bimonthly bulletin, blogs, and other information.

North American Association for Environmental Education (NAAEE)
Web: http://naaee.org/pages/index.html

The North American Association for Environmental Education (NAAEE) is a network of professionals, students, and volunteers working in the field of environmental education throughout North America and in over 55 countries around the world.

Oak Ridge Associated Universities (ORAU)
Web: http://www.orau.org

ORAU is a not-for-profit university consortium of about 100 member universities. The ORAU member universities share the objective of advancing scientific research and education by creating mutually beneficial collaborative partnerships involving academic institutions, government organizations, and industry. The emphasis is on developing and promoting partnerships with national laboratories, in particular the Oak Ridge National Laboratory (ORNL). ORAU operates as a federal contractor for the U.S. Department of Energy (DOE) by targeting the core areas of: (a) worker/public health and independent verification of environmental cleanup, (b) weapons of mass destruction national preparedness and emergency response, and (c) science education, workforce development, and scientific review programs.

Oak Ridge National Laboratory (ORNL)
Web: http://www.ornl.gov

Oak Ridge National Laboratory (ORNL) is a multiprogram science and technology laboratory managed under contract for the U.S. Department of Energy by several outside organizations over the years. As of 2008, the contractor is a not-for-profit company known as UT-Battelle, established to manage and operate the Oak Ridge National Laboratory for the U.S. Department of Energy. UT-Battelle is a limited liability partnership between the University of Tennessee and Battelle. Scientists and engineers at ORNL conduct basic and applied research and development to create scientific knowledge and technological solutions that strengthen the nation's leadership and abilities in key areas of science. ORNL has a rich history of toxicology research dating back to its inception as one of the laboratory facilities of the Manhattan Project. The Biosciences Division includes expertise and special facilities in mammalian genetics and genomics, computational biology, biophysics and biomedical technologies, and in toxicology and risk analysis. The Environmental Sciences Division (ESD) covers research, development of technologies, and performance of analyses to understand and assess responses of environmental systems at the environment–human interface and the consequences of alternative energy and environmental strategies.

Organisation for Economic Co-operation and Development (OECD)
Web: http://www.oecd.org
Web: http://www.oecdwash.org

The OECD brings together the governments of countries committed to democracy and the market economy from around the world to: (a) support sustainable economic growth, (b) boost employment, (c) raise living standards, (d) maintain financial stability, (e) assist other countries' economic development, and (f) contribute to growth in world trade. OECD's Chemical Safety program works on the development and co-ordination of environment health and safety activities internationally. One example of an OECD-led effort is the OECD (Q)SAR Application Toolbox, a software application intended to be used by governments, the chemical industry, and other stakeholders to fill gaps in (eco)toxicity data needed for assessing the hazards of chemicals. Another example is OECD's Working Party on Manufactured Nanomaterials, which has a 'sponsorship programme' in which countries share the testing of specific nanomaterials (MNs). Further, the eChemPortal is an OECD-led web-based gateway that provides direct free access to information on the properties of chemicals (physical-chemical properties, environmental fate and behavior, ecotoxicity, toxicity) as well as to hazard and risk assessments. It allows users to simultaneously search multiple databases, most of which are prepared for government chemical review programs. OECD's Environment Directorate provides governments with the analytical basis to develop policies that are effective and economically efficient, including through country performance reviews, data collection, policy analysis, projections and modeling, and the development of common approaches.

Pacific Northwest National Laboratory (PNL)
Web: http://www.pnl.gov

Battelle manages and operates the federal government's Pacific Northwest National Laboratory in Washington state. PNL's scientific missions include: (a) strengthening the U.S. scientific foundations for innovation, (b) increasing U.S. energy capacity and reducing dependence on imported oil, (c) preventing and counter terrorism related to Weapons of Mass Destruction, and (d) reducing the environmental effects of human activities and create sustainable systems. The William R Wiley Environmental Molecular Sciences Laboratory (http://www.emsl.pnl.gov/emslweb) focuses on integrated experimental and computational resources for discovery and technological innovation in the environmental molecular sciences to support the needs of DOE and the nation. Examples of toxicology-related efforts at PNL include the systems toxicology of nanomaterials, and the development of new environmental biomarkers.

People for the Ethical Treatment of Animals (PETA)
Web: http://www.peta.org/

PETA has more than two million members and supporters and is the largest animal rights organization in the world. It focuses its attention on situations involving the suffering of animals, and works through public education, cruelty investigations, research, animal rescue, legislation, special events, celebrity involvement, and protest campaigns.

Personal Care Products Council (PCPC)
(Formerly the Cosmetic, Toiletry and Fragrance Association, CTFA)
Web: http://www.personalcarecouncil.org/

The PCPC is the leading U.S. trade association for the cosmetic and personal care products industry. PCPC's mission is to enable its company members to continue developing and selling the safe, quality, and innovative cosmetic and personal care products. It offers services, products, and information on scientific, regulatory, and legislative developments in the personal care products industry. For example, its CosmeticsInfo.org website provides safety information about

cosmetic and personal care products, including their ingredients and how they are tested. PCPC's Cosmetic Ingredient Review (CIR) was established in 1976 with support of the U.S. Food & Drug Administration and the Consumer Federation of America. Although funded by the PCPC, CIR and the review process are independent from CTFA and the cosmetics industry. The CIR thoroughly reviews and assesses the safety of ingredients used in cosmetics in an open, unbiased, and expert manner, and publishes the results in the open, peer-reviewed scientific literature. The PCPC website offers a wide variety of online tools and services to members and non-members.

Pesticide Action Network North America (PANNA)
Web: http://www.panna.org

PANNA's mission is to combine science and community-led campaigns to force global phase outs of highly hazardous pesticides. Their work advances environmental justice, sustainable agriculture, and food sovereignty. Operates the PAN Pesticides Database.

Pharmaceutical Research and Manufacturers of America (PhRMA)
(Formerly the Pharmaceutical Manufacturers Association (PMA))
Web: http://phrma.org

PhRMA represents the leading pharmaceutical and biotechnology companies in the U.S. Its mission is to conduct effective advocacy for public policies that encourage discovery of important new medicines for patients by pharmaceutical/biotechnology research companies.

Physicians for Social Responsibility (PSR)
Web: http://www.psr.org

The PSR is a U.S.-based non-profit advocacy organization claiming to be the medical and public health voice for policies to stop nuclear war and proliferation and to slow, stop, and reverse global warming and toxic degradation of the environment. PSR's Environment and Health Program is: (a) pressing for policies to curb global warming, ensure clean air, and generate a sustainable energy future, (b) working to minimize toxic pollution of air, food, and drinking water and prevent human exposures to toxic substance, (c) urging awareness about the emerging links between chronic disease and environmental factors, (d) providing health professionals with resources that address the questions the health community has about environmental health, and (e) bringing health professionals valuable resources for colleagues and patients about our community's need for a safer, healthier environment.

(U.S.) Public Interest Research Groups (U.S. PIRG)
Web: http://www.uspirg.org

U.S. PIRG is the federation of state Public Interest Research Groups (PIRGs). It is an advocate for the public interest. U.S. PIRG's mission is to deliver persistent, result-oriented public interest activism that protects health, encourages a fair, sustainable economy, and fosters responsive, democratic government. The state PIRGs are independent, state-based, citizen-funded organizations that advocate for the public interest.

Rachel Carson Council (RCC)
(Formerly the Rachel Carson Trust for the Living Environment)
Web: http://www.rachelcarsoncouncil.com/ (Web site under development)

The RCC is a library with information at both scientific and public levels on pesticide-related issues. It produces publications about pesticide dangers and alternative pest controls, and also develops conferences and workshops.

Radiation Effects Research Foundation (RERF)
(Formerly the Atomic Bomb Casualty Commission)
Web: http://www.rerf.jp

RERF is a Japanese and U.S. not-for-profit scientific organization dedicated to studying the health effects of atomic bomb radiation, with a view toward contributing to the maintenance of the health and welfare of atomic bomb survivors and to the enhancement of the health of all mankind.

Research Institute for Fragrance Materials (RIFM)
Web: http://rifm.org/

The RIFM is an independent non-profit scientific organization. It generates, evaluates, and distributes scientific data on the safety assessment of fragrance raw materials found in perfumes, cosmetics, shampoos, creams, detergents, air fresheners, candles, and other personal and household products. Included among RIFM's efforts is the development of peer-reviewed 'fragrance monographs' published in *Food and Chemical Toxicology* and separately as updated sets in a RIFM compendium. RIFM's Database of Fragrance and Flavor Materials is the most comprehensive source worldwide of physical-chemical, toxicological, and eco-toxicological data, literature, and information on safety evaluation associated with known fragrance and flavor materials.

RESOLVE
Web: http://www.resolv.org

RESOLVE was established in 1977 as one of the first U.S. environmental dispute-resolution organizations,

and now operates internationally. RESOLVE provides a full range of alternative dispute resolution and consensus building services to individuals, organizations, and communities. Services include mediation of negotiated rulemaking, facilitation of workshops and public–private collaboratives, and conflict assessments for convening negations. RESOLVE maintains a section devoted to toxics and chemicals in the environment, which deals primarily with Superfund and related risk assessments to facilitate discussions and dialogs among stakeholders.

Resources for the Future, Center for Risk Management (RFF)
Web: http://www.rff.org

RFF calls itself the premier independent institute dedicated exclusively to analyzing environmental, energy, and natural resource topics, and was the first think tank devoted exclusively to natural resource and environmental issues. RFF scholars analyze critical issues concerning pollution control, energy policy, land and water use, hazardous waste, climate change, biodiversity, and the environmental challenges of developing countries. It publishes books, reports, a quarterly magazine, and other documents.

Science and Environmental Health Network (SEHN)
Web: http://www.sehn.org/

SEHN was founded in 1994 by a consortium of North American environmental organizations (including the Environmental Defense Fund, The Environmental Research Foundation, and OMB Watch) concerned about the misuse of science in ways that failed to protect the environment and human health. Since 1998, SEHN has been the leading proponent in the United States of the Precautionary Principle as a new basis for environmental and public health policy. SEHN has worked with issue-driven organizations, national environmental health coalitions, municipal and state governments, and several NGO/government teams to implement precautionary policies at local and state levels.

Scientific Group on Methodologies for the Safety Evaluation of Chemicals (SGOMSEC)

SGOMSEC was sponsored by the IPCS (International Program on Chemical Safety) within the World Health Organization (WHO), with the cooperation of United Nations Environment Programme (UNEP), International Labour Organisation (ILO), and the Scientific Programme on Problems of the Environment (SCOPE). The U.S. NIEHS and the European Commission have also contributed to SGOMSEC studies. The broad objective of SGOMSEC was to contribute to the reduction and prevention of risks caused to humans and non-human targets (ecosystems) by the introduction in the environment in increasing quantities of a large number of natural and man-made chemicals. This program was discontinued in late 2005 but the website has relevant toxicological publications and reports.

Scientists Center for Animal Welfare (SCAW)
Web: http://www.scaw.com

SCAW is a not-for-profit educational organization composed of research professionals dedicated to balancing animal welfare and excellence in basic and applied scientific inquiry. SCAW seeks to facilitate open discussion and helps craft solutions as well as promote best practices. It sponsors an educational Winter Conference and many seminars and workshops.

Sierra Club
Web: http://www.sierraclub.org

Founded in 1892 as one of America's first natural resources advice groups, the Sierra Club embraces a wide variety of issues that advocate the responsible use of the Earth's resources and ecosystems and to protect the quality of the environment. Provides extensive education and outreach campaigns at national and international levels. Its numerous chapters and several hundred affiliated groups in North America provide public information on a wide variety of environmental and natural resources topics, including those related to toxicology and environmental health.

Soap and Detergent Association (SDA)
Web: http://www.cleaning101.com

SDA is a not-for-profit organization representing North American manufacturers of household, industrial, and institutional cleaning products, their ingredients, finished packaging, oleochemical producers, and chemical distributors to the cleaning product industry. SDA's mission is to support the sustainability of the cleaning product and oleochemical industries, through research, education, outreach, and science-based advocacy. Activities include toxicology and regulatory issues.

Society for Chemical Hazard Communication (SCHC)
Web: http://www.schc.org

The SCHC is a non-profit organization with a mission to promote the improvement of chemical hazard communication, educate SCHC members on hazard communication issues, provide a forum for exchange of ideas and experiences, enhance the awareness of members and the general public of new developments in hazard communications, and to provide guidance and technical expertise to private, non-profit groups, and government organizations.

Society for Free Radical Biology and Medicine (SFRBM)
(Formerly The Oxygen Society)
Web: http://www.sfrbm.org/

Free radicals and reactive oxygen and nitrogen species now touch every biological and medical discipline. Efforts to counteract the damage caused by these species are gaining acceptance as a basis for novel therapeutic approaches, and the field of preventive medicine is experiencing an upsurge of interest in medically useful antioxidants and free radical scavengers. SFRBM fosters a balanced approach to understanding both the advantageous and deleterious properties of free radicals and reactive oxygen and nitrogen species.

Society for in Vitro Biology (SIVB)
(Formerly the Tissue Culture Association)
Web: http://www.sivb.org

The SIVB fosters the exchange of knowledge about the in vitro biology of cells, tissues, and organs from plants, humans, and other animals. It holds national and local conferences, meetings, and workshops, and supports teaching initiatives with educational institutions. Publications include a journal (*In Vitro Cellular and Developmental Biology* – separate animal and plant editions, and *Methods in Cell Science* (formerly *Journal of Tissue Culture Methods*)) and a newsletter (*In Vitro Report*).

Society for Risk Analysis (SRA)
Web: http://www.sra.org

SRA's scope includes risk assessment, risk characterization, risk communication, risk management, and policy relating to risk. Members include risk analysis professionals from varied areas, including human and environmental risk assessment. SRA publishes a peer-reviewed journal, *Risk Analysis*, which provides a focal point for new developments in risk analysis for scientists from a wide range of disciplines. The Society's website includes links to information about SRA, SRA's regional organizations and specialty groups, SRA's newsletter, job opportunities, and resources (speakers bureau, risk analysis glossary, academic programs, data, government agencies and laboratories, non-profit organizations, private sector consultants, providers of other information and materials, related societies and associations, and software providers).

Society of Environmental Journalists (SEJ)
Web: http://www.sej.org

Members include journalists, educators, and students. Its mission is to advance public understanding of environmental issues by improving the quality, accuracy, and visibility of environmental reporting. Publishes a newsletter *SEJournal*, and a biweekly 'TipSheet.' The Society of Environmental Journalists also offers TipSheet, WatchDog TipSheet, EJToday, Environmental Events Calendar and Useful Links via RSS News Feed.

Society of Environmental Toxicology and Chemistry (SETAC)
Web: http://www.setac.org

SETAC is a non-profit, worldwide professional society with the mission of supporting the development of principles and practices for protection, enhancement and management of sustainable environmental quality and ecosystem integrity. It promotes the advancement and application of scientific research related to contaminants and other stressors in the environment, education in the environmental sciences, and the use of science in environmental policy and decision-making. Members include professionals in the fields of chemistry, toxicology, biology, ecology, etc., promoting the use of multidisciplinary approaches to examine the impacts of chemicals and technology on the environment. It publishes a newsletter and other documents including a journal (*Environmental Toxicology and Chemistry*). SETAC also has offices in Europe, Asia/Pacificmailto:, and Latin America.

Society of Forensic Toxicologists (SOFT)
Web: http://www.soft-tox.org

SOFT members include practicing forensic toxicologists and others interested in promoting and developing forensic toxicology. The website contains annual meeting information, efforts to encourage training and research (including via SOFT-funded awards), employment opportunities, publications, and related links. SOFT publications include a newsletter and laboratory guidelines.

Society of Quality Assurance (SQA)
Web: http://www.sqa.org/newsite/public/pubhome.asp#

SQA is dedicated to providing a forum for information exchange and utilization of knowledge in research and regulatory quality assurance, promoting the profession through leadership and effective professional relationships, enhancing knowledge of regulatory and quality assurance concerns that impact research, and fostering the highest professional standards leading to growth, development, and recognition of the quality assurance profession worldwide.

Society of Toxicologic Pathologists (STP)
Web: http://www.toxpath.org

Members include toxicologic pathologists, veterinarians, physicians, and dentists interested in the pathological changes produced by pharmacological, chemical, and environmental agents. The principal aim is the

advancement of pathology as it pertains to changes elicited by pharmacologic, chemical, and environmental agents and factors that modify these responses. Publications include a newsletter and a journal (*Toxicologic Pathology*).

Society of Toxicology (SOT)
Web: http://www.toxicology.org

The Society of Toxicology is, perhaps, the premiere professional and scholarly organization of scientists from academic institutions, government, and industry representing the great variety of scientists who practice toxicology in the U.S. and abroad. The Society promotes the acquisition and utilization of knowledge in toxicology, aids in the protection of public health, and facilitates disciplines. The Society has a strong commitment to education in toxicology and to the recruitment of students and new members into the profession. Its official journal is *Toxicological Sciences*. SOT has numerous specialty sections, special interest groups, and regional chapters and a useful website including news and information on careers in toxicology.

Society of Toxicology of Canada (STC)
Web: http://www.stcweb.ca

The STC is a non-profit association whose objectives are to promote the acquisition, facilitate the dissemination, and encourage the utilization of knowledge in the science of toxicology. STC membership also includes membership in the Canadian Federation of Biological Societies (CFBS) and the International Union of Toxicology (IUTOX). It holds an annual symposium and members receive a newsletter providing a Canadian perspective on toxicological news. STC also develops public awareness initiatives, e.g., a Principles of Toxicology document and slide set.

Synthetic Organic Chemical Manufacturers Association (SOCMA)
Web: http://www.socma.org

SOCMA represents the U.S. batch, custom and specialty chemical industry. SOCMA committees include ones on chemical risk management, the environment, safety and security, and environmental, health, and safety performance improvement. Communication tools for members include several electronic newsletters, email Member Alerts, and an Internet portal (blog) that allows direct communication with SOCMA's President to discuss and debate topics, and podcasts on various topics. SOCMA manages several affiliated associations and consortia that address issues of common concern or interest to a particular sector of the chemical industry (e.g. chemical-specific or class of related chemicals or applications).

Teratology Society
Web: http://teratology.org

The Teratology Society is a multidisciplinary scientific society whose members study the causes and biological processes leading to abnormal development and birth defects at the fundamental and clinical level and appropriate measures for prevention. Several other societies with common interests meet in conjunction with the annual meetings of the Teratology Society, including the Neurobehavioral Teratology Society, Behavioral Toxicology Society, and Organization of Teratology Information Societies (OTIS).

Toxicology Education Foundation
Web: http://www.toxedfoundation.org

The Toxicology Education Foundation's purpose is to encourage, support, and promote charitable and educational activities that increase the public understanding of toxicology. TEF has developed and provides audiovisual materials for health professionals to use in presentations to the public in partnership with NIEHS and others in the private sector. The goal of the video 'Is It Safe?' is to empower the public to make good decisions about risk associated with every day products.

Toxicology Excellence for Risk Assessment (TERA)
Web: http://www.tera.org

TERA is an independent non-profit research and education organization with the mission of protecting public health by developing and communicating risk assessment information, sponsoring peer reviews and consultations, improving risk methods through research, educating the public on risk assessment issues, and providing sponsors and the public with independent and objective opinions. Specific activities of *TERA* include (a) the Verifiable Estimates for Risk Assessment (VERA) program, (b) compiling and freely distributing peer-reviewed risk values via the International Toxicity Estimates for Risk (ITER) database, (c) improving the process and efficiency of risk assessment, and increasing the capacity for developing risk information through the ARA, the Alliance for Risk Assessment, and RiskIE, the Risk Information Exchange, (d) conducting expert peer reviews and peer consultations of risk assessments and other information, (e) improving underlying methods for human and ecological risk assessment through research and publications, (f) education and training for the public and others on risk assessment issues, (g) public assistance and help for government agencies, and (h) improving the practice of risk assessment by independent, neutral, and objective guidance and advice.

Toxicology Forum (TF)
Web: http://www.toxforum.org

An international non-profit organization devoted to the organization of open dialogs among the various segments of society concerned with problems in toxicology. TF-sponsored meetings in the U.S. and Europe include experts from domestic and international government regulatory and health agencies, industry, academia, political policymakers, and public interest groups. The meetings promote discussion of a range of viewpoints on issues and topics that are unencumbered by a need to arrive at consensus.

United Nations (UN)
Web: http://www.un.org

The charter of the UN states its four main objectives of maintaining international peace and security, developing friendly relations among nations based on respect for the principle of equal rights and self-determination of peoples, achieving international cooperation in solving international problems of an economic, social, cultural, or humanitarian character and in promoting and encouraging respect for human rights and for fundamental freedoms for all without distinction as to race, sex, language, or religion, and to be a center for harmonizing the actions of nations in the attainment of these common ends. Organizations which are part of the UN system, and which are relevant to toxicology research include the FAO, IAEA, ILO, UNEP, and WHO.

United Nations Environment Programme (UNEP)
Web: http://www.unep.org

UNEP, established in 1972, is the voice for the environment within the United Nations system. UNEP acts as a catalyst, advocate, educator, and facilitator to promote the wise use and sustainable development of the global environment. To accomplish this, UNEP works with a wide range of partners, including United Nations entities, international organizations, national governments, non-governmental organizations, the private sector and civil society. Along with the World Bank and the UN Development Programme, UNEP is an implementing agency of the Global Environment Facility, to help developing countries meet costs of measures designed to achieve global environmental benefits in six focal areas including ozone layer depletion, and persistent organic pollutants. In an effort to help reduce great disparities in scientific resources between developed and developing nations, a consortium of international institutions led by UNEP launched, in 2006, a new collaborative initiative called Online Access to Research in the Environment (OARE).

U.S. Nuclear Regulatory Commission (NRC)
Web: http://www.nrc.gov

The Nuclear Regulatory Commission (NRC) was created as an independent agency by the U.S. Congress in 1974. The goal was to enable the safe use of radioactive materials for beneficial civilian purposes while ensuring protection of people and the environment. The NRC regulates commercial nuclear power plants and other uses of nuclear materials (e.g., in nuclear medicine) through licensing, inspection, and enforcement of requirements. The NRC's regulatory mission covers: (a) reactors (commercial reactors for generating electric power, and reactors used for research, testing, and training), (b) materials (uses of nuclear materials in medical, industrial, and academic settings, and facilities that produce nuclear fuel), and (c) waste (transportation, storage, and disposal of nuclear materials and waste, and the decommissioning of nuclear facilities).

U.S. Occupational Safety and Health Administration (OSHA)
Web: http://www.osha.gov

The mission of the OSHA, within the U.S. Federal government's Department of Labor, is to save lives, prevent injuries, and protect the health of personnel in their workplace environments. OSHA develops and promulgates occupational safety and health standards, develops and issues regulations and guidelines, conducts inspections and investigations, and issues citations and imposes penalties for non-compliance with regard to health and safety standards.

Water Environment Federation
Web: http://www.wef.org

WEF researches and publishes information on wastewater treatment and water quality protection, provides technical expertise and training on issues including non-point source pollution, hazardous waste, residuals management, and groundwater; sponsors conferences and other special events around the world, and reviews, testifies, and comments on environmental regulations and legislation.

World Health Organization (WHO)
Web: http://www.who.int/en/

WHO sponsors a number of programs related to chemical safety, environmental health, and environmental pollution. The International Programme on Chemical Safety (IPCS), for example, established in 1980, is a joint programme of three Cooperating Organizations – WHO, ILO and UNEP, implementing activities related to chemical safety. WHO is the Executing Agency of the IPCS, whose main roles are to establish the scientific basis for safe use of chemicals, and to strengthen national capabilities and capacities for chemical safety.

WMD First Responders
Web: http://wmdfirstresponders.com/

This website was created to help improve the response capabilities of members assigned to civilian and military organizations and agencies that could respond to terrorist attacks or events involving the use of a weapon of mass destruction (WMD) (e.g., chemical, biological, radiological, nuclear, and explosive material). For the purpose of this website, first responders are members of emergency communications centers (ECCs), emergency medical services (EMS), fire, and rescue services; hazmat (HAZMAT) teams, law enforcement agencies; bomb squads, special weapons and tactics teams (SWAT), hospitals; public health; risk management; security, emergency and disaster management, transportation and public works, gas, water and electric companies, the American Red Cross, etc.

World Resources Institute (WRI)
Web: http://www.wri.org

WRI was founded in 1982 as an environmental think tank that goes beyond research to find practical ways to protect the Earth and improve people's lives. Its mission is to move human society to live in ways that protect the Earth's environment and its capacity to provide for the needs and aspirations of current and future generations.

World Wildlife Fund (WWF)
Web: http://www.worldwildlife.org/

WWF's mission is the conservation of nature. It claims to be the largest multinational conservation organization in the world with efforts in 100 countries. The WWF is supported by 1.2 million members in the U.S. and approximately five million around the world. Its efforts include: (a) protecting natural areas and wild populations of plants and animals, including endangered species, (b) promoting sustainable approaches to the use of renewable natural resources, and (c) promoting more efficient use of resources and energy and the maximum reduction of pollution.

Worldwatch Institute
Web: http://www.worldwatch.org

The Worldwatch Institute is an independent research organization performing fact-based analysis of critical global issues. Worldwatch focuses on the 21st century challenges of climate change, resource degradation, population growth, and poverty, and develops and disseminates data and innovative strategies for achieving a sustainable society. Worldwatch claims that its research is the gold-standard for sustainability analysis for decision makers in government, civil society, business, and academia.

SPECIAL GROUPS

Within some of the organizations listed previously, or separate from them, are a variety of groups functioning as ad hoc or standing committees or that serve in a coordinating, collaborative, advisory, or other special capacity. There are far too many to itemize fully; the following are among the foremost.

Environmental Protection Agency, Science Advisory Board (SAB)
Web: http://yosemite.epa.gov/sab/sabpeople.nsf/WebCommittees/BOARD

Established in 1978, the SAB is a public advisory group providing extramural scientific information and advice to the administrator and other officials of the EPA. The SAB is structured to provide balanced, expert assessment of scientific matters relating to problems facing the agency. Members of and consultants to the board constitute a distinguished body of scientists, engineers, and economists who are recognized, non-governmental experts in their respective fields. These individuals are drawn from academia, industry, and environmental communities throughout the United States and, in some cases, other countries. The board functions as a technical peer-review panel, conducting its business in public view and benefiting from public input during its deliberations. Among the SAB's standing committees, as of mid-2008, are the Ecological Processes and Effects Committee, Environmental Engineering Committee, Exposure and Human Health Committee, and the Radiation Advisory Committee.

Global Change Research Information Office (GCRIO)
Web: http://www.gcrio.org.
Web: http://www.ostp.gov/cs/nstc/committees-cenr

The GCRIO provides access to data and information on climate change research, adaptation/mitigation strategies and technologies, and global change-related educational resources. This is on behalf of various U.S. federal agencies involved in the U.S. Global Change Research Program (USGCRP).

National Council for Science and Environment (NCSE)
(Formerly the Committee for the National Institute for the Environment, CNIE)
Web: http://ncseonline.org/

The NCSE is a not-for-profit organization. Its mission is to improve the scientific basis for making decisions on environmental issues. It conducts programs that will increase the number and quality of people capable of bringing science to bear on the many environmental challenges facing the world through the successful operation of a National Institute for the

Environment (NIE). Its National Library for the Environment (http://www.cnie.org/nle/) provides free online access to environmental information. NCSE's *Encyclopedia of Earth* is an electronic reference about the Earth, its natural environments, and their interaction with society. The encyclopedia is a free, fully searchable collection of articles written by scholars, professionals, educators, and experts who collaborate and review each other's work.

National Institutes of Health, National Library of Medicine, Toxicology and Environmental Health Information Program (TEHIP)
Web: http://sis.nlm.nih.gov/enviro.html

TEHIP was originally established in 1967 as the Toxicology Information Program to create automated toxicology databases and to provide toxicology information and data services. The major program with the National Library of Medicine's Division of Specialized Information Services (SIS), TEHIP's scope has broadened to include environmental and occupational health. It now provides selected core information resources and services, facilitates access to national and international information resources, and strengthens the information infrastructure of toxicology and environmental health. Databases sponsored by TEHIP are described elsewhere in this book. Among the important committees falling under the auspices of TEHIP is the Hazardous Substances Data Bank (HSDB) Scientific Review Panel (SRP), a committee of experts drawn from the major subject disciplines within the HSDB's scope that ensures the scientific accuracy and quality of the file.

National Institutes of Health, Toxicology Study Sections
Web: http://cms.csr.nih.gov/PeerReviewMeetings/CSRIRGDescription/DIGIRG/SIEE.htm

The original Toxicology Study Section was established within NIH's Division of Research Grants (DRG) in 1958. Over time, the number of peer review panels (Study Sections) grew and there were six study sections mostly composed of toxicologists and pharmacologists within the NIH's Center for Scientific Review (CSR). These study sections reviewed applications for research and training for NIH institutes. In the early-to-mid 2000s, the CSR began reorganizing the Integrated Review Groups (IRGs) and individual Study Sections, and many of the toxicology-related study sections were eliminated. What remained were the NAL (Neurotoxicology and Alcohol) and XNDA (Xenobiotic and Nutrient Disposition and Action) study sections; however, in early 2008 a new Systemic Injury by Environmental Exposure (SIEE) Special Emphasis Panel (SEP) was created as a temporary standing SEP. The SIEE is a pilot program and it began reviewing applications submitted in June 2008. The performance of the SIEE will be critically reviewed after several review cycles and further changes could occur in future years.

National Nanotechnology Initiative (NNI)
Web: http://www.nano.gov/html/about/home_about.html

The NNI was established to coordinate Federal nanotechnology research and development and serve as a central locus for communication, cooperation, and collaboration for all Federal agencies that wish to participate. As of mid-2008, the NNI consists of the individual and cooperative nanotechnology-related activities of 25 Federal agencies with a range of research and regulatory roles and responsibilities. The goals of the NNI include: (a) advancing a world-class nanotechnology research and development program, (b) fostering the transfer of new technologies into products for commercial and public benefit, (c) developing and sustaining educational resources, a skilled workforce, and the supporting infrastructure and tools to advance nanotechnology, and (d) supporting responsible development of nanotechnology.

National Research Council, Board on Environmental Studies and Toxicology (BEST)
Web: http://www.dels.nas.edu/best/

The BEST is the (U.S) National Academies' principal study unit for environmental pollution problems affecting human health, human impacts on the environment, and the assessment and management of related risks to human health and the environment. BEST provides independent expert assistance to the federal government and advice to the nation on matters of science and technology affecting public policy on important environmental and ecological problems. The typical mechanism for achieving this goal is the deliberative process of study committees composed of experts from academic institutions and other organizations. Studies may be undertaken in response to requests from federal agencies or Congress, or they may result from the deliberations of board members in the strategic planning process. BEST addresses air and water pollution, solid and hazardous waste, toxicology, epidemiology, risk assessment, applied ecology, natural resources, and environmental engineering, economics, law, and policy. The oversight of BEST's program is provided by the National Research Council's Division on Earth and Life Studies. Information about BEST events, reports, current projects, and emerging issues is available via http://dels.nas.edu/best/reports.php/.

National Toxicology Program (NTP)
Web: http://ntp-server.niehs.nih.gov

The NTP is a U.S. interagency program with the mission to evaluate agents of public health concern by developing and applying tools of modern toxicology and molecular biology. The program was created to: (a) coordinate toxicology testing programs within the federal government, (b) strengthen the science base in toxicology, (c) develop and validate improved testing methods, and (d) provide information about potentially toxic chemicals to health, regulatory, and research agencies, scientific and medical communities, and the public The work is performed using an objective, science-based approach to deal with critical issues in toxicology using the best science available to prioritize, design, conduct, and interpret the results. The NTP consists of relevant toxicology activities of the National Institute of Environmental Health Sciences (NIH/NIEHS), the Centers for Disease Control and Prevention's National Institute for Occupational Safety and Health (CDC/NIOSH), and the Food and Drug Administration's National Center for Toxicological Research (FDA/NCTR). Primary scientific oversight is provided by the NTP Board of Scientific Counselors and its Technical Reports Review Subcommittee. The documents developed by NTP include the *Biennial Report on Carcinogens*, containing a list of all substances which either are known to be human carcinogens or may reasonably be anticipated to be human carcinogens and to which a significant number of persons residing in the United States are exposed. Also available are the *NTP Annual Plan* and the companion *Review of Current DHHS, DOE, and EPA Research Related to Toxicology.* NTP also issues many technical reports on its toxicology studies and short-term toxicity studies, as well as a management status report. As of 2008, the NTP is converting study reports into an electronic format which will be accessible from the website, and is loading study information into databases accessible for searching via the website. An example of NTP's research efforts is a broad-based research program to address potential human health hazards associated with nanoscale materials. The goal is to evaluate the toxicological properties of major nanoscale materials classes representing a cross-section of composition, size, surface coatings, and physicochemical properties.

National Toxicology Program (NTP), Interagency Center for the Evaluation of Alternative Toxicological Methods (NICEATM) and the Interagency Coordinating Committee on the Validation of Alternative Methods (ICCVAM)
Web: http://iccvam.niehs.nih.gov/

The NTP Interagency Center for the Evaluation of Alternative Toxicological Methods (NICEATM) administers the Interagency Coordinating Committee on the Validation of Alternative Methods (ICCVAM) and provides scientific and operational support for ICCVAM-related activities. The ICCVAM Authorization Act of 2000 (42 U.S.C. 285) established ICCVAM as a permanent interagency committee of the NIEHS under NICEATM. ICCVAM is composed of representatives from 15 Federal regulatory and research agencies that use, generate, or disseminate toxicological information. The Committee conducts technical evaluations of new, revised, and alternative test methods with regulatory applicability, and promotes the scientific validation and regulatory acceptance of test methods that more accurately assess the safety and hazards of chemicals and products and that refine, reduce, or replace animal use.

Toxic Substances Control Act (TSCA), Interagency Testing Committee (ITC)
Web: http://www.epa.gov/oppt/itc/

The TSCA ITC is an independent advisory committee to the EPA Administrator that was created in 1976 under section 4(e) of the Toxic Substances Control Act (TSCA). Sixteen U.S. government organizations are ITC members. The members nominate industrial chemicals to the ITC when their organizations need data that can be obtained through the ITC. Such data include unpublished production volume, use, exposure, monitoring, environmental fate, and ecological and health effects data. The ITC coordinates data needs for the nominated chemicals with those of other member organizations and determines if these chemicals should be: (a) added to the Priority Testing List and recommended or designated for testing, (b) deferred for testing and not added to the list, or (c) removed from the list. By coordinating federal data needs and establishing partnerships with manufacturers, importers, processors, and users, the ITC provides an infrastructure to obtain information on industrial chemicals.

United States Congress

Commerce, Trade, and Consumer Protection

The jurisdiction of this subcommittee of interest to toxicologists includes consumer affairs and consumer protection, consumer product safety (the Consumer Product Safety Commission), product liability, and motor vehicle safety.

Energy and Air Quality

The jurisdiction of this subcommittee of interest to toxicologists includes laws, programs, and government

activities affecting the U.S. energy policy, fossil energy, renewable energy resources, synthetic fuels, regulation of nuclear facilities, nuclear energy and waste, and the Clean Air Act.

Environment and Hazardous Materials

The jurisdiction of this subcommittee includes environmental protection, including the Safe Drinking Water Act and risk assessment matters, solid waste, hazardous waste and toxic substances (including Superfund and the Resource Conservation and Recovery Act (RCRA)), mining, oil, gas, and coal combustion wastes, and noise pollution.

Health

The jurisdiction of this subcommittee includes public health and quarantine, hospital construction, mental health and research, biomedical programs and health protection in general, food and drugs, and drug abuse.

United States House Committee on Energy and Commerce

Web: http://energycommerce.house.gov/

The following subcommittees will be of interest to the toxicology community.

United States Senate Committee on Environment and Public Works

The following subcommittees will be of interest to the toxicology community.

Clean Air and Nuclear Safety

The jurisdiction of this subcommittee includes the Clean Air Act, indoor air, and nuclear plant safety.

Private Sector and Consumer Solutions to Global Warming and Wildlife Protection

The jurisdiction of this subcommittee of interest to toxicologists includes global warming, fisheries and wildlife, the Endangered Species Act (ESA), and national wildlife refuges.

Public Sector Solutions to Global Warming, Oversight, and Children's Health Protection

The jurisdiction of this subcommittee of interest to toxicologists includes global warming, children's health protection. Yucca Mountain, and the National Environmental Policy Act (NEPA).

Superfund and Environmental Health

The jurisdiction of this subcommittee of interest to toxicologists includes Superfund and Brownfields, the Resource Conservation and Recovery Act (RCRA), the Toxic Substances Control Act (TSCA), the Emergency Planning and Community Right to Know Act (EPCRA), Persistent Organic Pollutants (POPs), environmental justice, and risk assessment.

Transportation and Infrastructure

The jurisdiction of this subcommittee of interest to toxicologists includes water resources, federal disaster relief programs, and green buildings.

Transportation Safety, Infrastructure Security, and Water Quality

The jurisdiction of this subcommittee of interest to toxicologists includes drinking water, chemical, wastewater security, the Clean Water Act, including wetlands, the Safe Drinking Water Act, ·invasive species, and transportation safety.

CHAPTER

63

Journals and Newsletters

FRED BERMAN

SCIENTIFIC JOURNALS

Scientific journals have a long and honorable history. Their beginnings generally date back to 1665, when the French *Le Journal des Scavans* and the English *Philosophical Transactions* (of the Royal Society of London) began publication within months of each other. General scholarly journals of this type, and later, journals in broad areas of science and medicine, were repositories of early toxicology papers. Scientific disciplines became, as they continue to become, more specialized, and toxicological literature gradually found its way into journals in areas such as medicine, chemistry, biology, industrial hygiene, and particularly pharmacology. The *Index-Catalogue of the Library of the Surgeon-General's Office, United States Army*, forerunner of the National Library of Medicine's *Index Medicus*, was first published in 1880. It listed books, journals, and theses published prior to that date and included the subject headings of 'Toxicology' and 'Poisons.' The preponderance of this early scientific literature was written in German, French, and English.

Some early journals devoted to toxicology were *Sammlung von Vergifiungsfaellen* (Germany, begun 1930, currently called *Archives of Toxicology*), *Farmakilogiia i Toksikologiia* (Russia, begun in 1938, currently called *Eksperimentalnaia i Klinicheskaia Farmakologiia*), and *Acta Pharmacologica et Toxicologica* (Denmark, begun in 1945, currently called *Pharmacology and Toxicology*). In the U.S., the journal *Toxicology and Applied Pharmacology*, begun in 1945, became one of the official journals of the United States Society of Toxicology, founded in 1961.

One might note that journal title changes are not an uncommon occurrence. The conceptual link between pharmacology and toxicology, as well as cross-disciplinary linkages that are apparent among journals concentrating, for example, on the environment and pollution, continue today and are therefore reflected in the literature. Specific examples include such journals as *Archives of Environmental Health*, known today as *Archives of Environmental and Occupational Health*, or the *Journal of Pharmacological Methods*, now titled the *Journal of Pharmacological and Toxicological Methods*. Today, toxicology continues to be spread across the broader scientific journal literature, although as this chapter demonstrates, there remain many journals that focus on toxicology in general or specialized terms. Entire journal titles are devoted to such areas as aquatic toxicology, biomarkers, immunotoxicology, molecular toxicology, neurotoxicology, and in vitro toxicology.

As with books, journals today are not limited to print media. Most journals are available on CD-ROM and online through the Internet, typically on their publishers' Web sites. Publishers may offer the entire text or selected portions of journal issues online. Alternately, they may keep readers up to date by providing online article abstracts or tables of contents. Many publishers also offer free individualized email alerting services that deliver customized tables of contents and/or alerts to recently posted articles within a selected area of research. At the least, journal publishers with web addresses provide descriptions of their journal titles and ordering information. The list of toxicology journals that follows lists URLs for journal or publisher websites, when available. Readers are encouraged to consult the website of a journal's publisher to learn more about what is offered via electronic access.

A recent development in scientific publishing has been the appearance of open access journals, which publish peer-reviewed articles that are free and available permanently online. In lieu of subscription fees, publishers' page costs are covered by per-article fees paid for by the authors or their supporting institutions. Examples of open access publishing include BioMed Central (http://www.biomedcentral.com), an open access publisher that offers over 150 free online journals, including toxicology journals, and PubMed Central (http://www.pubmedcentral.nih.gov), the U.S. National Institutes of Health free digital archive of biomedical and life sciences journal literature. Open-access toxicology journals, along with their URLs, are included in this chapter.

The periodicals in this chapter represent a selective list of scientific journals that focus on toxicology and related disciplines, such as risk analysis, occupational medicine, environmental health, and ecotoxicology. Many other journals that publish toxicological articles but whose thrust lies elsewhere are not included. Thus, although one of the journals in the list concerns immunopharmacology/immunotoxicology, the many other immunology titles, which may contain toxicology articles from time to time, are not included. At the end of the chapter is a brief list of related titles that include articles of bearing on toxicology.

Monograph series tend to be a nightmare in terms of bibliographic control. Are they books or are they journals? In the second edition of this book, such book series were included in the Journals chapter. Like journals, they are published on an ongoing basis, although usually not as frequently. However, in look and use, they are more like books, with individual volumes typically focusing on a single topic or a group of interrelated topics. Therefore, monograph series and other special serial publications are categorized as 'books' in the various subject chapters.

The journals that follow publish English-language articles exclusively or mostly. Foreign-language toxicology journals are cited in the individual country chapters later in this book. We have selected only titles that are currently being published. Closed (i.e., discontinued) titles are not included. Obviously some of these titles may be discontinued in the future, or change title, publisher, or place of publication. Vigilance is always necessary in keeping up with journals. Publishing industry takeovers compound the problem of identifying and locating journals. Dates, where available, represent the year (as accurate as we could find) that the journal, either under its current or previous title(s), was first published.

The list represents largely professional journals publishing technical and scientific articles. Magazines for general consumption only that carry articles related to toxicology and the environment are not part of this main list, although a number of them do an outstanding job of presenting current issues and controversies in easy-to-read and entertaining packages. Interestingly enough given the increasing consumer curiosity about health and science, some very fine professional journals in toxicology (e.g., *Environmental Health Perspectives*) and science (e.g., *Science*) have lately seen fit to devote a portion of their pages to just such general interest material.

To keep up with periodical titles – what's born, what dies, what changes – is not easy. Some helpful sources include:

- ***Pub List*** (http://www.publist.com). A comprehensive online directory of information on over 150 000 print and electronic publications and 8000 newspapers around the world. Free. Data come from sources such as 'Ulrich's International Periodicals Directory' and 'Editor and Publisher International year book.'
- ***Ulrich's Periodicals Directory.*** R. R. Bowker LLC, New Providence, NJ (http://www.csa.com/ulrichssupport). (Includes irregular serials and annuals.)
- ***Gale Directory of Publications and Broadcast Media.*** Tomson Gale, Detroit, MI (http://gale.cengage.com/).
- ***The Standard Periodical Directory.*** Oxbridge Communications, New York (For Oxbridge's excellent online resource Mediafinder, which locates journals, books, and newsletters, go to http://www.mediafinder.com).
- The **Library of Congress**' electronic catalogs (http://www.loc.gov).
- The **National Library of Medicine's** Public Access Catalog, 'Locator Plus (http://locatorplus.gov).
- ***NewJour.*** Electronic journals and newsletters available on the Internet (http://library.georgetown.edu/newjour/).

RESOURCES

Journals

Adverse Drug Reaction Bulletin (1966–)
Lippincott Williams and Wilkins, Philadelphia, PA
ISSN: 0044-6394
Web: http://www.lww.com

A bimonthly loose-leaf publication that typically presents a single article of clinical relevance on adverse effects of drugs.

Ambio (1972–)
Royal Swedish Academy of Sciences, Stockholm
ISSN: 0044-7447
Web: http://ambio.allenpress.com

Presents reports, synopses, and comments related to the sustainable use of natural resources, global change, and other general environmental issues.

American Journal of Industrial Medicine (1980–)
Wiley-Liss, New York
ISSN: 0271-3586
Web: http://www3.interscience.wiley.com

This distinguished journal covers a broad array of topics related to environmental and occupational health and is a good source for epidemiological studies.

American Journal of Pharmacology and Toxicology (2006–)
Science Publications, Vails Gate, NY
ISSN: 1557-4962
Web: http://www.scipub.org

Publishes articles on all aspects of pharmacology and toxicology.

Annals of the ICRP (1977–)
Pergamon Press, Oxford, UK
ISSN: 0416-6453
Web: http://www.elsevier.com

A review journal presenting the reports and recommendations of the International Commission on Radiological Protection, a group dedicated to providing guidance on the widespread use of radiation sources caused by developments in the field of nuclear energy.

Annals of Occupational Hygiene (1958–)
Elsevier Science, Oxford, UK
ISSN: 0003-4878
Web: http://www.oxfordjournals.org/

Published for the British Occupational Hygiene Society. This journal promotes all aspects of occupational and environmental hygiene and health. It is aimed at all who are interested in the effects of work on health. Occupational toxicology is one of the core subject areas represented.

Annual Review of Pharmacology and Toxicology (1961–)
Annual Reviews, Palo Alto, CA
ISSN: 0362-1642
Web: http://arjournals.annualreviews.org

In aggregate, this review series with extensive references presents an encyclopedic look at all aspects of toxicology and pharmacology. It has a subject index for the current volume and cumulative author and chapter title indices for volumes from the preceding 5 years.

Aquatic Toxicology (1981–)
Elsevier, Amsterdam
ISSN: 0166-445X
Web: http://www.elsevier.com

Publishes original scientific papers and reviews dealing with such broad topics as mechanisms of toxicity in aquatic environments, effects of agents on aquatic ecosystems, toxicant-induced alterations in organisms, and human health aspects of aquatic toxicology.

Archives of Complex Environmental Studies (1989–)
ACES Pub. Ltd., Tampere, Finland
ISSN: 0787-0396

An international interdisciplinary journal on health sciences, environmental sciences, and applied environmental technology.

Archives of Environmental Contamination and Toxicology (1973–)
Springer-Verlag, New York
ISSN: 0090-4341
Web: http://www.springerlink.com

A repository of research articles covering air, water, and soil contamination and pollution and their human health aspects, as well as the effects of deleterious substances in the total environment.

Archives of Environmental & Occupational Health (1960–)
Heldref Publications, Washington, DC
ISSN: 0003-9896
Web: http://www.heldref.org

Formerly the *Archives of Environmental Health*, this is the official publication of the Society for Occupational and Environmental Health. Publishes epidemiological, clinical, and experimental studies dealing with the effects of environmental agents on human health. Especially interested in the health significance of toxic waste, new energy technology and industrial processes, and the environmental causation of neurobehavioral dysfunction, birth defects, cancer, and chronic degenerative disease.

Archives of Toxicology (1930–)
Springer-Verlag, Berlin
ISSN: 0340-5761
Web: http://www.springerlink.com

This august journal with a long history aims to provide up-to-date information on the latest advances in

toxicology. Particular emphasis is given to studies relating to defined effects of chemicals and mechanisms of toxicity, including toxic activities at the molecular level in humans and experimental animals. Also devotes space to analysis, toxicokinetics, and forensic toxicology. It is the official journal of the European Society of Toxicology (EUROTOX) and publishes the proceedings of EUROTOX meetings as annual supplements.

Archives of Toxicology, Kinetics and Xenobiotic Metabolism (1993–)
ISSN: 0354-3854
Web: http://www.periodicals.ru/import

Toxicology Section of the Serbian Medical Society, Belgrade, Federal Republic of Yugoslavia

Devoted to the evaluation of data, methods, and opinions in the fields of toxicology, pharmacology, clinical pharmacology, and xenobiotic metabolism.

Atmospheric Environment (1967–)
Elsevier Science, Oxford, UK
ISSN: 1352-2310
Web: http://www.elsevier.com (1994–)
ISSN: 0960-1686 (Part A 1991–1993)
ISSN: 0957-1272 (Part B 1991–1993)
ISSN: 0004-6981 (1967–1989)

Covers all aspects of the interaction of people and ecosystems with their atmospheric environment. Includes such areas as air pollution research, air quality and its effects, dispersion and transport, deposition biospheric-atmospheric exchange, etc.

Basic & Clinical Pharmacology and Toxicology (1945–)
Nordic Pharmacological Society, Copenhagen
ISSN: 1742-7835
Web: http://www.blackwellpublishing.com

Continues *Pharmacology and Toxicology*, and before that, *Acta Pharmacologica et Toxicologica*. Publishes original scientific research in all fields of experimental pharmacology and toxicology, including biochemical, cellular, and molecular pharmacology and toxicology.

Biodegradation (1990–)
Kluwer Academic, Dordrecht, The Netherlands
ISSN: 0923-9820
Web: http://www.springer.com

Publishes papers on all aspects of science pertaining to the detoxification, recycling, amelioration, or treatment of waste materials and pollutants by naturally occurring microbial strains or associations or recombinant microorganisms.

Bioelectromagnetics (1980–)
Wiley-Liss, New York
ISSN: 0197-8462
Web: http://www.wiley.com

Journal of the Bioelectromagnetics Society, the Society for Physical Regulation in Biology and Medicine, and the European Bioelectromagnetics Association. Devoted to research on biological systems as they are influenced by natural or manufactured electric and/or magnetic fields.

Biomarkers (1996–)
Taylor & Francis, London
ISSN: 1354-750X
Web: http://www.tandf.co.uk

Subtitled *Biochemical Indicators of Exposure, Response and Susceptibility to Chemicals*. Includes papers on the development and validation of biomarkers and their use and interpretation. Contains original articles, short communications, and reviews.

Biomedical and Environmental Sciences (1988–)
Academic Press, Duluth, MN
ISSN: 0895-3988
Web: http://www.besjournal.com

An international journal with an emphasis on scientific findings in China, published under the auspices of the Chinese Center for Disease Control and Prevention. Publishes English-language articles dealing with biological and toxic effects of environmental pollutants on humans and other forms of life. Also publishes reports dealing with the entry, transport, and fate of natural and anthropogenic chemicals in the biosphere and their impact on human health and well-being.

BMC Clinical Pharmacology (2001–)
BioMed Central, London
ISSN: 1472-6904
Web: http://www.biomedcentral.com

An open access journal publishing original peer-reviewed research articles in all aspects of clinical pharmacology, including adverse drug reactions and toxicology.

Bulletin of Environmental Contamination and Toxicology (1966–)
Springer-Verlag, New York
ISSN: 0007-4861
Web: http://www.springer.com

Provides rapid publication of significant advances and discoveries in the fields of air, soil, water, and food contamination and pollution, as well as articles on

methodology and other disciplines concerned with the introduction, presence, and effects of toxicants in the total environment.

Birth Defects Research Part B: Developmental and Reproductive Toxicology (2003–)
Wiley-Liss, Inc. Hoboken, NJ
ISSN: 1542-9733
Web: http://www.wiley.com

An official publication of the Teratology Society, formerly published as *Teratogenesis, Carcinogenesis and Mutagenesis*. Provides original research and reviews in fields related to embryo-fetal development and reproduction. Part A of this journal is titled *Clinical and Molecular Teratology* and Part C is titled *Embryo Today: Reviews*.

Cancer Causes and Control (1990–)
Rapid Communications of Oxford, Ltd.
ISSN: 0957-5243
Web: http://www.springer.com

Reports on and stimulates new avenues of investigation into the causes, control, and subsequent prevention of cancer.

Carcinogenesis (1980–)
Oxford University Press, Oxford, UK
ISSN: 0143-3334
Web: http://www.oxfordjournals.org

A multidisciplinary journal publishing full-length papers and short communications in the areas of cancer biology, molecular epidemiology, cancer prevention, and carcinogenesis (including viral, chemical, and physical carcinogenesis, metabolism of carcinogens, and the formation, detection, identification, and quantification of environmental carcinogens).

Cardiovascular Toxicology (2001–)
Humana Press, Totowa, NJ
ISSN: 1530-7905
Web: http://www.humanapress.com

Publishes papers that elucidate the effects, molecular mechanisms, and signaling pathways of environmental toxicants on the cardiovascular system; reports on the detrimental effects of new cardiovascular drugs as well as the cardiovascular effects of non-cardiovascular drugs, anticancer chemotherapy and gene therapy; and reports safety and toxicological data on new cardiovascular and non-cardiovascular drugs.

Cell Biology and Toxicology (1984–)
Kluwer Academic, Dordrecht, The Netherlands
ISSN: 0742-2091
Web: http://www.springer.com

Official journal of the Societe Pharmaco-Toxicologie Cellulaire. Provides a rapid publication outlet for papers in the areas of cell biology and genetic, molecular, and cellular toxicology.

Central European Journal of Occupational and Environmental Medicine (1995–)
Occupational Health Foundation and National Institute of Occupational Health, Budapest, Hungary

Deals with health effects and prevention of work-related diseases, epidemiological studies, and experimental studies on occupational and environmental health effects.

Chemical Research in Toxicology (1988–)
American Chemical Society, Washington, DC
ISSN: 0893-228X
Web: http://pubs.acs.org

Published with the cooperation of the International Society for the Study of Xenobiotics. Includes articles, communications, invited reviews, and perspectives on structural, mechanistic, and technological advances in research related to the toxicological effects of chemical agents.

Chemico-Biological Interactions (1969–)
Elsevier, Shannon, Ireland
ISSN: 0009-2797
Web: http://www.elsevier.com

Subtitled *A Journal of Molecular and Biochemical Toxicology*, this is the official journal of the Hepatocyte Users Group of North America, publishing research reports, rapid communications, review articles, and commentaries that examine: the molecular aspects of cytotoxicity, carcinogenesis, mutagenesis, and teratogenesis; and the molecular mechanisms by which drugs exert their therapeutic or toxic effects.

Chemosphere (1972–)
Elsevier Science, Oxford, UK
ISSN: 0045-6535
Web: http://www.elsevier.com

Subtitled *Chemistry, Biology and Toxicology as Related to Environmental Problems*. Covers topics such as environmental fate of chemicals, ecotoxicology, atmospheric chemistry and global change, environmental chemicals and analysis, air and water pollution, toxicology and effects on humans, occupational hazards and exposure, and environmental technology.

Clinical Toxicology (1968–)
Taylor & Francis, New York
ISSN: 0731-3810
Web: http://www.tandf.co.uk

Formerly the *Journal of Toxicology. Clinical Toxicology*, an official publication of the American Academy of Clinical Toxicology and the European Association of Poisons Centres and Clinical Toxicologists. Publishes peer-reviewed scientific research related to advances in clinical toxicology.

Comparative Biochemistry and Physiology. Part C: Toxicology & Pharmacology (2001–)
Elsevier Science, New York
ISSN: 1532-0456 (2001–)
Web: http://www.elsevier.com
ISSN: 0742-8413 (1993–2000)
ISSN: 0742-8413 (1983–1993)

Publishes original articles concerned with chemical and drug action at different levels of organization; biotransformation of xenobiotics; mechanisms of toxicity, including reactive oxygen species and carcinogenesis; endocrine disruptors; natural products chemistry; and signal transduction.

Contact Dermatitis (1975–)
Munksgaard, Copenhagen
ISSN: 0105-1873
Web: www.blackwellpublishing.com

The official publication of the European Society of Contact Dermatitis, this journal is designed primarily for clinicians interested in various types of occupational dermatitis. This includes both allergic and irritant (toxic) types of contact dermatitis, occupational (industrial) dermatitis, and consumer's dermatitis from such products as cosmetics and toiletries.

Critical Reviews in Environmental Science and Technology (1970–)
CRC Press, Boca Raton, FL
ISSN: 1064-3389
Web: http://www.tandf.co.uk

An international forum for the critical review of current knowledge on the broad range of topics constituting environmental science.

Critical Reviews in Toxicology (1971–)
Taylor & Francis, Philadelphia, PA
ISSN: 1040-8444
Web: http://www.tandf.co.uk

Extensive up-to-date critical assessment of toxicology and related scientific disciplines.

Cutaneous and Ocular Toxicology (1982–)
Taylor & Francis, Philadelphia, PA
ISSN: 1556-9527
Web: http://www.tandf.co.uk

Formerly the *Journal of Toxicology. Cutaneous and Ocular Toxicology*, this is the official journal of the International Society of Ocular Toxicology (ISOT). Explores cutaneous and ocular irritation, sensitization, phototoxicity, and photoallergenicity of cosmetics, drugs, soaps, and other detergents, fragrances, textiles, preservatives, adhesives, environmental exposures, and occupational exposures.

Drug and Chemical Toxicology (1978–)
Marcel Dekker, New York
ISSN: 0148-0545
Web: http://www.tandf.co.uk

Publishes full-length research papers, review articles, and short communications relating to the broad spectrum of toxicological data relevant to risk assessment and harmful effects due to exposure.

Drug Metabolism and Disposition (1973–)
American Society for Pharmacology and Experimental Therapeutics (ASPET), Bethesda, MD
ISSN: 0090-9556
Web: http://www.aspet.org

An official publication of the American Society for Pharmacology and Experimental Therapeutics. Articles describe the results of original research on xenobiotic metabolism and disposition. Xenobiotics include therapeutic agents as well as environmental chemicals, and research may involve the use of in vivo or in vitro approaches, including cultured cells and heterologous expression systems.

Drug Metabolism and Drug Interactions (1988–)
Freund, London
ISSN: 0334-2190
Web: http://www.freundpublishing.com

Devoted to mechanisms by which drugs and other foreign compounds are metabolized; the mechanisms by which drugs may interact with each other as well as with biological systems; and the pharmacological and toxicological consequences of such metabolism and interaction.

Drug Metabolism Reviews (1972–)
Marcel Dekker, New York
ISSN: 0360-2532
Web: http://www.tandf.co.uk

Features critical, in-depth reviews dealing with the fate of xenobiotics (drugs and other foreign compounds) in any biological system.

Drug Safety (1990–)
ADIS International, Auckland, New Zealand
ISSN: 0114-5916
Web: http://www.ingenta.com

Aims to assist in the further development of the rational use of drugs, focusing on practical medical aspects

relevant to the diagnosis and treatment of acute poisonings and the recognition, epidemiology, management, and avoidance of adverse drug reactions.

EcoHealth (2004–)
Springer, New York
ISSN: 1612-9202
Web: http://www.springer.com

This journal arises from the merging of two complementary journals, *Ecosystem Health* and *Global Change and Human Health*. Focuses on human and wildlife health, and the integration of knowledge at the interface between ecological and human health sciences.

Ecotoxicology (1992–)
Springer, Netherlands
ISSN: 0963-9292
Web: http://www.springer.com

Publishes fundamental research on the effects of toxic chemicals on populations, communities, and terrestrial, freshwater, and marine ecosystems. Aims to elucidate mechanisms and processes whereby chemicals exert their effects on ecosystems and the impact caused at the population or community level.

Ecotoxicology and Environmental Safety (1977–)
Academic Press, Orlando, FL
ISSN: 0147-6513
Web: http://www.elsevier.com

Official journal of the International Society of Ecotoxicology and Environmental Safety. Publishes manuscripts dealing with studies of the biological and toxic effects caused by natural or synthetic chemical pollutants to ecosystems, whether animal, plant, or microbial.

Environment (1969–)
Heldref Publications, Washington, DC
ISSN: 0013-9157
Web: http://www.heldref.org

Offers authoritative analyses of key environmental issues via comprehensive articles, critical reviews of major governmental and institutional reports, book recommendations, commentaries, and news briefs.

Environment International (1978–)
Pergammon, New York
ISSN: 0160-4120
Web: http://www.elsevier.com

Subtitled, *A Journal of Environmental Science, Risk & Health*, it publishes articles that quantify the impact of chemical, biological, and physical contaminants in the human environment and addresses human impacts on the natural environment.

Environmental Dermatology (1994–)
Japanese Society for Contact Dermatitis, Nagoya, Japan
ISSN: 1340-4601
Web: http://www.fujita-hu.ac.jp/JSCD

The official journal of the Japanese Society for Contact Dermatitis. Publishes manuscripts covering the scope of environmental (daily life and occupational) dermatology from basic studies to pre-clinical and clinical studies.

Environmental Engineering Science (1997–)
Mary Ann Liebert, Larchmont, NY
ISSN: 1092-8758
Web: http://www.liebertpub.com

Publishes papers on environmental science topics that include development and application of fundamental principles toward solving problems in land, air, and water media.

Environmental Forensics (1999–)
Taylor & Francis, Philadelphia, PA
ISSN: 1527-5922
Web: http://www.tandf.co.uk

A forum for scientific investigations that address contamination within the environmental media of air, water, soil, and biota that is subject to law court, arbitration, public debate, or formal argumentation. The journal is an international, quarterly, peer-reviewed publication offering scientific studies that explore source, fate, transport, and human health and ecological effects of environmental contamination, with contamination being delineated in terms of chemical characterization, biological influence, responsible parties, and legal consequences.

Environmental Geochemistry and Health (1985–)
Springer-Verlag, Netherlands
ISSN: 0269-4042
Web: http://www.springer.com

Covers all aspects of applied environmental geochemistry, including pollution and the influence of the environment on plant, animal, and human life.

Environmental Health and Preventive Medicine (1996–)
Japanese Society for Hygiene, Sapporo, Japan
ISSN: 1342-078X
Web: http://www.nacos.com/jsh

Official journal of the Japanese Society for Hygiene. Devoted to the publication of papers on human health sciences related to biological, physical, chemical, medical, psycho-social, and other environmental factors.

Environmental Health Perspectives (1972–)
U.S. National Institute of Environmental Health Sciences, Research Triangle Park, NC
ISSN: 0091-6765
Web: http://www.ehponline.org

A very informative and well-designed journal serving as a forum for the discussion of issues in environmental health, including molecular studies related to environmental health and susceptibility. Includes perspectives, correspondence, commentary, news, and research articles, plus occasional supplements.

Environmental Management (1976–)
Springer-Verlag, New York
ISSN: 0364-152X
Web: http://www.springer.com

An international journal for decision-makers, scientists, and environmental auditors. Publishes research and opinion concerning the use and conservation of natural resources, the protection of habitats, and the control of hazards.

Environmental Modeling and Software (1986–)
Elsevier Science, New York
ISSN: 1364-8152 (1997–)
Web: http://www.elsevier.com
ISSN: 0266-9838 (1986–1996)

Publishes research articles, review papers, and short communications on recent advances in environmental modeling and software. Includes Environment Data News, available gratis online (http://www.uea.ac.uk/%7Ee870/envdata.html).

Environmental and Molecular Mutagenesis (1979–)
Wiley-Liss, New York
ISSN: 0893-6692 (1987–)
Web: http://www.wiley.com
ISSN: 0192-2521 (1979–1987)

Publishes original research papers on mutation and mutation-related topics, such as mechanisms of mutagenesis, environmental modification of DNA, repair of DNA damage, genetic and cytogenetic methods for studying genetic damage, mutagenicity screening, methods for estimating mutagenic hazards to humans, and epidemiological studies relating to environmental mutagens.

Environmental Monitoring and Assessment (1981–)
Kluwer Academic Publishers, Dordrecht, The Netherlands
ISSN: 0167-6369
Web: http://www.springer.com

Emphasizes technical developments and data arising from environmental monitoring and assessment, the use of scientific principles in the design of monitoring systems, and the use of monitoring data in assessing pollution risks to humans and the environment.

Environmental Pollution (1970–)
Elsevier Science, Oxford, UK
ISSN: 0269-7491(1987–)
Web: http://www.elsevier.com
ISSN: 0143-1471 (1980–1986)
ISSN: 0013-9327 (1970–1979)

An international journal addressing issues relevant to the nature, distribution, and ecological effects of all types and forms of chemical pollutants in air, soil, and water.

Environmental Research (1967–)
Academic Press, Orlando, FL
ISSN: 0013-9351
Web: http://www.elsevier.com

Subtitled *A Multidisciplinary Journal of Environmental Sciences, Ecology, and Public Health*. Publishes original reports describing studies of the toxic effects of environmental agents and conditions in humans and animals, including both experimental subjects and ecosystems. A true multi-disciplinary journal.

Environmental Science and Pollution Research International (1994–)
ECOMED, Landsberg, Germany
ISSN: 0944-1344
Web: http://www.ecomed.de

A wide-ranging look at a variety of issues relevant to the environment and toxicology.

Environmental Science and Technology (1967–)
American Chemical Society, Washington, DC
ISSN: 0013-936X
Web: http://pubs.acs.org

Covers a wide range of environmental disciplines via feature articles, environmental policy analysis, research watch, letters, research papers, communications, and critical reviews.

Environmental Sciences (1991–)
Scientific Publishing Division of MYU, Tokyo
ISSN 0915-955X
Web: http://www.myu-inc.jp/myukk/ES/index.html

Subtitled *An International Journal of Environmental Physiology and Toxicology*. Includes original research and reviews on the chemical characteristics of substances found in air, water, and soil and their biological and toxicological effects on plants, animals, and humans.

Environmental Toxicology (1986–)
John Wiley, New York
ISSN: 1520-4081 (1999–)
Web: http://www.wiley.com
ISSN: 1053-4725 (1991–1998)

Formerly called *Environmental Toxicology and Water Quality*. Devoted to the publication of papers on all aspects of environmental toxicology, including mechanisms, fate, and pathways; ecosystem impact assessment, water, air, and soil quality criteria; etc.

Environmental Toxicology and Chemistry (1982–)
SETAC Press, Pensacola, FL
ISSN: 0730-7268
Web: http://www.setac.org

The official journal of the Society of Environmental Toxicology and Chemistry. Divided into three sections: Environmental Chemistry, Environmental Toxicology, and Hazard/Risk Assessment.

Environmental Toxicology and Pharmacology (1996–)
Elsevier, Amsterdam
ISSN 1382-6689
Web: http://www.elsevier.com

Publishes results of studies concerning toxic and pharmacological effects of human and veterinary drugs and of environmental contaminants in animals and humans. Full-length papers, short communications, full-length reviews, and mini-reviews.

Food Additives and Contaminants (1984–)
Taylor and Francis, London
ISSN: 0265-203X
Web: http://www.tandf.co.uk

Includes articles relating to the detection, determination, occurrence, persistence, safety evaluation, and control of naturally occurring and man-made additives and contaminants in the food chain.

Food and Chemical Toxicology (1963–)
Elsevier Scientific, Exeter, UK
ISSN: 0278-6915 (1982–)
Web: http://www.elsevier.com
ISSN: 0015-6264 (1963–1981)

A continuation of *Food and Cosmetics Toxicology*. An international journal published in association with BIBRA (British Industrial Biological Research Association). Publishes papers reporting and interpreting original toxicological research, particularly studies presenting an understanding of the mechanisms that underlie toxic effects or improvements in methods for predicting adverse effects. Also includes brief communications, reviews, letters to the editor, abstracts from the literature, and a current awareness section.

Food and Drug Law Journal (1946–)
Food and Drug Law Institute, Washington, DC
ISSN: 1064-590X
Web: http://www.fdli.org

The official journal of the Food and Drug Law Institute. Papers on the progress of the law in the fields of foods, drugs, cosmetics, medical devices, and biologics.

Free Radical Biology and Medicine (1987–)
Elsevier Science, New York
ISSN: 0891-5849
Web: http://www.elsevier.com

The official journal of the Society for Free Radical Biology and Medicine. Features papers on chemical, biochemical, physiological, pathological, pharmacological, toxicological, and medical approaches to free radical research.

Free Radical Research (1985–)
Harwood Academic, Amsterdam
ISSN: 1071-5762
Web: http://www.tandf.co.uk

Publishes articles on the chemistry of free radicals, the production of free radicals by xenobiotics and biological systems, free radical damage to cells and tissues, and defense mechanisms against free radical damage.

Green Chemistry (1999–)
Royal Society of Chemistry, Cambridge, UK
ISSN: 1463-9262
Web: http://www.rsc.org

Covers all research that relates to a reduction in the environmental impact of chemicals, whether from improved production methods; formulation and delivery systems; the use of sustainable resources; use or recovery and recycling of waste; or product substitution. Includes life-cycle analysis, environmental risk analysis, and legislation.

Health Physics (1958–)
Williams and Wilkins, Baltimore, MD
ISSN: 0017-9078
Web: http://www.lww.com

Official journal of the Health Physics Society. Publishes manuscripts on the theoretical and applied fields of radiation protection, including ionizing and non-ionizing radiation.

Human and Ecological Risk Assessment (1995–)
Taylor & Francis, Philadelphia
ISSN: 1080-7039
Web: http://www.tandf.co.uk

Designed to enhance the communication and cooperation of professionals working on human risk assessment

with those in ecological risk assessment. Looks at such issues such as exposure assessment, hazard assessment, environmental fate assessment, epidemiology, animal extrapolation, risk management, and risk communication.

Human and Experimental Toxicology (1981–)
SAGE Publications, London
ISSN: 0960-3271
Web: http://www.sagepub.co.uk

The official journal of the British Toxicology Society. Papers are published on all aspects of experimental and clinical studies of functional, biochemical, immunologic, and pathological toxic processes and disorders in vivo and in vitro; on their causal mechanisms; on toxicity in human and animal patients; and on the treatment of toxicity.

Immunopharmacology and Immunotoxicology (1978–)
Taylor and Francis, New York
ISSN: 0892-3973
Web: http://www.tandf.co.uk

A forum for publication of clinical studies and research results in the areas of immunopharmacology and immunotoxicology. The basic theme deals with alterations of the immune system.

Indoor Air (1991–)
Blackwell Publishing, Copenhagen
ISSN: 0905-6947
Web: http://www.blackwellpublishing.com

Official journal of the International Society of Indoor Air Quality and Climate. Provides a forum for reporting original research results in the broad area defined by the indoor environment of non-industrial buildings.

Indoor and Built Environment (1992–)
SAGE Publications, Thousand Oaks, CA
ISSN: 1420-326X
Web: http://www.sagepub.co.uk

The journal of the International Society of the Built Environment. Topics covered pertain to the quality of the indoor and built environment and how these might affect the health, performance, efficiency, and comfort of people living or working there.

Industrial Health (1963–)
National Institute of Industrial Health, Kawasaki, Japan
ISSN: 0019-8366
Web: http://www.jniosh.go.jp

Covers research pertaining to prevention of occupational diseases and to the maintenance and promotion of workers' health.

Inhalation Toxicology (1989–)
Taylor and Francis, Philadelphia, PA
ISSN: 0895-8378
Web: http://www.tandf.co.uk

A key forum for international exchange of the latest advances in pulmonary toxicology. Topics include the pathogenesis and mechanism of lung disease, extrapolation of animal data to humans, effects of inhaled chemicals on the extrapulmonary system, innovative lung model systems for predicting human disease, aerosol science, and new inhalation exposure techniques.

International Archives of Occupational and Environmental Health (1930–)
Springer-Verlag, Berlin
ISSN: 0340-0131
Web: http://www.springer.com

Covers topics such as clinical and epidemiological studies on morbidity and mortality, studies relevant to the estimation of human health risks, human experimental studies on environmental health effects, and methods. Includes original articles, editorials, reviews, short communications, and book reviews.

International Journal of Environmental Health Research (1991–)
Taylor & Francis, Oxfordshire, UK
ISSN: 0960-3123
Web: http://www.tandf.co.uk

A quarterly publication devoted to rapid publication of research in environmental health. It considers the natural environment and health, the built environment and health, and communicable diseases.

International Journal of Environmental Studies (1970–)
Gordon and Breach, New York
ISSN: 0020-7233
Web: http://www.tandf.co.uk

Section A, Environmental Studies, covers areas such as ecology, occupational hygiene, industrial health, radiation, noise, pollution, environmental medicine, etc. *Section B, Environmental Science and Technology*, covers areas such as acid rain, air and water pollution control processes and technology, occupational health, water chemistry, etc.

International Journal of Occupational and Environmental Health (1995–)
Hanley and Belfus, Philadelphia, PA
ISSN: 1077-3525
Web: http://www.ijoeh.com

The official journal of the International Commission on Occupational Health. Publishes papers in the broad field of occupational and environmental medicine.

International Journal of Occupational Medicine and Environmental Health (1988)
Nofer Institute of Occupational Medicine and the Polish Association of Occupational Medicine, Lodz, Poland
ISSN: 1077-3525
Web: http://versita.com

Provides a good, largely European perspective on occupational medicine and environmental health.

International Journal of Radiation Biology (1959–)
Taylor and Francis, London
ISSN: 0955-3002
Web: http://www.tandf.co.uk

Focuses on the physical, chemical, and especially biological and medical effects of ionizing and non-ionizing radiation. Includes book reviews and meetings calendar.

International Journal of Toxicology (1982–)
Taylor and Francis, Washington, DC
ISSN: 1091-5818
Web: http://www.tandf.co.uk

Formerly titled *Journal of the American College of Toxicology*, this is the College's official journal. Offers papers on the toxicity of industrial chemicals, pharmaceutical agents, environmental contaminants, and other entities and explores their mechanisms of action or relevance to human health. Special issues are devoted to the Cosmetic Ingredients Review Expert Panel and the Acute Toxicity Data Report.

Journal of the Air and Waste Management Association (1955–)
Air and Waste Management Association, Pittsburgh, PA
ISSN: 1096-2247
Web: http://www.awma.org/journal

Presents papers of interest to professionals in the air pollution control and waste management fields.

Journal of Analytical Toxicology (1977–)
Preston Publications, Niles, IL
ISSN: 0146-4760
Web: http://www.jatox.com

Papers relate to the isolation, identification, and quantitation of potentially toxic substances and their biotransformation products in specimens of human, animal, or environmental origin.

Journal of Applied Toxicology (1981–)
John Wiley and Sons, Chichester, UK
ISSN: 0260-437X
Web: http://www.wiley.com

Areas of concern include the study of toxic effects of chemicals and materials in the fields of teratology, reproduction, mutagenesis, carcinogenesis, health, the environment, pathology, pharmacokinetics, and biochemical mechanisms, as well as epidemiology and analytical methods and alternatives to the use of animals.

Journal of the Association of Food and Drug Officials (1937–)
Association of Food and Drug Officials, York, PA
ISSN: 0898-4131
Web: http://www.afdo.org

The mission of the Association of Food and Drug Officials as reflected in its journal, is to further uniformity in the adoption and enforcement of food, drug, medical devices, cosmetics, and product safety laws, rules, and regulations.

Journal of Biochemical and Molecular Toxicology (1986–)
John Wiley and Sons, New York
ISSN: 1095-6670
Web: http://www.wiley.com

Contains original research papers, rapid communications, mini-reviews, and book reviews, all focusing on the molecular mechanisms of action and detoxification of exogenous and endogenous chemicals and toxic agents.

Journal of Environmental Biology (1980–)
JEB Foundation, Muzaffarnagar, India
ISSN: 0254-8704
Web: http://www.geocities.com/j_environ_biol

A research journal publishing original research and short research papers, as well as short reviews, dealing with environmental pollution and toxicology of plants and animals.

Journal of Environmental Health (1938–)
National Environmental Health Association, Denver, CO
ISSN: 0022-0892
Web: http://www.neha.org

Official publication of the National Environmental Health Association, presenting interesting feature articles, updates, news items, calendar, and career opportunities, all relating to environmental health.

Journal of Environmental Medicine (1999–)
John Wiley and Sons, Chichester, UK
ISSN: 1095-1539
Web: http://www3.interscience.wiley.com

Publishes original papers relating to environmental medicine and allied disciplines, focusing on the adverse effects on humans of external physical, chemical, and biological factors in the general environment, primarily from a medical standpoint. Emphasizes identification, prevention, diagnosis, and management of adverse health effects in humans, related to the physical and chemical contamination of outdoor and indoor air, soil, and water.

Journal of Environmental Monitoring (1999–)
Royal Society of Chemistry, Cambridge, UK
ISSN: 1464-0325
Web: http://www.rsc.org

Dedicated to assessing exposure and health risks through the latest developments in measurement science. Intended for environmental and health professionals in industry, officials from governmental and regulatory agencies, and research scientists interested in the environment.

Journal of Environmental Pathology, Toxicology and Oncology (1977–)
Begell House, New York
ISSN: 0731-8898
Web: http://www.begellhouse.com

Official organ of the International Society for Environmental Toxicology and Cancer. Publishes research on ecological effects on the structure and function of cells and tissues, with an emphasis on the environmental effects on carcinogenesis.

Journal of Environmental Quality (1972–)
American Society of Agronomy, Madison, WI
ISSN: 0047-2425
Web: http://www.agronomy.org

Deals with aspects of environmental quality in natural and agricultural ecosystems. Main sections are technical reports, reviews and analyses, short communications, and environmental issues.

Journal of Environmental Radioactivity (1984–)
Elsevier Science, Oxford, UK
ISSN: 0265-931X
Web: http://www.elsevier.com

Includes research and review papers on all aspects of the occurrence of radioactivity in natural systems.

Journal of Environmental Science and Health (1976–)
Taylor & Francis, Philadelphia, PA
ISSN: (Part A) 1093-4529
Web: http://www.tandf.co.uk
(Part B) 0360-1234
(Part C) 1059-0501

Part A, Toxic/Hazardous Substances & Environmental Engineering, covers science and engineering as applied to environmental problems. *Part B, Pesticides, Food Contaminants, and Agricultural Wastes*, focuses on such areas as analytical techniques applicable to residues, persistence, binding, translocation, biodegradation, fate, etc. *Part C, Environmental Carcinogenesis and Ecotoxicology Reviews*, covers environmental carcinogenesis, related broad aspects of other environmentally induced pathogenesis, and ecotoxicology.

Journal of Exposure Science and Environmental Epidemiology (1991–)
Nature Publishing Group, New York
ISSN: 1559-064X
Web: http://www.nature.com

Formerly the *Journal of Exposure Analysis and Environmental Epidemiology*, this is the official publication of the International Society of Exposure Analysis. Emphasis on exposure analysis includes: measurement and modeling; exposure mechanisms; molecular biomarkers; genomics, proteomics, and metabonomics; chemical, biological, and physical principles of human exposure analysis; occupational exposure studies; and population-based studies.

Journal of Food Protection (1977–)
International Association for Food Protection, Des Moines, IA
ISSN: 0362-028X
Web: http://www.foodprotection.org

Official publication of the International Association for Food Protection (IAFP), whose mission is to provide food safety professionals worldwide with a forum to exchange information on protecting the food supply.

Journal of Hazardous Materials (1975–)
Elsevier, Amsterdam
ISSN: 0304-3894
Web: http://www.elsevier.com

Deals with all aspects of hazardous materials arising from their inherent chemical or physical properties. *Part A: Risk Assessment and Management*, deals with the characterization of the harmful effects of hazardous materials. *Part B: Environmental Technologies*, addresses pollution control processes for solid, liquid and gaseous wastes as well as the remediation of soil and groundwater contamination.

Journal of Medical Toxicology (2005–)
University of Pennsylvania Press, Philadelphia PA
ISSN: 1556-9039
Web: http://www.upenn.edu/pennpress

The official print journal of the American College of Medical Toxicology. Focuses on the diagnosis, management, and prevention of poisoning and toxicity and other adverse health effects resulting from medications, chemicals, occupational, and environmental agents and biological hazards.

Journal of Nutritional and Environmental Medicine (1990–)
Taylor & Francis, London
ISSN: 1359-0847
Web: http://www.tandf.co.uk

Formerly the *Journal of Nutritional Medicine*. Focuses on studies of clinical relevance in areas such as toxicology, nutritional toxicology, chemical sensitivity, allergy, nutrition and reproductive function, antioxidants, nutritional supplementation, etc.

Journal of Occupational and Environmental Hygiene (2004–)
Taylor and Francis, Inc., Philadelphia, PA
ISSN: 1545-9624
Web: http://www.tandf.co.uk

A joint publication of the American Conference of Governmental Industrial Hygienists and American Industrial Hygiene Association, this journal succeeds the AIHA Journal and Applied Occupational and Environmental Hygiene. Publishes research and other articles concerning the recognition, evaluation, and control of potential occupational health hazards in the work environment and in the community.

Journal of Occupational and Environmental Medicine (1959–)
Lipincott Williams and Wilkins, Baltimore, MD
ISSN: 1076-2752
Web: http://www.joem.org

Official journal of the American College of Occupational and Environmental Medicine. A wide-ranging journal covering many areas related to occupational medicine and the environment.

Journal of Occupational Medicine and Toxicology (2006–)
BioMed Central, London
Web: http://www.occup-med.com

This is an open access online journal aimed at clinicians and researchers interested in the diagnosis, prevention, management, and analysis of occupational diseases, injuries, and disability, as well as in the promotion of health in workers, their families, and communities. Articles published include original research, reviews, short reports, methodology articles, case reports, commentaries, debates, and hypotheses.

Journal of Pharmacological and Toxicological Methods (1978–)
Elsevier Science, New York
ISSN: 1056-8719
Web: http://www.elsevier.com

Formerly published as *Journal of Pharmacological Methods*. Publishes original scientific papers arising from the development of new and/or existing methods of investigation used in pharmacology and toxicology.

Journal of Radiation Research (1960–)
Japan Radiation Research Society, Chiba, Japan
ISSN: 0449-3060
Web: http://www.jstage.jst.go.jp

Official organ of the Japan Radiation Research Society. Articles in a broad spectrum of radiation research areas.

Journal of Radiological Protection (1981–)
Institute of Physics Publishing, Bristol, UK
ISSN: 0952-4746
Web: http://www.iop.org

Official journal of the UK Society for Radiological Protection. Covers all aspects of radiological protection, including non-ionizing and ionizing radiation, dosimetry, biological effects, etc.

Journal of Toxicological Sciences (1976–)
Japanese Society of Toxicological Sciences, Sapporo, Japan
ISSN: 0388-1350
Web: http://www.jtoxsci.org

An official journal of the Japanese Society of Toxicological Science. A general toxicology journal with an emphasis on experimental animal studies.

Journal of Toxicology and Environmental Health (1975–)
Taylor & Francis, Washington, DC
ISSN: (Part A) 1528-7394
Web: http://www.tandf.co.uk
(Part B) 1093-7404

Considers articles on the toxicological effects of natural and anthropogenic environmental pollutants and their actions on intact organisms as well as in in vitro systems. Fields of special interest include carcinogenesis, mutagenesis, teratology, neurotoxicity, environmental factors affecting health, risk assessment, and other toxicological phenomena. In two parts, A and B. Part B is entitled *Critical Reviews*.

Management of Environmental Quality: An International Journal (2003–)
Bradford, UK

ISSN: 1477-7835
Web: http://www.emeraldinsight.com
Previously published as Environmental Management and Health
Web: http://www.emeraldinsight.com/0956-6163.htm

Examines environmental factors and their impact on ecosystems and strategies for remediation of environmental problems, with a view to reducing deleterious effects of human activities.

Molecular Carcinogenesis (1985–)
Wiley-Liss, New York
ISSN: 0899-1987
Web: http://www.wiley.com

Presents information describing investigations of molecular aspects of the mechanisms involved in chemical, physical, and viral (biological) carcinogenesis – in the forms of brief communications, research papers, and working hypotheses.

Mutagenesis (1986–)
Oxford University Press, Oxford, UK
ISSN: 0267-8357
Web: http://www.oxfordjournals.org

A multidisciplinary journal designed to bring together research aimed at the identification, characterization, and elucidation of the mechanisms of action of physical, chemical, and biological agents capable of producing genetic change in living organisms and at the study of the consequences of such changes.

Mutation Research (1964–)
Elsevier, Amsterdam
ISSN: 0027-5107
Web: http://www.elsevier.com

A group of journals related to mutagenesis, chromosome breakage, and related subjects. The journal presently consists of three different sections under the collective title of Mutation Research. The sections are titled: Fundamental and Molecular Mechanisms of Mutagenesis; Genetic Toxicology and Environmental Mutagenesis; and Reviews in Mutation Research. An allied volume, DNA Repair: Responses to DNA damage and other aspects of genomic stability, is editorially separate from *Mutation Research* but remains part of the full-set subscription.

Nanotoxicology (2007–)
Taylor and Francis Group, London
ISSN:1743-5390
Web: http://www.informaworld.com

Addresses human and environmental exposures, hazards and risks associated with the use and development of nano-structured materials, including 'materials with at least one dimension in the nanometer size range'. These nanomaterials include a range of materials generated for purposeful delivery into the body (food, medicines, diagnostics, and prosthetics), consumer products (e.g. paints, cosmetics, electronics, and clothing), and particles designed for environmental applications (e.g. remediation).

Neurotoxicity Research (1999–)
F.P. Graham Publishing, Mountain Home, TN
ISSN: 1029-8428
Web: http://www.fpgrahamco.com

Official journal of the Neurotoxicity Society. Reports both basic and clinical research on classical neurotoxicity mechanisms associated with neurodegeneration, necrosis, neuronal apoptosis, nerve regeneration and neurotrophin mechanisms, and related topics.

Neurotoxicology (1979–)
Elsevier Science, New York
ISSN: 0161-813X
Web: http://www.elsevier.com

Publishes peer-reviewed original research dealing with the effects of toxic substances on the nervous system of humans and experimental animals of all ages. Emphasizes papers dealing with the neurotoxic effect of environmentally significant chemical hazards, manufactured drugs, and naturally occurring compounds.

Neurotoxicology and Teratology (1981–)
Elsevier Science, New York
ISSN: 0892-0362
Web: http://www.elsevier.com

Sponsored by the Behavioral Toxicology Society and the Neurobehavioral Teratology Society. Presents original research reports of systematic studies in the areas of neurotoxicology and developmental toxicology in which the primary emphasis and theoretical content are on the nervous system and behavior. Includes brief communications and mini-reviews.

Occupational and Environmental Medicine (1994–)
British Medical Journal Publishing Group, London
ISSN: 1351-0711
Web: http://www.bmj.com

Formerly *The British Journal of Industrial Medicine*. Includes papers relevant to occupational and environmental medicine, including epidemiological studies and toxicological studies of chemicals of industrial, agricultural, and environmental importance.

Occupational Medicine (1951–)
Oxford University Press, Oxford, UK
ISSN: 0962-7480

Web: http://www.oxfordjournals.org

Designed to enhance the standards and quality of the practice of occupational medicine via original papers, reviews, viewpoints, book reviews, etc.

Particle and Fibre Toxicology (2004–)
BioMed Central, London
Web: http://www.biomedcentral.com

An open access journal for new scientific data, hypotheses, and reviews on the toxicological effects of particles and fibers, including their physico-chemistry, exposure measurement, and human health effects.

Pesticide Biochemistry and Physiology (1971–)
Elsevier, Amsterdam
ISSN: 0048-3575
Web: http://www.elsevier.com

Papers deal with the biochemistry and physiology of insecticides, herbicides, fungicides, acaracides, nematocides, rodenticides, and similar compounds – including non-lethal pest control agents – in terms of the biochemistry and physiology of both target and non-target organisms and the biochemical transformations of the agents themselves.

Pest Management Science (2000–)
John Wiley, New York
ISSN: 1526-498X
Web: http://www.wiley.com

Formerly titled *Pesticide Science*, this journal is published on behalf of The Society of Chemical Industry. It covers all aspects of research and development, application, use, and impact on the environment of products designed for pest control and crop protection.

Radiation and Environmental Biophysics (1963–)
Springer-Verlag, Berlin
ISSN: 0301-634X
Web: http://www.springer.com

Devoted to fundamental and applied issues in radiation research and biophysics, including the biophysics of ionizing and non-ionizing radiation, biological effects of physical factors, and risk assessment and modeling for radiation and environmental factors.

Radiation Research (1954–)
Academic Press, New York
ISSN: 0033-7587
Web: http://www.radres.org

Official journal of the Radiation Research Society. Publishes original articles, rapid communications, short communications, commentaries, and letters related to radiation effects and related subjects in the areas of physics, chemistry, biology, and medicine. Covers ionizing radiation; ultraviolet, visible, and infrared light; and microwaves, ultrasound, and heat.

Regulatory Toxicology and Pharmacology (1981–)
Academic Press, New York
ISSN: 0273-2300
Web: http://www.isrtp.org

Official journal of the International Society of Regulatory Toxicology and Pharmacology. Devoted to reports of significant developments, public opinion, scientific data, and ideas that bridge the gap between scientific information and the legal aspects of toxicological and pharmacological regulation.

Reproductive Toxicology (1987–)
Elsevier, New York
ISSN: 0890-6238
Web: http://www.elsevier.com

Features original research on the influence of chemical and physical agents on reproduction. In particular, seeks to link information on the application of in vitro, animal, and clinical research to the practice of clinical medicine.

Research Communications in Pharmacology and Toxicology (1996–)
PJD Publications, Westbury, NY
ISSN: 1087-1101
Web: http://www.pjdonline.com

Offers reviews, research articles, and letters in the fields of pharmacology and toxicology, including molecular and clinical studies.

Reviews of Environmental Contamination and Toxicology (1962–)
Springer-Verlag, New York
ISSN: 0179-5953
Web: http://www.springer.com

Continuation of *Residue Reviews*. Includes detailed review articles concerned with any aspect of chemical contaminants, including pesticides, in the total environment, in terms of toxicological considerations and consequences.

Reviews on Environmental Health (1972–)
Freund Publishing House, London
ISSN: 0048-7554
Web: http://www.freundpublishing.com

This quarterly periodical offers comprehensive reviews in the field of environmental health and disease. It deals with the physiological and psycho-sociological interrelationships between humans and their surroundings.

Risk Analysis (1981–)
Blackwell Publishing, Ames, IA
ISSN: 0272-4332
Web: http://www.blackwellpublishing.com

An official publication of the Society for Risk Analysis. Provides a focal point for new developments in risk analysis for scientists from a wide range of disciplines. It deals with health risks, engineering, mathematical and theoretical aspects of risks, and social and psychological aspects of risks, such as risk perception, acceptability, economics, and ethics.

SAR and QSAR in Environmental Research (1993–)
Gordon and Breach Science Publishers, Reading, UK
ISSN: 1062-936X
Web: http://www.tandf.co.uk

Papers cover fundamental and practical aspects of the structure–activity and structure–property relationships in the fields of environmental science, agrochemistry, toxicology, pharmacology, and applied chemistry. Focuses on emerging techniques for the building of SAR and QSAR models.

Scandinavian Journal of Work, Environment and Health (1975–)
Finnish Institute of Occupational Health, Helsinki, Finland
ISSN: 0355-3140
Web: http://www.sjweh.fi

Deals with topics concerning the interactions between work and health – such as occupational medicine, epidemiology, toxicology, hygiene, safety, physiology, psychology, ergonomics, and sociology.

Science of the Total Environment (1972–)
Elsevier, Amsterdam
ISSN: 0048-9697
Web: http://www.elsevier.com

Concerned with changes in the natural level and distribution of chemical elements and compounds that may affect the well-being of the living world, or represent a threat to human health. Emphasis is placed on applied environmental chemistry.

Soil and Sediment Contamination (1992–)
Taylor & Francis, Philidelphia, PA
ISSN: 1532-0383
Web: http://www.tandf.co.uk

Formerly the *Journal of Soil Contamination*, this is the main vehicle of communication of the Association for the Environmental Health of Soils (AEHS). Covers such areas as analytical chemistry, site assessment, environmental fate and modeling, remediation techniques, risk assessment issues, regulatory issues, and legal considerations.

Therapeutic Drug Monitoring (1979–)
Lippincott, Williams & Wilkins, Philadelphia, PA
ISSN: 0163-4356
Web: http://www.lww.com

Official journal of the International Association of Therapeutic Drug Monitoring and Clinical Toxicology. Publishes review articles on specific classes of drugs, case reports, technical notes, original research and continuing education articles, including articles detailing the factors that affect the rate and extent drugs are absorbed, metabolized, and excreted.

Toxicologic Pathology (1972–)
Taylor & Francis, Philadelphia, PA
ISSN: 0192-6233
Web: http://www.tandf.co.uk

An official publication of the Society of Toxicologic Pathologists. Papers focus on the multidisciplinary elements that constitute toxicologic pathology, including spontaneous and experimentally induced morphological and functional changes, environmental exposures, case reports, and risk assessment and investigative techniques.

Toxicological and Environmental Chemistry (1972–)
Taylor & Francis, Philadelphia
ISSN: 0277-0248
Web: http://www.tandf.co.uk

Devoted to the fundamental aspects of analysis, metabolism, general chemistry, and biochemistry of xenobiotic compounds and natural toxins as related to the environment and human health.

Toxicological Reviews (2003–2006)
Adis International, Auckland, New Zealand
ISSN: 1176-2551
Web: http://www.adisonline.com

Formerly known as *Adverse Drug Reactions and Toxicological Reviews*, this journal provides critical reviews on a variety of toxicological subjects, with an emphasis on the adverse effects of drugs and other chemicals on human health.

Toxicological Sciences (1998–)
Oxford University Press, Carey, NC
ISSN: 1096-6080
Web: http://www.oxfordjournals.org

This journal replaces *Fundamental and Applied Toxicology*, for many years one of the Society of Toxicology's official publications. It encompasses all aspects of toxicology.

Toxicology (1973–)
Elsevier Science, Shannon, Ireland
ISSN: 0300-483X
Web: http://www.elsevier.com

Publishes original scientific papers on the adverse effects of foreign agents on the health of humans, animals, and ecosystems. Emphasis is on toxic effects observed at relevant exposure doses that have direct impact on safety evaluation and risk assessment practices.

Toxicology and Applied Pharmacology (1959–)
Academic Press, New York
ISSN: 0041-008X
Web: http://www.elsevier.com

An official journal of the Society of Toxicology. Publishes original research pertaining to the action of chemicals, drugs, and natural products on the structure and function of animal (including human) cells and/or tissues. Considers papers on mechanistic approaches and those dealing with alternatives to the use of experimental animals.

Toxicology and Industrial Health (1985–)
SAGE Publications, London
ISSN: 0748-2337
Web: http://www.sagepub.co.uk

Deals with basic and applied research in toxicology, biochemical toxicology, genetic and cellular toxicology, and risk assessment associated with hazardous wastes and groundwater.

Toxicology Letters (1977–)
Elsevier, Amsterdam
ISSN: 0378-4274
Web: http://www.elsevier.com

An international journal for the rapid publication of short reports on all aspects of toxicology, especially mechanisms of toxicity.

Toxicology Mechanisms and Methods (2002–)
Taylor and Francis, Philadelphia, PA
ISSN: 1537-6516
Web: http://www.tandf.co.uk

A merger of *Toxicology Methods* (ISSN: 1051-7235) and *Toxic Substance Mechanisms* (ISSN: 1076-9188), covers subjects dealing with the mechanisms by which foreign chemicals cause toxic tissue injury, from molecular and cellular mechanisms of action to the consideration of mechanistic evidence in establishing regulatory policy. Chemical substances of interest include industrial compounds, environmental pollutants, hazardous wastes, drugs, pesticides, and chemical warfare agents.

Toxicology in Vitro (1987–)
Pergamon Press, Oxford, UK
ISSN: 0887-2333
Web: http://www.elsevier.com

An international journal produced in association with BIBRA and publishing research and reviews on the use of in vitro techniques for determining the toxic effects of chemicals and elucidating their mechanisms of action.

Toxicon (1962–)
Elsevier Science, Amsterdam
ISSN: 0041-0101
Web: http://www.elsevier.com

The official journal of the International Society on Toxinology, this journal focuses on toxins from animals, plants, and microorganisms.

Toxin Reviews (1982–)
Taylor & Francis, Philadelphia, PA
ISSN: 1556-9543
Web: http://www.tandf.co.uk

Formerly the *Journal of Toxicology. Toxin Reviews*, this journal brings together assorted papers related to toxins – their characteristics, activities, and mechanisms of action.

Veterinary and Human Toxicology (1977–)
Publication Office, Comparative Toxicology Laboratories, Kansas State University, Manhattan, KS
ISSN: 0145-6296

The broad field of toxicology is covered, with original research, case reports, field observations in domestic and wild animals and in humans, scientific reviews, documentation of unusual or controversial events, announcements and news items, and letters.

Waste Management (1980–)
Elsevier Science, Oxford, UK
ISSN: 0956-053X
Web: http://www.elsevier.com

Devoted to the presentation of hazardous, radioactive, and industrial wastes. Includes issues such as generation, prevention, control, treatment or detoxification, handling, and ultimate residual disposition.

Water, Air, and Soil Pollution (1971–)
Springer, Dordrecht, The Netherlands
ISSN: 0049-6979
Web: http://www.springer.com

Covers physical and biological processes affecting flora, air, water, and solid earth in relation to environmental pollution. Topics include sources, transport,

deposition, accumulation, disposition, and mitigation of acid precipitation; atmospheric pollution; heavy metals; water pollution; and effects of pollutants on human beings, vegetation, fish, aquatic species, microorganisms, animals, etc.

Water Environment Research (1930–)
Water Environment Federation, Alexandria, VA
ISSN: 1061-4303
Web: http://www.wef.org

Scope ranges from degradation of water resources and basic concerns of groundwater quality and pollution control to new methods for solving complex hazardous and toxic waste problems.

Xenobiotica (1971–)
Taylor and Francis, London
ISSN: 0049-8254
Web: http://www.tandf.co.uk

Subtitled *The Fate and Safety Evaluation of Foreign Compounds in Biological Systems*. Covers general xenobio-chemistry, molecular toxicology, and clinical pharmacokinetics and metabolism.

ADDITIONAL JOURNALS CARRYING RELEVANT ARTICLES

General Science

Annals of the New York Academy of Sciences

Nature

New Scientist

Proceedings of the National Academy of Sciences of the United States of America

Science

Scientific American

General Medical Journals

BMJ (formerly *British Medical Journal*)

JAMA (formerly *Journal of the American Medical Association*)

Lancet

Cancer

Cancer Epidemiology, Biomarkers and Prevention

Cancer Research

Journal of the National Cancer Institute

Epidemiology

American Journal of Epidemiology

Epidemiology

Pathology

American Journal of Pathology

Archives of Pathology and Laboratory Medicine

Experimental and Molecular Pathology

Journal of Clinical Pathology

Pharmacology

Clinical Pharmacology and Therapeutics

Drug Delivery

Journal of Pharmacology and Experimental Therapeutics

Naunyn-Schmiedebergs Archives of Pharmacology

Pharmacology and Therapeutics

Public Health

American Journal of Public Health

Canadian Journal of Public Health

Public Health Reports

Waste Management

P2: Pollution Prevention Review

Remediation

Waste Management and Research

Popular and Trade Magazines

Chemecology

E: The Environmental Magazine

EM (by the Air and Waste Management Association)

Greenpeace

NEWSLETTERS

Newsletters are a valuable and timely means of communicating recent developments in toxicology and risk assessment. These include recent scientific advances and issues, upcoming meetings and documents, and other information. Newsletters may announce or comment on a wide variety of research and activities,

sometimes before journal publication or listing in traditional indexing, abstracting, and current awareness services. The contents of newsletters can vary greatly, as can the viewpoints of the editors, publishers, or sponsoring agencies or organizations.

Paper versions of newsletters are becoming fewer and fewer in number as they, and all other publication types, move to digital form on the Web. Companion information sources to newsletters, such as blogs and news feeds, are designed strictly for the Web. More information about these is available in this book's Internet chapter.

Virtually every professional organization, and the vast majority of other organizations, such as governmental, non-governmental, academic, and corporate ones publish and make available on the Web, what is either overtly called, or is, in effect, a newsletter. Many newsletters are transient or subject to change in name, frequency, Web URL, scope, etc. Rather than itemize them all here, readers are directed to the Organizations chapter of this book to find newsletters which are institutionally based. Indeed, often an organization's website's home page itself features news. A brief exploration on, or search of, an organization's website, should lead you to its newsletter. A few newsletter directories follow.

MediaFinder
Web: http://www.mediafinder.com/

An extensive database of U.S. and Canadian magazines, catalogs, newspapers, newsletters, and journals.

Newsletter Access
Web: http://www.newsletteraccess.com/

An extensive directory of independent newsletters online.

Newsletters ASAP
Web: http://www.gale.cengage.com/tlist/sb5115.html

Newsletters ASAP, a fee-based portal from Gale Cengage, offers timely information and expert perspectives found in today's most well-read and respected business and industry newsletters. Publications are full text and cover such topics as advertising, biotechnology, government, pharmaceuticals and more.

Below is a selection of newsletter-type online publications and alerting services not directly affiliated with a major toxicology organization, but which are relevant to toxicology and related fields.

Biological Effects of Low Level Exposure Newsletter
Web: http://www.belleonline.com/newsletters.htm

Bureau of National Affairs, Environmental Health and Safety Products
Web: http://www.bna.com/products/ens/

Publishes, among others, Air Pollution Control Guide, Chemical Regulation Reporter, Daily Environment Report, Environment Reporter, Job Safety and Health, Occupational Safety and Health Reporter, Toxics Law Daily, Toxic Law Reporter, and World Climate Change Report.

ChemAdvisory Newsletter
Web: http://www.chemadvisor.com/News_ChemADVISORY.aspx

Environmental Law Reporter
Web: http://www.elr.info

FDC Reports
Web: http://fdcreports.com/

Regulatory, legislative, and business news affecting the U.S. drug, biotechnology, medical device, non-prescription drug, nutritionals, and cosmetics industries.

FoodRegulation.com
Web: http://www.foodregulation.com

News about the regulation of food and pesticides.

GreenFacts
Web: http://www.greenfacts.org

A quarterly newsletter from the non-profit organization with the mission to develop publicly understandable summaries of scientific reports on toxicology-related and other topics.

National Capital Area Chapter, Society of Toxicology
Web: http://www.toxicology.org/isot/RC/ncac/newsletter.htm

A representative newsletter of the many geographically based ones published by SOT chapters.

Occ-Env-Med-L
Web: http://www.occhealthnews.net

A free, electronic, international forum for occupational and environmental medicine.

RiskWorld e-Newsletter
Web: http://www.riskworld.com/RiskWorld/enewsletter.htm

Although published infrequently as of mid-2008, the goal is to notify readers of significant new postings on the RiskWorld website (http://www.riskworld.com), itself a source for news and links to other risk-related sites.

Thomson West
Web: http://west.thomson.com

Environmental law news, including the Toxic Torts Litigation Reporter.

CHAPTER

64

General Interest and Popular Works

FREDERICK W. STOSS

INTRODUCTION

Prior to the publication of Rachel Carson's *Silent Spring*, there were few general interest or popular works found in library collections. The following five titles are among the oldest general-interest titles about toxicology or the broadly defined concepts of environmental or occupational health: *Consumers Can Protect Their Own Health* by Harold Aaron (1960, Greeley, CO: Council on Consumer Information); *What You Should Know about Poisons*, by Heinz Norden (1930, Girard, KA: Haldeman-Julius Publications), *Some types of industrial poisoning*, by Grace Potter (1929, Boston: The Consumers' League of Massachusetts); *The Practical Home Physician* by Henry M Lyman (1887, Albany, N.Y.: Selleck, Ross; reprinted in 1907, Chicago: Thompson) which included full and accurate directions for treating wounds, injuries, poisoning, and *The House and Its Surroundings* (1879, New York: D. Appleton and Company).

There are currently more than 850 book titles addressing the complex and often controversial issues related to toxicology and environmental or occupational health and medicine. There was a dramatic rise in the publication of books in the years immediately following the publication of *Silent Spring* in 1962 and more rapidly after the 1970s first Earth Day. Episodic peaks coincide with annual Earth Days and its subsequent major anniversary dates (10th, 20th, 25th, and 30th). The date of the first Earth Day in 1970 also occurs in a landmark year that saw the passage of major environmental laws, such as the National Environmental Policy Act and amendments to Federal environmental legislation (the National Environmental Policy Act, Clean Air Act, Clean Water Act, etc.). The year 1970 also marks the creation of the Environmental Protection Agency and the National Oceanic and Atmospheric Administration as part of a major reorganization of the U.S. Government. Clearly, the social awareness issue of the 1960s and 1970s sparked the interest of the public-at-large to environmental issues, which is reflected in the publication and retention of books in libraries.

General interest in and concerns about toxic chemicals and hazardous materials in the environment remains in the public spotlight, and stems from an already long-term awareness of living in a chemically contaminated world in the post-*Silent Spring*, post-Love Canal, post-Superfund, post-Bhopal, eras. Since the publication of the third edition of this book, additional factors have come into play to stimulate and sustain the public's fascination with toxic chemicals in the environment and the burgeoning publication of books targeted to a mass market of non-technical and non-scientific audiences:

- A continuing awareness of the location and management of hazardous and toxic wastes, and chemical discharges (legally regulated, accidental, and intentionally illegal) in areas racially, economically, socially, and politically disenfranchised has given rise to an intense examination of the concepts of environmental justice and ethics; however publication of work on this aspect of toxicology appears to be declining.
- The increased risks to children from exposure to chemicals in the environments where they live and play.
- Unabated worries related to drug and alcohol abuse among older children and teenagers.

There are a number of sources from which popular, general interest, and consumer-oriented monographs

about the environment, including those related to toxic chemicals and agents, environmental health and medicine, and hazardous materials can be located. The online or digital versions of bibliographic databases, such as *OCLC First Search* and *Books in Print* are among the most useful. Over the years a number of other publications serving as locators to the environmental literature (anthologies and bibliographic guides) have appeared. Select environmental anthologies serving as guides to the literature are provided here:

- *Resources for College Libraries* (New Providence, NJ: R.R. Bowker, Inc., 2006+)
- *Best Books for Academic Libraries* (Temecula, CA: Best Books, Inc., 2002–2003)
- *Literature and the Environment* by George Hart (Westport, Conn.: Greenwood Press, 2004)
- *Visions of the Land: Science, Literature, and the American Environment from the Era of Exploration to the Age of Ecology* by Michael A. Bryson (Charlottesville: University Press of Virginia, 2002)
- *Using the Biological Literature: A Practical Guide* by Diane Schmidt (NY: Marcel Dekker, 2002)
- *Getting Over the Color Green: Contemporary Environmental Literature of the Southwest* by Scott Slovic (Tucson: University of Arizona Press, 2001)
- *American Literary Environmentalism* by David Mazel (Athens: University of Georgia Press, 2000).

For locating relevant titles from before the year 2000, the following guides are suggested:

- *Environmental Literature: An Encyclopedia of Works, Authors, and Themes* by Patricia D. Netzley (Santa Barbara, CA.: ABC-CLIO, 1999
- *Reading the Earth: New Directions in the Study of Literature and Environment* by Michael P. Branch (Moscow, Idaho: University of Idaho Press, 1998)
- *Classics in Environmental Studies: An Overview of Classic Texts in Environmental Studies* by Nelissen, Nicolaas Johannes Maria Nelissen and Leo Klinkers (Utrecht: International Books, 1997)
- *Earth Works: Recommended Fiction and Nonfiction about Nature and the Environment for Adults and Young Adults* by Jim Dwyer (New York: Neal-Schuman Publishers, 1996)
- *Reading about the Environment: An Introductory Guide* by P.E. Jansma (Englewood, CO.: Libraries Unlimited, 1993)
- *Beacham's guide to environmental issues & sources* by Walton Beacham (Washington, DC: Beacham Publishing, Inc., 1993)
- *E for Environment: An Annotated Bibliography of Children's Books with Environmental Themes* by Patti K Sinclair (New Providence, NJ: R.R. Bowker, 1992)
- *The Island Press Bibliography of Environmental Literature* by Joseph Arthur Miller, Joseph Arthur (Washington, DC: Island Press, 1992)
- *In Praise of Nature* by Stephanie Mills and Jeanne Carstensen (Washington, D.C.: Island Press, 1990)
- *Teaching Environmental Literature: Materials, Methods, Resources* by Frederick O. Waage (New York: Modern Language Association of America, 1985).

Many of the classic works related to the body of writings called nature literature or environmental literature have served as models for an ever-growing number of monograph titles related to the topics associated with toxicology, environmental health, and environmental conditions in the places where we work, learn, live, and play. The flowing list of anthologies and collected works is useful for identifying relevant authors and titles of works from which these essays, excerpts, and other extractions are found:

- *Of Discovery and Destiny: An Anthology of American Writers and the American Land* by Robert C Baron and Elizabeth Darby Junkin (Golden, CO: Fulcrum, 1986)
- *The Literature of Nature: The British and American Traditions* by Robert J. Begiebing and Owen Grumbling (Medford, NJ: Plexus, 1990)
- *The Rolling Stone Environmental Reader* (Washington, DC: Island Press, 1992)
- *American Nature Writing* by John A. Murray (San Francisco, CA: Sierra Club Books, 1994, 1995, 1996, 1997, 1998; Oregon State University Press, 1999, 2000, 2001, 2002, 2003)
- The Norton Book of Nature Writing edited by Robert Finch and John Elder (NY: W.W. Norton Co., 1990); College Edition is a revised and enhanced with a field guide (NY: W.W. Norton Co., 2002)
- *The Best American Science and Nature Writing* whose series editor is Tim Folger (Boston, MA: Houghton Mifflin Co., 2000, 2002, 2003, 2004, 2005, 2006)
- *Visions of the Land: Science, Literature, and the American Environment from the Era of Exploration to the Age of Ecology*, written by Michael A. Bryson (Charlottesville, VA: University Press of Virginia, 2002)
- *The Environment and Society Reader* edited by R. Scott Frey (Boston, MA: Allyn and Bacon (Pearson Education), 2001).

THE IMPACT OF *SILENT SPRING* AND RACHEL CARSON – CELEBRATING CARSON'S 100TH BIRTHDAY

May 27, 2007 marked the 100th anniversary of the birth of Rachel Carson, whose impact on the environmental movement of the 1960s and 1970s has been

incalculable. Over the course of the five decades since she wrote one of the most important environmental books of all time, hundreds of books related to environmentalism have been published. Upon her death, Carson left a substantial bequest to the Sierra Club, including future royalties from sales of *Silent Spring*.

Silent Spring has seen scores of printings in hardcover and paper back, special anniversary, and special 'collector's editions.' It has been translated into dozens of languages, and has made a profound impact on the environment and ecology. There are scores of biographical works published about the life of Rachel Carson. Many of these are collective works of famous women scientists, writers, authors, environmental leaders, naturalists, and 'most important people.' Questia, a large online information service with one of the largest online collections of books and journals, librarians provide an evaluated listing of 13 books on Rachel Carson (see: http://www.questia.com/library/rachel-carson.jsp). There are three definitive biographical works on Carson worth noting: *Rachel Carson: Witness for Nature* by Linda J. Lear (New York: H. Holt, 1997), *The House of Life: Rachel Carson at Work* by Paul Brooks and Rachel Carson (Boston, Houghton, Mifflin, 1972, 1989), and *The Gentle Subversive: Rachel Carson, Silent Spring, and the Rise of the Environmental Movement* by Mark H. Lytle (New York: Oxford University Press, 2007).

Silent Spring soon became a metaphor for other issues related to toxic chemicals and other hazardous substances in the environment. In addition to serving as a muse for other authors and writers, Rachel Carson and her book spawned a new generation of literature with the same underlying theme propagated by Carson – human impacts on the environment and the need to inform the public. These works provide an extended corpus of the environmental literature from the mid-1960s to the present, and include a number of works written by Rachel Carson, and thought to have been lost, such as *Lost Woods: The Discovered Writing of Rachel Carson* (Boston, MA: Beacon Press, 1998), *Silent Spring Revisited* (Washington, DC: American Chemical Society, 1987), *Before Silent Spring: Pesticides and Public Health in Pre-DDT America* (Princeton, NJ: University Press 1975), and *War and Nature: Fighting Humans and Insects with Chemicals from World War I to Silent Spring* (New York: Cambridge University Press, 2001).

Houghton-Mifflin Publishers released in the months prior to the 100th anniversary of Rachel Carson's birth, a collection of essays, *Courage for the Earth: Writers, Scientists, and Activists Celebrate the Life and Writing of Rachel Carson* (Peter Matthiessen, Editor, Boston, MA: Houghton Mifflin, 2007). Contributors to this work include John Elder, Al Gore, John Hay, Freeman House, Linda Lear, Robert Michael Pyle, Janisse Ray, Sandra Steingraber, Terry Tempest Williams, and E. O. Wilson. Each writer provides a testimony to the stimulation provided by Carson and her writings, how they sustained an interest in the environment and launched a multi-generation movement calling for the protection of our environment and the natural resources found in and associated with the environments in which we live, work, and play.

CONTEMPORARY WORKS

Since the publication of the last edition of this book a significant improvement in access is the migration of information resources to digital, full-text content. Book literature has not escaped this aspect of the continuing digital revolution in which we are now deeply embedded. Google Book Search is one means of accessing books in their digital formats and allows users to search the full text of books of interest and learn where to buy or borrow them. In the late 1990s Google co-founders Sergey Brin and Larry Page were working on a research project supported by the Stanford Digital Library Technologies Project to make digital libraries work. Google is inspired by several digitization projects such as the Library of Congress American Memory Project, Project Gutenberg (http://www.gutenberg.org/wiki/Main_Page), the Million Book Project (http://www.archive.org/details/millionbooks), and the Universal Library (http://www.ul.cs.cmu.edu/html/) to deliver large volumes of digital information. E-books will continue to grow as does demands for easy access to information.

A search of *Google Book Search* allows searchers to see a portion of the book in the Snippet View or the Sample Pages View, which provides links to places where you can buy or borrow it. If a book is out of copyright, you may be able to display the Full Book View for full-text access to the title. It is suggested that if readers of this current work should include searches of *Google Book Search* to determine its status as a full-text online title, or from where items might be borrowed or purchased. For details about *Google Book Search* go to their website at http://books.google.com/. Here are, however, few general interest and popular books provided in ebook formats.

An amazon.com bookseller provides a somewhat robust search capability to identify electronic books and documents, but the offerings are at this time rather sparse. For instance, in a search for electronic content for items related to 'lead poisoning,' amazon.com provides links to 32 items, most of which are available for purchase from technical publishers. A similar situation is found among the 24 electronic

content items retrieved by searching the word, 'pollution.' Because of the nature of this genre of popular and general interest literature, publishers will dictate the availability of their books in electronic, full-text formats, based on market-driven conditions. It is best to consult individual publishers' websites to determine if a particular title is available in ebook format. It is anticipated that more titles may be moving to digital platforms in the coming years.

The single largest phenomenon relating book sales and distribution is the emergence of amazon.com as a major entity in the selling of books. While amazon.com does not have an impressive or robust search engine, it does provide a number of value-added services and features that are of tremendous interest to the book-buying community at-large: publisher's detailed marketing and promotional information, published and customer book reviews, a list of other books purchased by those buying a particular title (an interesting means to do relevancy searching!), availability of lower-cost used copies, the ability to sell a book to Amazon.com, and a variety of sorting options: titles in alphabetical order, price, publication date, relevance to search criteria, and average customer reviews.

Emergence of titles in the alternative, small, and independent presses (e.g., New Society Press, Island Press) indicates niche marketing of specialized topics by these smaller publishers, and a growing disinterest among the larger publishing houses in taking on the publication of more risky titles that may not provide the desired revenues to sustain these larger business units.

Works published by alternative presses often provide interpretations and perspectives of environmental conditions not adequately addressed by the mainstream 'mass media.' It is also noted that these alternative, non-traditional sources of information are the victims of poor bibliographic control and low profile in the marketplace. Identification and acquisition of alternative resources requires inventive use of the few bibliographic sources covering alternative resources, and has been noted in the library collection management literature by the implementation of creative techniques such as networking and 'cascading' to identify and obtain these resources (Anton 1994). Alternative presses in both electronic and print formats will continue to play a role in shaping the science research and public policy agendas well into the future (Weintraub 2000). *Alternative Publishers of Books in North America*, 6th Edition by Byron Anderson (Duluth, MN: Library Juice Press, 2006) is one of the most comprehensive directories of the smaller, alternative presses.

A small sampling, by title, of toxicology general interest and popular books published between 2000 and 2007 follows.

Applegate JS (2004)
Environmental risk
Aldershot, UK; Burlington, VT: Ashgate/Dartmouth

Ashton K, Green ES (2005)
The toxic consumer: Living healthy in a hazardous world (Green Essentials Living Guide Series)
White Church, Bristol, UK: Pukka Herbs

Babal K (2005)
Seafood sense: the truth about seafood nutrition & safety
North Bergen, NJ: Basic Health Publications

Bader W (2007)
Toxic bedrooms: your guide to a safe night's sleep
Topanga, CA: Freedom Press

Baillie-Hamilton P (2005)
Toxic overload: A doctor's plan for combating the illnesses caused by chemicals in our foods, our homes, and our medicine cabinets
New York: Avery

Baker S, Driver J (2001)
Residential exposure assessment: a sourcebook
New York: Kluwer Academic/Plenum

Baker-Laporte P, Elliott E, Banta J (2001)
Prescriptions for a healthy house: a practical guide for architects, builders, and homeowners
Gabriola Island, BC: New Society Publishers

Balkin K (2004)
Food-borne illnesses
San Diego, CA: Greenhaven Press

Bellenir K (2002)
Drug information for teens: health tips about the physical and mental effects of substance abuse
Detroit, MI: Omnigraphics

Bellenir K (2004)
Smoking concerns sourcebook: basic consumer health information about nicotine addiction and smoking cessation
Detroit, MI: Omnigraphics

Benarde MA (2002)
You've been had!: how the media and environmentalists turned Americans into a nation of hypochondriacs
New Brunswick, NJ: Rutgers University Press

Blanc PD (2007)
How everyday products make people sick: toxins at home and in the workplace
Berkeley, CA: University of California Press

Bolognese E (2006)
Staying healthy in a toxic world
Apple Valley, MN: Center Path Pub.

Bower LM (2000)
Creating a healthy household: the ultimate guide for healthier, safer, less-toxic living
Bloomington, IN: Healthy House Institute

Bowker, Michael (2003)
Fatal deception: the terrifying true story of how asbestos is killing America
New York: Touchstone

Brouwer F, Ervin DE (2002)
Public concerns, environmental standards, and agricultural trade
Wallingford, UK ; New York: CABI Publishers

Brown P (2007)
Toxic exposures: Contested illnesses and the environmental health movement
New York: Columbia University Press

Bryson, Christopher (2004)
The fluoride deception
New York: Seven Stories Press

Burke C (2007)
To buy or not to buy organic: what you need to know to choose the healthiest, safest, most earth-friendly food
New York: Marlowe & Company

Chiasson, Cindy (2000)
Get the real dirt: contaminated real estate and the law in Alberta
Edmonton, Canada: Environmental Law Centre

Clarke B (2003)
Good fish guide
Ross-on-Wye, UK: Marine Conservation Society

Collin RW (2006)
The Environmental Protection Agency: cleaning up America's act
Westport, CN: Greenwood Press

Corburn J (2005)
Street science: community knowledge and environmental health justice
Cambridge, MA: MIT Press

Cordry HV (2001)
Tobacco: a reference handbook
Santa Barbara, CA: ABC-CLIO

Covey HC (2007)
The methamphetamine crisis: strategies to save addicts, families, and communities
Westport, CO: Praeger Publishers

Cummins R, Lilliston B (2000)
Genetically engineered food: a self-defense guide for consumers
New York: Marlowe

Davis DL (2002)
When smoke ran like water: tales of environmental deception and the battle against pollution
New York: Basic Books

Davis DL (2007)
The secret history of the war on cancer
New York: BasicBooks

John Emsley (2005)
The elements of murder: A history of poison
New York: Oxford University Press

Erickson K (2002)
Drop dead gorgeous: protecting yourself from the hidden dangers of cosmetics
Chicago, IL: Contemporary Books

Farley T, Cohen D (2005)
Prescription for a healthy nation: a new approach to improving our lives by fixing our everyday world
Boston, MA: Beacon Press

Feldman SA (2005)
Poison arrows
London: Metro

Ferrières M (2006)
Sacred cow, mad cow: a history of food fears
New York: Columbia University Press

Fitzgerald R (2006)
The hundred-year lie: how food and medicine are destroying your health
New York: Dutton

Flynn J, Slovic P (2001)
Risk, media, and stigma: understanding public challenges to modern science and technology
London; Sterling, VA: Earthscan

Friis RH (2007)
Essentials of environmental health
Sudbury, MA: Jones and Bartlett

George TS (2001)
Minamata: pollution and the struggle for democracy in postwar Japan
Cambridge, MA: Harvard University Asia Center: Distributed by Harvard University Press

Gilbert SG (2004)
A small dose of toxicology: the health effects of common chemicals
Boca Raton, FL: CRC Press

Ginsberg G, Toal B (2006)
What's toxic, what's not
New York: Berkley Books

Greene AR (2007)
Raising baby green: the earth-friendly guide to pregnancy, childbirth, and baby care
San Francisco, CA: Jossey-Bass

Halweil B, Mastny L (2006)
Catch of the day: choosing seafood for healthier oceans
Washington, DC: Worldwatch Institute

Harris N (2005)
Amphetamines
Detroit, MI: Thompson/Gale, Farmington Hills, MI: Greenhaven Press

Hart K (2002, 2003)
Eating in the dark: America's experiment with genetically engineered food
New York: Vintage Books, 2003; New York: Pantheon Books 2002

Hatherill JR (2003)
The braingate: the little-known doorway that lets nutrients in and keeps toxic agents out
Washington, DC: Regnery Pub

Heaton S (2001)
Organic farming, food quality and human health: a review of the evidence
Bristol, UK: Soil Association

Hoffmann SA, Taylor MR (2005)
Toward safer food: perspectives on risk and priority setting
Washington, DC: Resources for the Future

Holstege CP, Turkington C (2006)
Deadly daffodils, toxic caterpillars: the family guide to preventing and treating accidental poisoning inside and outside the home
New York: Stewart, Tabori & Chang

Horn G (2006)
Living green: a practical guide to simple sustainability
Topanga, CA: Freedom Press

Hull JS (2001)
Sweet poison: how the world's most popular artificial sweetener is killing us – my story
Far Hills, NJ: New Horizon Press

Hunter BT (2004)
Soil and your health: healthy soil is vital to your health
North Bergen, NJ: Basic Health Publications

Israel BA (2005)
Methods in community-based participatory research for health
San Francisco, CA: Jossey-Bass

Johansen, Bruce E (2003)
The Dirty Dozen: Toxic chemicals and the Earth's future
Westport, CO: Praeger

Johnston R, McIvor A (2000)
Lethal work: a history of the asbestos tragedy in Scotland
East Linton, UK: Tuckwell

Kallen SA (2005)
Nuclear and toxic waste
Farmingt+on Hills, MI: Greenhaven Press

Kallen SA (2005)
Food safety
Detroit, MI: Greenhaven Press

Kane WM (2002)
Health Matters! Environmental poisoning, Volume 6
Danbury, CO: Grolier Educational

Kessel I, O'Connor JT (2001)
Getting the lead out: the complete resource for preventing and coping with lead poisoning
Cambridge, MA: Perseus Publishers

Ketcham K, Pace NA (2003)
Teens under the influence: the truth about kids, alcohol, and other drugs: how to recognize the problem, and what to do about it
New York: Ballantine Books

Koren, Gideon (2004)
The complete guide to everyday risks in pregnancy & breastfeeding: answers to your questions about morning sickness, medications, herbs, diseases, chemical exposures & more
Toronto: R. Rose

Krieger RI, Ragsdale NN (2007)
Assessing exposures and reducing risks to people from the use of pesticides
Washington, DC: American Chemical Society: Distributed by Oxford University Press

Kroll-Smith JS, Brown P (2000)
Illness and the environment: a reader in contested medicine
New York : New York University Press

Kuhn C, Swartzwelder S, Wilson W (2000)
Pumped: straight facts for athletes about drugs, supplements, and training
New York: W.W. Norton & Co.

Kuhn C, Swartzwelder S, Wilson W (2003)
Buzzed: The straight facts about the most used and abused drugs from alcohol to Ecstasy (835)
New York: W. W. Norton

LaDou J (2007)
Current occupational & environmental medicine
New York: McGraw-Hill

Lankarge V (2003)
What every home owner needs to know about mold and what to do about it
New York: McGraw-Hill

Leon W, DeWaal CS (2002)
Is our food safe?: a consumer's guide to protecting your health and the environment
New York: Three Rivers Press

Levine MJ (2007)
Pesticides: a toxic time bomb in our midst
Westport, CO: Praeger Publishers

Lyons C (2007)
Stain-resistant, nonstick, waterproof, and lethal: the hidden dangers of C8
Westport, CO: Praeger

Macinnis P (2005)
Poisons: from hemlock to botox to the killer bean of Calabar
New York: Arcade Pub.

Malkan S
Not just a pretty face: The ugly side of the beauty industry
Gabriola Island, BC: New Society Publishers

Mangold T, Goldberg J (2000)
Plague wars: a true story of biological warfare
New York: St. Martin's Press

Mangold T, Goldberg J (2001)
Plague wars: the terrifying reality of biological warfare
New York: St. Martin's Griffin

Matthews DD (2002)
Household safety sourcebook
Detroit, MI: Omnigraphics

Markowitz GE, Rosner D (2002, 2003)
Deceit and denial: the deadly politics of industrial pollution
Berkeley, CA, London: University of California Press

Matthews DD (2003)
Environmental health sourcebook
Detroit, MI: Omnigraphics

Mayor A (2003)
Greek fire, poison arrows and scorpion bombs
Overlook Duckworth, UK: Woodstock

McDilda DG (2007)
The everything green living book: easy ways to conserve energy, protect your family's health, and help save the environment
Avon, MA: Adams Media

McDonald L (2007)
The toxic sandbox: the truth about environmental toxins and our children's health
New York: Penguin

McGurty EM (2007)
Transforming environmentalism: Warren county, PCBS, and the origins of environmental justice
New Brunswick, NJ: Rutgers University Press

Money NP (2004)
Carpet monsters and killer spores: a natural history of toxic mold
New York: Oxford University Press

Moore EA (2002)
Autoimmune diseases and their environmental triggers
Jefferson, NC: McFarland

Morizumi, Takashi (2002)
Children of the Gulf War: a different nuclear war
Hiroshima: Global Association for Banning Depleted Uranium Weapons

Morris RD (2007)
The blue death: disease, disaster and the water we drink
New York, NY: HarperCollins Publishers

Murakami H, Birnbaum A, Gabriel JP (2004)
Underground: The Tokyo gas attack and the Japanese psyche
New York: Vintage International

Murphy PC (2005)
What a book can do: the publication and reception of Silent spring
Amherst, MA: University of Massachusetts Press

Narbonne J-F (2000)
Dioxin contamination in foodstuffs
Croton-on-Hudson, NY: Manhattan Pub. Co. (distributor)

Nelson L, Shih RD, Balick MJ (2007)
Handbook of poisonous and injurious plants
New York: New York Botanical Garden: Springer

Nestle M (2003, 2004)
Safe food: bacteria, biotechnology, and bioterrorism
Berkeley, CA: University of California Press

Neustaedter R (2002)
The vaccine guide: risks and benefits for children and adults
Berkeley, CA: North Atlantic Books

Nottingham, Stephen (2003)
Eat your genes: how genetically modified food is entering our diet
London, New York: Zed Books Ltd

Nugent S (2004)
How to survive on a toxic planet
Arizona: Alethia Corp.

O'Donnell K (2001)
Inhalants and your nasal passages: the incredibly disgusting story
New York: Rosen Central

Offit PA, Bell LM (2003)
Vaccines: what you should know
Hoboken, NJ: John Wiley

Olfman S (2006)
No child left different: America's lost tolerance and the psychiatric over medication of our kids
Westport, CO: Praeger Publishers

Oregon Pesticide Analytical and Response Center (2004)
What you should know about pest control in your home: a consumer's guide to pest control options
Portland, OR: Oregon Pesticide Analytical and Response Center (PARC)

Parker JN, Parker PM (2004)
Occupational health a medical dictionary, bibliography, and annotated research guide to Internet references
San Diego, CA: ICON Health Publishers

Parker JN, Parker PM (2002)
The official patient's sourcebook on toxic shock syndrome
San Diego, CA: ICON Health Publications

Pellow DN (2007)
Resisting global toxics: transnational movements for environmental justice
Cambridge, MA: MIT Press

Pezzullo PC (2007)
Toxic tourism: rhetorics of pollution, travel, and environmental justice
Tuscaloosa, AL: University of Alabama Press

Pimentel D, Westra L (2000)
Ecological integrity: integrating environment, conservation, and health
Washington, DC: Island Press, 2000

Pitts C (2003)
Get a whiff of this: Perfumes (fragrances) – the invisible chemical poisons
Bloomington, IN: 1st Books

Rapp DJ (2004)
Our toxic world, a wake up call: how to keep yourself and your loved ones out of harm's way: chemicals damage your body, brain, behavior and sex
Buffalo, NY: Environmental Medical Research Foundation

Roberts, Michael (2002)
Nothing is without poison: understanding drugs
Hong Kong: Chinese University of Hong Kong

Robson M, Toscano W (2007)
Risk assessment for environmental health
San Francisco, CA: Jossey-Bass

Rodricks JV (2007)
Calculated risks: the toxicity and human health risks of chemicals in our environment
Cambridge, New York: Cambridge University Press

Rogers E, Kostigen T (2007)
The green book: the everyday guide to saving the planet one simple step at a time
New York: Three Rivers Press

Ropeik D, Gray G (2002)
Risk: a practical guide for deciding what's really safe and what's dangerous in the world around you
Boston, MA: Houghton Mifflin

Satin M (2007)
Death in the pot: the impact of food poisoning on history
Amherst, NY: Prometheus Books

Schapiro M (2007)
Exposed: the toxic chemistry of everyday products – who's at risk and what's at stake for American power
White River Junction, VT: Chelsea Green Publishers

Schwartz-Nobel L (2007)
Poisoned nation: pollution, greed, and the rise of deadly epidemics
New York: St. Martin's Press

Shah S (2006)
The body hunters: testing new drugs on the world's poorest patients
New York: New Press: Distributed by W.W. Norton

Shaw I (2005)
Is it safe to eat?: Enjoy eating and minimize food risks
New York: Springer

Shevory TC (2007)
Toxic burn: the grassroots struggle against the WTI incinerator
Minneapolis, MN: University of Minnesota Press

Shrader-Frechette KS (2007)
Taking action, saving lives: our duties to protect environmental and public health
Oxford; New York: Oxford University Press

Sneller MR (2003)
A breath of fresh air
Tucson, AZ: Fresh Air Press

Sprankling JG, Weber GS (2007)
The law of hazardous wastes and toxic substances in a nutshell
St. Paul, MN: Thomson/West

Steinzor R (2008)
Mother Earth and Uncle Sam: how pollution and hollow government hurt our kids
Austin, TX: University of Texas Press

Stelljes ME (2008)
Toxicology for nontoxicologists
Lanham, MD: Government Institutes

Stevens S, Bannon A (2007)
Book of poisons: a guide for writers
Cincinnati, OH: Writer's Digest Books

Stevenson, Margaret (2002)
Lead poisoning: what it is and what you can do about it
Edison, NJ: Legal Services of New Jersey

Stewart CE, Nixon RG (2004)
Surviving weapons of mass destruction
Sudbury, MA: Jones and Bartlett Publishers

Stone TW, Darlington G (2000)
Pills, potions, and poisons: how drugs work
Oxford; New York: Oxford University Press

Stripp RA (2007)
The forensic aspects of poisons
New York: Chelsea House

Sullivan PJ (2007)
Toxic legacy: synthetic toxins in the food, water, and air of American cities
Amsterdam; Boston, MA: Elsevier Academic Press

Sze J (2007)
Noxious New York: the racial politics of urban health and environmental justice
Cambridge, MA: MIT Press

Thomas P (2006, 2008)
What's in this stuff? The hidden toxins in everyday products and what you can do about them
New York: Penguin Group

Tierno PM (2002)
Protect yourself against bioterrorism
New York: Pocket Books

Tren R, Bate R (2001)
Malaria and the DDT story
London: Institute of Economic Affairs

Trestrail JH (2006)
The poison quiz book: Pearls of wisdom
New York: McGraw-Hill Medical Publishing

Van Straten M (2007)
The little book of detox tips for people on the go
London: Quadrille Publishing

Viscusi WK (2002)
Smoke-filled rooms: a postmortem on the tobacco deal
Chicago, IL: University of Chicago Press

Visser MJ (2007)
Cold, clear, and deadly: unraveling a toxic legacy
East Lansing, MI: Michigan State University Press

Walker M (2000)
Elements of danger: protect yourself against the hazards of modern dentistry
Charlottesville, VA: Hampton Roads

Waller TAN, Rumball D (2004)
Treating drinkers and drug users in the community
Oxford, UK; Malden, MA: Blackwell Science

Walsh WE (2003)
Home allergies: don't let your home make you sick
St. Paul, MN: Adult and Child Allergy Publications

Whitford F (2002)
The complete book of pesticide management science, regulation, stewardship, and communication
New York: J. Wiley

Williams ME (2003)
Is global warming a threat?
San Diego, CA: Greenhaven Press

Willinger M (2001)
Environmental quality, health and the value of life
Cambridge: EVE Concerted Action

DEFINING A CORE LIST OF 'WIDELY HELD BOOKS' IN LIBRARIES

The following is a ranked list of books in descending order by the number of libraries (excluding public and private elementary and secondary schools) claiming them in their holdings as of January 2007. These data are reported to OCLC (Online Computer Library Center, 6565 Kilgour Place, Dublin, Ohio 43017-3395, http://www.oclc.org/). The WorldCat database is the backbone of the OCLC sytem. WorldCat contains more than 90 million records reported from more than 40 000 libraries worldwide. Full bibliographic descriptions and cataloging information is provided for books, serials, manuscripts, sound recordings, audiovisual materials, maps, music scores, and computer-readable files. WorldCat does not include information on individual articles, stories in journals, magazines, newspapers, or

book chapters. A Beta-version of a free, public, version of WorldCat is available at http://worldcat.org/.

The books represented below represent a core list of toxicology-related books that are of a popular, general interest nature. After the book's title, there is a parenthetic number, which is the total number of libraries reporting to OCLC that title. This ranking does not included additional records added or updated to the OCLC database since later 2006. For those widely held books published since 2000, only the title and number of holding libraries are provide, because their more complete record is in the above section.

As a point of reference, Rachel Carson's classic book, *Silent Spring* is provided a total of nearly 105 unique bibliographic records for all editions, languages, formats (print, large-print, books-on-tape, etc.) with more than 9100 individual library records determined by the OCLC database. The highest ranked toxicology-related books published according to this OCLC criteria are:

Barzilay JI, Weinberg WG, Eley JW (1999)
The Water We Drink: Water Quality and its Effects on Health (1331)
New Brunswick, NJ: Rutgers University Press

Bennett W, Goldfinger SE (1987)
Your Good Health: How To Stay Well, and What To Do When You're Not (921)
Cambridge, MA: Harvard University Press

Berkeley, CA: University of California Press
Davis DL (2002)
When Smoke Ran Like Water: Tales of Environmental Deception and the Battle Against Pollution (1450)
New York: Basic Books

Bernards N (1986, 1991)
The Environmental Crisis – Opposing Viewpoints (2528)
San Diego, CA: Greenhaven Press (1991); St. Paul, MN: Greenhaven Press (1986)

Carson R (1907–1964), Lear LJ (1998)
Lost Woods: The Discovered Writing of Rachel Carson (1296)
Boston, MA: Beacon Press

Chivian E (1993)
Critical Condition: Human Health and the Environment (778)
Cambridge, MA: MIT Press

Cohen G, O'Connor JT (1990)
Fighting Toxics: A Manual for Protecting Your Family Community, and Workplace (869)
Washington, DC: Island Press

Cummins R, Lilliston B (2000)
Genetically Engineered Food: A Self-Defense Guide for Consumers (934)
New York: Marlowe

Dadd-Redalia D (1986)
The nontoxic home: protecting yourself and your family from everyday toxics and health hazards (754)
Los Angeles, CA: J.P. Tarcher; New York: Distributed by St. Martin's Press

Dunlap TR (1981)
DDT: Scientists, Citizens, and Public Policy (1049)
Princeton, N.J.: Princeton University Press

Ehrlich PR (comp.), Holdren JP, Holm RW (1971)
Man and the Ecosphere: Readings from Scientific American (1090)
San Francisco, CA: W. H. Freeman

Emsley J (1994)
The Consumer's Good Chemical Guide: A Jargon-Free Guide to the Chemicals of Everyday Life (791)
Oxford, UK; New York: W.H. Freeman

Garrett L (1994)
The Coming Plague: Newly Emerging Diseases in a World Out of Balance (this book is held by 2692 libraries)
New York: Farrar, Straus and Giroux

Gay K (1988)
Silent Killers: Radon and Other Hazards (1130)
New York: F. Watts

Gibbs LM (1995)
Dying from dioxin: a citizen's guide to reclaiming our health and rebuilding democracy (768)
Boston, MA: South End Press

Gibbs LM (1995)
Dying from dioxin: a citizen's guide to reclaiming our health and rebuilding democracy (760)
Boston, MA: South End Press

Harrison W (1972)
Sowing the Wind: A Report from Ralph Nader's Center for Study of Responsive Law on Food Safety and the Chemical Harvest (911)

Harte J (1991)
Toxics A to Z: A Guide to Everyday Pollution Hazards (2024)

Hills SL (1987)
Corporate Violence: Injury and Death for Profit (819)
Totowa, NJ: Rowman & Littlefield

Johansen BE (2003)
The Dirty Dozen: Toxic Chemicals and the Earth's Future (1148)
Westport, CO: Praeger

King J, Rothman M (1985)
Troubled Water: The Poisoning of America's Drinking Water – How Government and Industry Allowed It To Happen, and What You Can Do To Ensure a Safe Supply in the Home (996)
Emmaus, Pa.: Rodale Press

Kuhn C, Swartzwelder S, Wilson W, Wilson LH, Foster J (2003)
Buzzed: The Straight Facts about the Most Used and Abused Drugs from Alcohol to Ecstasy (835)
New York: W.W. Norton

Lappé M (1991)
Chemical Deception: The Toxic Threat to Health and the Environment (1215)
San Francisco, CA: Sierra Club Books

Legator MS, Harper BL (1985)
The health detective's handbook: a guide to the investigation of environmental health hazards by nonprofessionals (745)
Baltimore, MD: Johns Hopkins University Press

Lerner S (1997)
Eco-Pioneers: Practical Visionaries Solving Today's Environmental Problems (862)
Cambridge, MA: MIT Press

Marco GJ, Hollingworth RM, and others (1987)
Silent Spring Revisited (1023)
Washington, DC: American Chemical Society

Markowitz GE, Rosner D (2002)
Deceit and Denial: The Deadly Politics of Industrial Pollution (927)
Berkeley, CA: University of California Press

Moore TG (1998)
Climate of Fear: Why We Shouldn't Worry about Global Warming (812)
Washington, DC: Cato Institute, 1998

Murakami H, Birnbaum A, Gabriel JP (2001)
Underground: The Tokyo Gas Attack and the Japanese Psyche (878)
New York: Vintage International

Naar J (1990)
Design for a Livable Planet: How You Can Help Clean Up the Environment (1177)
New York: Perennial Library

Null G (1990)
Clearer, cleaner, safer, greener: a blueprint for detoxifying your environment (744)
New York: Villard Books

Olkowski W, Daar S, Olkowski H (1991)
Common-Sense Pest Control (1233)
Newtown, CT: Taunton Press

Petrikin JS (1995)
Environmental justice (765)
San Diego, CA: Greenhaven Press

Russell E (2001)
War and Nature: Fighting Humans and Insects with Chemicals from World War I to Silent Spring (801)
Cambridge, UK; New York: Cambridge University Press

Sadler AE (1996)
The Environment – Opposing Viewpoints (1153)
San Diego, CA: Greenhaven Press

Shein L (1998)
Inequality: Opposing Viewpoints in Social Problems (1162)
San Diego, CA: Greenhaven Press

Sittig M (1981)
Handbook of toxic and hazardous chemicals (727)
Park Ridge, NJ: Noyes Publications

Southwick CH (1996)
Global ecology in human perspective (756)
New York: Oxford University Press

Stewart JC (1990)
Drinking Water Hazards: How to Know if There Are Toxic Chemicals in Your Water and What To Do if There Are (1006)
Hiram, OH: Envirographics

Upton AC, Graber E (1993)
Staying healthy in a risky environment: the New York University Medical Center family guide (726)
New York: Simon & Schuster

Walters MJ (2003)
Six Modern Plagues and How We Are Causing Them (1326)
Washington, DC: Island Press/Shearwater Books

Weil A, Rosen W (1993, 1998)
From Chocolate to Morphine: Everything You Need to Know about Mind-Altering Drugs (855)
Boston, MA: Houghton Mifflin

Whorton JC (1974)
Before Silent Spring: Pesticides and Public Health in Pre-DDT America (1173)
Princeton, NJ: Princeton University Press

Wildavsky AB (1995, 1997)
But Is It True? A Citizen's Guide to Environmental Health and Safety Issues (896)
Cambridge, MA: Harvard University Press

CONSUMERS' ONE STOP RESOURCE: CHANNING BETE

Channing Bete Company (200 State Road, South Deerfield, MA 01373-0200; 1-800-499-6464; www.channing-bete.com) has some of the most widely distributed and read general-interest booklets produced. The company was started in 1936 as an advertising agency, founded by Channing L. Bete, Sr. Its trademark format and style is called Scriptography. It is easily recognized as a hybrid of a very easily read text for various ages and reading levels, and generally black and white illustrations, many of which appear as coloring-book-styled drawings or stylized, pencil drawings of a photograph. The text of these booklets is written in a distinctive easy-to-read style to foster interest and retention of the information provided.

Resources can be purchased in single issues or small quantities, but the Channing Bete publications are more often bought in large, bulk quantities for distribution en masse to a specific end user, client, or target audience. Custom printing of an organization's name, points of contact, etc., can also be added to such bulk shipments. Table-top and floor-stand style display racks are also available.

'Public Health' is one of the larger categories of publications with major sections devoted to Health Promotion: HIV/AIDS, STDs and Sexual Responsibility, Demand Management, Health Promotion, Nutrition, Smoking Prevention/Cessation, Poisoning Prevention, Lead Poisoning Prevention, Home and Family Safety; Disease Management: Diseases and Conditions, Pregnancy, Child Health, and Behavioral Health.

Examples of individual booklets pertaining to a broadly defined concept of toxicology and environmental and occupational health include the following (listed in alphabetic order):

- About Alcohol
- About Cocaine
- About Drugs
- Asthma in Children
- Be a Lead-Safe Family:
- Binge Drinking Can Be Deadly
- Children's Lead Levels – A Guide for Parents
- Coping with Chemotherapy
- 'Crack' Cocaine
- Crack Cocaine – What Everyone Should Know
- Drugs – The Wrong Choice
- Finding Health information on the Internet
- Good Health for All – About Your Public Health Department
- HIV, AIDS and Young People – Protect Your Health AND Your Future
- Keep Your Child Lead-Safe
- Keep Kids Safe from Lead – A Story for Parents
- Lead and Pregnancy
- Lead and Pregnancy – Protect Yourself and Your Baby
- Lead Hazards at Home Pop-Up Set
- Lead Poisoning
- Let's Learn about Alcohol: An Information and Activities Book
- Let's Learn about Spit Tobacco: An Information & Activities Book
- Marijuana and the Mind: Intoxication and Addiction
- My Book about Keeping Away from Poison
- My Book about Poison
- My Book about Staying Safe Around Lead
- Poison and You!
- Poison-Proof Your Home – For Your Child's Safety
- On Kicking Nicotine
- Pregnant? Don't Smoke
- Public Health – Working for a Healthy Community
- Quit Smoking for Baby and You
- Quit Smoking for Baby and You: A Self-Care Handbook
- Recovery from Alcohol or Other Drug Addiction
- Spit Tobacco
- Talking with Your Child about Alcohol and Drugs
- Women and Alcohol
- Your Child's Lead Test

TOXIC FICTION

Within the category of popular and general-interest works related to toxicology and environmental health are adult fictional works. Since the early 1970s, as the dangers of chemical and radiological wastes took to the headlines of newspapers worldwide, there has been an increase in the number of fictional works about toxic and chemical wastes. Library holdings data suggest fictional works dealing with hazardous wastes, toxic spills, poisonings, and disease outbreaks are popular offerings in public and many academic libraries. Your public librarian (and some college and university librarians) can assist in locating titles from this genre, such as Joseph Wambaughs' *Finnegan's Week* (New York: W. Morrow, 1993), *Sacred Clowns* by Tony Hillerman (New York: Harper Collins, 1993),

Don DeLillo's *Underworld* (New York: Alfred A. Knopf, 2004), and Joyce Carol Oates novel about Love Canal, '*The Falls*' (New York: Ecco, 2004; New York: Harper Perennial, 2005).

JUVENILE LITERATURE

Monographic literature with themes focusing on toxic substances, drugs and alcohol abuse, chemical wastes in the environment abound for younger audiences. There are both fictional and non-fictional works available for children generally at reading levels of middle school and above. While there can be educational value from all of these forms, the non-fictional works tend to be written for older children and come in the form of reference works, textbooks, and other monographs written specifically for age-appropriate investigation and information research. There are scores of titles from which to choose and it is strongly suggested to contact a school librarian or media specialist or a public librarian for assistance in finding such works as *Inhalants: The Toxic Fumes* by John R Glowa (New York: Chelsea House, 1986, 1996), *River Rats* by Caroline Stevermer (Fiction, San Diego: Harcourt Brace Jovanovich, 1992), *Toxic Waste: Clean-up, or Cover-up?* by Malcolm E Weiss (New York: Franklin Watts, 1984), and *The Chemo Kid* by Robert Lipsyte (Fiction, New York: Harper Collins). So popular is the genre of environmental and nature-themed books, that as of this writing, the Task Force on the Environment of the American Library Association is working to establish a national children's environmental book award for best fiction and non-fiction works.

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Atton C (1994) Beyond the mainstream: Examining alternative sources for stock selection. Library Rev. 43(4): 57–64.

Bleise A, Danesi PR, Burkart W (2003) Properties, use, and health effects of depleted uranium (DU): a general overview. J. Environ. Radio. 64: 93–112.

Stoss FW (2003) Sustainable communities and the roles libraries and librarians play. Reference User Serv. Quart. 42(3): 206–210.

Weintraub I (2000) The impact of alternative presses on scientific communication. Intern. J. Grey Lit. 1(2): 54–59.

CHAPTER

65

Technical Reports and Government Information

FREDERICK W. STOSS

INTRODUCTION

It is fitting to open this chapter with a comment on the life of one of the most important information innovators of the twentieth century, Alvin Weinberg, who died in October 2006 at the age of 91.

Weinberg was Director of Oak Ridge National Laboratory (ORNL) from 1955–1973 and led ORNL's R&D efforts in areas related to early research into the biological effects of radiation on human genetics. He was also leader in the research efforts on the environmental effects of pollution and ecological studies related to human influences on the environment.

It is here, however, that we pause to recognize Weinberg's critical role in directing U.S. government information policies, which are still being realized today. The tremendous surge of research in science, engineering, and medicine created a critical information overload, which was perceived as a threat to science and national security (dramatically realized in 1957 with launching of the first artificial satellite, *Sputnik*, into space by the Russians during the heightened years of The Cold War). Weinberg's panel found that scientists were 'being snowed under by a mound of undigested reports, papers, meetings, and books.' Scientists needed help in finding the buried gems.

Weinberg was a member of the President's Science Advisory Commission and in 1961 chaired the Kennedy Administration's Panel of Science Information. The report issued in 1963 by this commission, *Science, Government and Information: The Responsibilities of the Technical Community and the Government in the Transfer of Information; A Report* (also known as the 'Weinberg Report') emphasized the need to communicate scientific information to technical and lay audiences. The report's basic thesis was that the transfer of information was an integral and inseparable part of the research and development process and the government had a responsibility for assuring this information was readily available (U.S. GPO 1963).

The proposed solution was the creation of information centers, and the recommendation received broad acceptance. Nationally, more than 300 science information centers were formed to manage the scientific 'information revolution.' John Derek de Solla Price coined the term 'invisible college,' as a means to define communication and the sharing of technical information among peers (de Solla Price 1963). It was Alvin Weinberg who gave these 'colleges' their respective 'campuses' in which to grow, thrive, and intermingle.

A collection of Weinberg's papers is at a special website compiled by the U.S. Department of Energy's Office of Scientific and Technical Information (STI, see: http://www.osti.gov/featuredsites/weinberg.shtml). The historical significance of this unprecedented era of research expansion and its resulting growth of scientific and technical information are well-documented (Capshew 1992, Lesk 1995).

Since publication of the third edition of this book in 2000, there has been one event in history that has greatly affected the availability and dissemination of government information in the United States – the tragic events of the terrorist attack on the United State on September 11, 2001 with the deliberate hijacking

and crashing of commercial airplanes into the World Trade Center building, the Pentagon, and an aborted attack resulting in a crash-landing of United Flight 93 in a remote field in Pennsylvania and the subsequent anthrax attacks over the course of several weeks beginning on September 18, 2001. Letters containing anthrax spores were mailed to several news media offices and two Democratic U.S. Senators, killing five people and infecting 17 others. The crime remains unsolved. These events are still influencing heated debates in information and policy circles today, including the ongoing debates of the USA PATRIOT (Uniting and Strengthening America by Providing Appropriate Tools Required to Intercept and Obstruct Terrorism) Act (P.L. 107-56, signed by President George W. Bush on October 16, 2001) and its impacts on producing, providing, and disseminating government information.

There are numerous news stories and editorials (Gordon-Murnane 2002, Oder 2002, Ojala 2002, Pinell-Stevens 2003) and scholarly articles (Caidi 2005, Feinberg 2004, Hammitt 2005, Herman 2004, Jaeger and Burnett 2005, Lee 2003, Martorella 2006, Relyea 2004, Roberts 2004, Smock 2003) in the literature of librarianship and data and information management addressing this issue. It is well beyond the scope of this chapter to delve into the various (political, social, and cultural) ramifications of the direct and indirect effects of impacts of the terrorist attacks and the resulting 'war on terror,' other than alerting the reader to their monumental significance in the realm of access to U.S. government data and information.

The National Research Council provides an outstanding summary of the implication of this event in its report of interagency meetings held to discuss the implications of information and data sharing in the post-9/11 era. The following is taken from the introduction of the report's introduction, and sets the tone for its intent:

> The tragedy of September 11, 2001, the subsequent anthrax attacks, and ongoing terror threats internationally have markedly changed national and international security. As concerns about threats and terrorist activities have become global, so have the rapid transfer of information and communication. The confluence of the globalization of business and the revolution in information storage and transmittal has changed the landscape upon which to build national and international security. This requires a re-examination of the security measures developed during the days of the Cold War to assess whether those tools are still appropriate and to determine how they are affecting the current science and technology enterprises.
>
> (NRC 2007)

As a direct result of the threats of terror to the U.S., the National Strategy for Homeland Security and the Homeland Security Act of 2002 saw the creation of the Department of Homeland Security (DHS), providing the core for a national network of organizations and institutions to keep the U.S. secure from various natural and human threats. The Department of Homeland Security is made up of four major directorates: Border and Transportation Security, Emergency Preparedness and Response, Science and Technology, and Information Analysis and Infrastructure Protection, with the enveloping of other agencies, programs, and services related to toxicology (including biological and chemical warfare and agents), environmental health, and other safety and security linkages:

- Border and Transportation Security
- The Transportation Security Administration (Transportation)
- Animal and Plant Health Inspection Service (part) (Agriculture)
- The Emergency Preparedness and Response
- The Federal Emergency Management Agency (FEMA)
- Strategic National Stockpile and the National Disaster Medical System (HHS)
- Nuclear Incident Response Team (Energy)
- The Science and Technology
- CBRN Countermeasures Programs (Energy)
- Environmental Measurements Laboratory (Energy)
- National BW Defense Analysis Center (Defense)
- Plum Island Animal Disease Center (Agriculture)
- The Information Analysis and Infrastructure Protection (including the CIA, FBI, DIA and NSA)
- National Communications System (Defense)
- Energy Security and Assurance Program (Energy).

While the focus of this new department is on combating terrorist attacks against the United States, there are numerous reports dealing with preparedness for natural disasters (earthquake, hurricane, and other severe weather) and disasters of human origins; they have applicability to dealing with major incidents dealing with toxic threats or the threats of chemical and biological agents in the environment. Technical reports and documents from within this newly created department are widespread.

THE PLIGHT OF THE EPA LIBRARIES

A significant threat to the nation's environmental information infrastructure took place since the publication of the last edition of *Information Resources in Toxicology* with a proposed dismantling of the U.S. Environmental Protection Agency's library system.

Beginning in 2004 the EPA began what some have viewed as a much-needed restructuring of a large information network and what others look at as the attempt to severely eliminate a time-tested and trust source of environmental data, information, and literature.

Beginning October 1, 2006, EPA announced that they would transition to a new National Framework for the Headquarters and Regional Libraries (http://www.epa.gov/natlibra/Library_Plan_National_Framework081506final.pdf), which was released in August of 2006. The document describes a new model EPA will implement to ensure that Agency staff and the public receive quality library services.

Initial language of a June 23, 2007, report in the Senate Interior Appropriations Bill earmarked $2 million for EPA to restore publicly available library facilities in each region. Subsequent Congressional approval of this bill required the EPA's submission of a plan on how it will use funding to reopen facilities by December 31, 2007 (http://www.epa.gov/natlibra/documents/Library_Report_to_Congress.pdf). Subsequently, the Fiscal Year 2008 U.S. Environmental Protection Agency budget, approved in the omnibus budget bill, allocates $1 million to restore EPA's network of libraries. The EPA was required to provide Congress with a report regarding 'actions it will take to restore publicly available libraries to provide environmental information and data to each EPA region within 90 days of the enactment of this Act.'

The EPA Office of Environmental Information Report to Congress, EPA National Library Network Report to Congress (see http://www.epa.gov/natlibra/documents/Library_Report_to_Congress.pdf) was issued by the Agency on March 26, 2008. Among its provisions are the following items:

- Re-establish on-site libraries in Region 5 in Chicago, Region 6 in Dallas, Region 7 in Kansas City, and the consolidated EPA Headquarters Repository and Chemical Library in Washington, DC.
- Enable Regional EPA libraries to update their collections, facilities, and equipment to meet Network standards.
- Conduct a formal needs assessment for EPA library services to support future development.

A 56-page GAO report, Environmental Protection: EPA Needs to Ensure That Best Practices and Procedures are Followed When Making Further Changes to Its Library Network, GAO-08-304 EPA Libraries (see: http://www.gao.gov/new.items/d08304.pdf) GAO reviewed pertinent EPA policies, plans, and guidance and interviewed EPA officials and staff from each of the 26 libraries. GAO made four recommendations in this report aimed at best practices and procedures that EPA should follow when continuing to reorganize its library network.

GAO recommended that the Administrator of EPA continue the agency's moratorium on changes to the library network 'until the agency (1) develops a strategy to justify its reorganization plans; (2) improves its outreach efforts; (3) ensures sufficient oversight and control over the reorganization process, and continuously and consistently monitors the impact of the reorganization on EPA staff and the public; and (4) implements procedures that ensure that library materials are dispersed and disposed of consistently and in accordance with federal property management regulations. EPA agreed with the recommendations made in our report.'

WILL THE NATIONAL AGRICULTURAL LIBRARY BE NEXT?

The National Agricultural Library (NAL), supported by the U.S. Department of Agriculture is noted as the greatest agricultural library in the world. Its user base is as broad as is the agricultural community from the single-family farm to the corporate leaders of the Fortune 100 agro-business companies. The NAL budget has remained 'flat-lined,' but as the final paragraphs of this fourth edition are edited, NAL's budget is slated for drastic cuts in the Federal governments 2008 Fiscal Year, which began Oct. 1, 2008. The proposed cuts may 'curtail acquisition of new printed works, endanger preservation of its special collections, halt document delivery and turn a national library into a local one.' (Damrosch 2008).

In response to the proposed cuts, the American Library Association (ALA) and the Association of Research Libraries (ARL) sent a letter to the Honorable Rosa DeLauro, Chairwoman of the U.S. House of Representatives' Subcommittee on Agriculture, Rural Development, and Related Agencies, a part of the Committee on Appropriations, requesting necessary appropriations for the National Agricultural Library on March 20, 2008 (http://www.wo.ala.org/districtdispatch/wp-content/uploads/2008/04/letter_nalapprops.pdf). In the Washington Post special feature article, staff writer, Barbara Damrosch provides a concise statement concerning the plight of both the EPA's National Library Network and the National Agricultural Library:

> A library is a lot like a seed bank, in which the germ plasm of the world's plant varieties is preserved for future generations. Without this rich diversity of old seeds to draw on, the breeding of new plants capable of meeting future challenges can't be guaranteed. In addition, the seeds must be grown out from time to time to test their viability and to keep them adaptable to present conditions. The same is true of books. If no one reads them, puts their contents through the paces of real life and uses them to cultivate knowledge, the future will see a poor harvest indeed.
>
> (Damrosch 2008)

TECHNICAL REPORT LITERATURE

U.S. Government information can be an elusive entity with which to deal. It is a literature marked by technical reports, legislative and judicial hearings, public communication documents, brochures, pamphlets, official guidelines, regulations, and standards. Large university libraries are generally participants in the U.S. Federal Depository Library program, which the Government Printing Office (GPO) describes:

> The **Federal Depository Library Program** (FDLP) is by far the largest and best known of the Office of Information Dissemination (SuDocs). Established by Congress to ensure that the American public has access to its Government's information, this program involves the acquisition, format conversion, and distribution of depository materials and the coordination of Federal depository libraries in the 50 states, the District of Columbia and U.S. territories. The mission of the FDLP is to disseminate information products from all three branches of the Government to over 1,250 libraries nationwide. (http://www.gpoaccess.gov/fdlp.html)

Federal publications and other information products are generally available for free public use in Federal depository libraries throughout the United States. In addition to the publications, trained librarians are available to assist in their use. You can locate Federal Depository Libraries from the *GPO Access* site at www.gpoaccess.gov/libraries.html. A good source of Federal government information for children is *Ben's Guide to Government* for kids at bensguide.gpo.gov/.

In many cases such depository libraries provide users of their collections of government documents inventories of the major finding tools, bibliographic databases, Web compilations used to identify, locate, and retrieve government information (such as those at the University at Buffalo's Government Documents Collection in its Arts and Sciences Libraries; Smith 2007, Herman 2006). The following resources and information taken from the resources, product description pages (PDPs) are provided here as the primary finding tools to identify government information, including technical reports and government documents. Those items provided a '[P]-superscript' are resources freely available to the public at-large, while those resources provide a '[$]-superscript' are commercially available database for which subscription fees must be paid for individual or site-license use.

- The *CQ Electronic Library*[$] covers public policy issues & U.S. Congress news & analysis with policy content.
- *FirstGov*[P] (http://www.usa.gov/) is a major gateway site for one-stop shopping for government information, including many resources related to toxicology, environmental and occupational health and medicine, pollutants, chemical and radiological risks.
- *Government Periodicals Universe*[$] indexes journals and periodicals published by the U.S. government. *GPO Access*[P] (http://www.gpoaccess.gov/index.html) GPO Access is the home page of the Government Printing Office's Superintendent of Documents. That agency administers the Government Printing Office Depository Program whereby GPO forwards to depository libraries copies of government publications without charge. The depositories in turn agree to make the data available to the entire community.
- *LexisNexis Congressional*[$], formerly Congressional Universe, is a LexisNexis™ product that indexes and provides selected full texts of Congressional publications, regulations, laws, legislative histories, and background information on members of Congress.
- The *CIS Index* covers 1970 to present. Full-text coverage varies depending on publication (see above) and update schedules vary. Historical Full Text and Historical Indexes cover Congressional publications from 1789–1969.
- *Catalog of U.S. Government Publications* (U.S. Government Printing Office)[P] (http://catalog.gpo.gov/F) indexes U.S. government publications in all formats issued since 1976. GPO intends to add earlier documents in the future. The GPO Monthly Catalog, published by OCLC, is a commercial edition of the same.
- The *NTIS*[P,$] database (public access: http://www.ntis.gov/), compiled by the U.S. Department of Commerce, National Technical Information Service covers technical reports submitted for government-sponsored research and development projects. Also included are reports made available by various U.S. government agencies and some foreign governments.
- *THOMAS*[P] is a database of Congressional and legislative information including bills, the Congressional Record – proceedings and debates of Congress, Congressional reports, legislative histories, and public laws. Contains leads to most data published since 1989 are full text. Earlier resources are only cited.
- *TRIS (Transportation Research Information Services) Online*[P] provides access to more than 400 000 bibliographic records covering transportation research on air, highway, rail, and maritime transport, mass transit, and other transportation modes. Subjects included are regulations and legislation, energy, environmental and maintenance technology, operations, traffic control, and communications.
- *U.S. Government BOOKSTORE* (US Government Printing Office)[P] lists federal government publications available for sale from GPO. Claitor's Law

Books and Publishing Division also sells GPO documents at http://www.claitors.com/gpo.htm.

- *U.S. Government Manual* [P] is the official handbook of the Federal Government; the United States Government Manual provides comprehensive information on the agencies of the legislative, judicial, and executive branches. It also includes information on quasi-official agencies, international organizations in which the United States participates, and boards, commissions, and committees.

NATIONAL TECHNICAL INFORMATION SERVICE (NTIS)

Since the preparation and publication of the third edition of this book the NTIS database, provided by the National Technical Information Service, shows nearly 16 000 toxicology-related records entered. These entries reflect the mission of the NTIS database, which covers technical reports submitted for government-sponsored research and development projects. Also included are reports made available by various U.S. government agencies and some foreign governments. Major areas included are the physical sciences, technology, engineering, biological sciences, medicine and health sciences, agriculture and social sciences. Its print counterparts include Government Reports Announcements & Index (1971–1996), US Government Research & Development Reports (1965–1971), US Government Research Reports (1955–1964), and Bibliography of Scientific & Industrial Reports (1946–1954).

While the total number of toxicology-related technical reports inventoried in the NTIS database may seem impressive, it falls far short of previous decades' production of technical report literature. An analysis of the technical report literature recorded in the NTIS database from 1950 to 2007 was performed in the NTIS database on the Engineering Index platform, which includes a rather robust means to analyze the citations retrievals. Searches were conducted for three major subcategories of the toxicology report literature: 'toxicology' (toxic, toxics, toxicologic, toxicological, toxicological, toxicity or toxicities); environmental health, environmental medicine, occupational health, occupational medicine; and air pollution, water pollution, solid wastes pollution, pesticides pollution, radiation pollution, environmental control pollution. The combined total of these three subcategories was also done. Plotting the results of this comprehensive search over the period 1950 to 2007 is shown in Figure 65.1.

There remains much to be done in the analysis of this plot. However, if one takes into consideration the

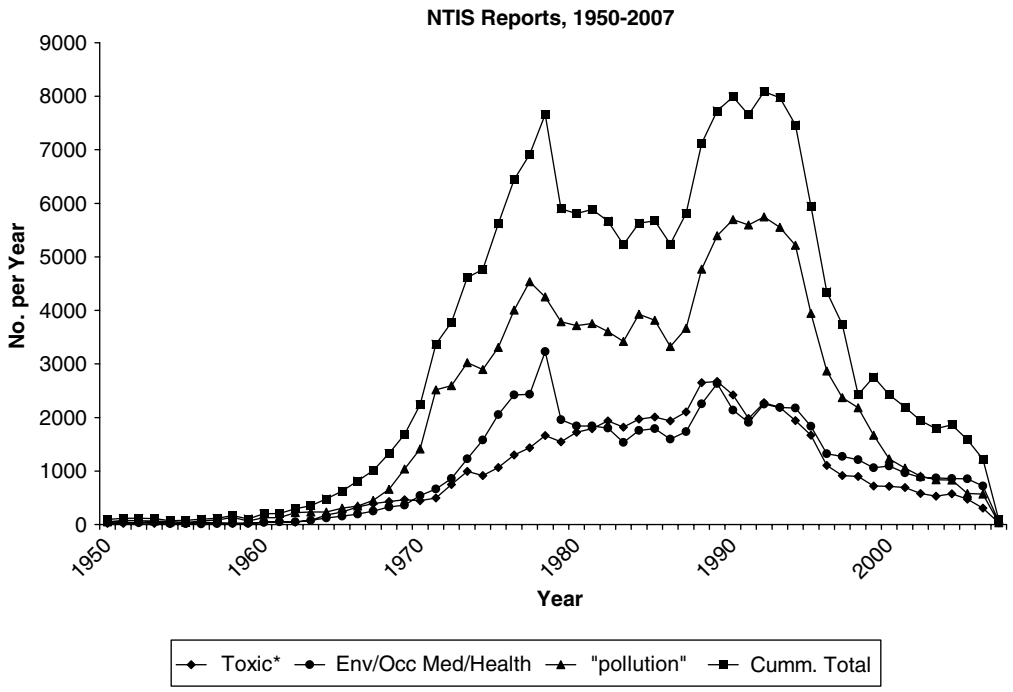

FIGURE 65.1 Toxicology-related report literature in the NTIS Database from 1950 to 2007

volume of Federal legislation related to the protection of the environments in which we work, play, and recreate, one easily can see the impacts that social and political change have on the production of technical information resulting from research and development programs and campaigns over time. These trends reflect funding priorities of political powers in Congress and the Executive Branch of the U.S. Government, research priorities within government agencies supporting various research and development projects, monitoring programs, and other factors that influence the production and capture of technical report literature by bibliographic utilities. The U.S. Government Accounting Office provides evidence that the steady declines noted in the above graph is part of a general trend across all NTIS full-text holdings:

> … in recent years, NTIS' repository has been growing at a slower pace – from about 56,000 reports published in 1995 to just over 10,000 published in 2000 (as of mid-November 2000). However, the Assistant to the Director of NTIS said that since about 75 to 80 percent of the reports in NTIS' collection for a given year are added in the years following the year of publication, the final number of reports for 2000 might increase significantly. Nevertheless, the Assistant to the Director of NTIS acknowledges that the total number of reports added to the repository in recent years has been declining.
>
> (U.S. Government Accounting Office 2001)

Figure 65.2 shows the production of journal articles retrieved from the *Chemical Abstracts* portion of the Chemical Abstracts Service's *SciFinder Scholar* database. Since there has not been such a precipitous drop in the publication of journal articles between the years 1995 to 2007 in the open scientific journal literature, it is safe to assume that a general decrease in publication may not be the cause of such a drop in the publication of technical report literature. An analysis of the Chemical Abstracts Services SciFinder Scholar database over the period of 1950 to 2007 for the concepts of toxicology, environmental health and occupational health covered in the journal literature shows an initial jump in the production of literature coincident to increased environmental awareness in the early to mid-1960s, with a steady first-order growth in the annual production of journal articles from about 2500 articles per year in the late 1960s to the early 1970s to more than 30 000 articles per year since 2000 (with the trend increasing in each year, except for a slight decrease in the year 2000).

Since the production of the third edition of this current book in 1999, the 20 most frequently contributing federal agencies, departments, and laboratories (including those of contractors and subcontractors) of toxicology-related technical reports are in ranked order (number of entries for each agency is provided in a parenthetic note) are:

- National Institute for Occupational Safety and Health, Washington, DC (495)
- Environmental Protection Agency Office of Water (252)
- Environmental Protection Agency Office of Emergency and Remedial Response (236)

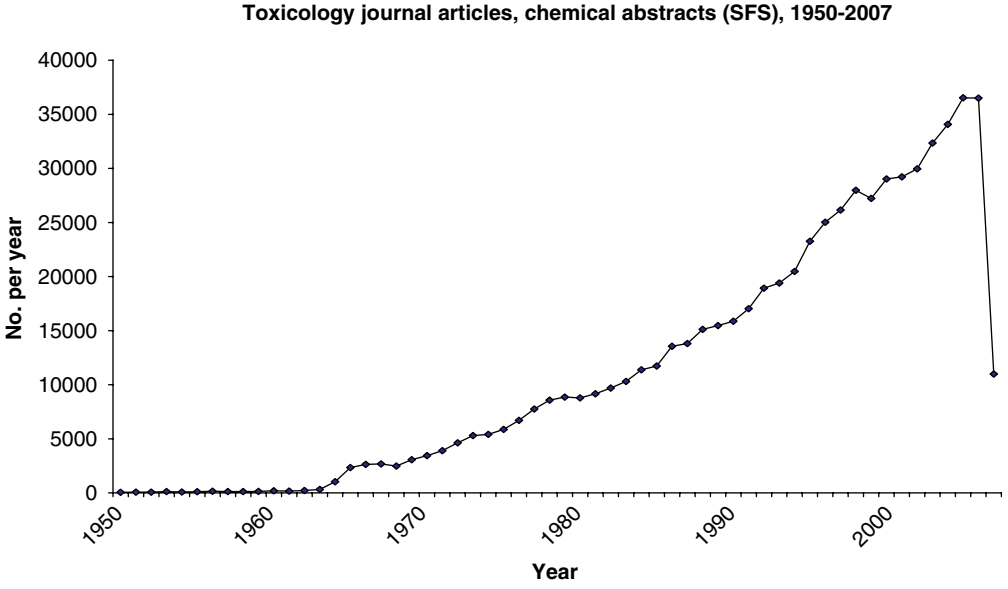

FIGURE 65.2 Publication of toxicology-related journal articles in Chemical Abstracts 1950–2007

- Agency for Toxic Substances and Disease Registry (213)
- Environmental Protection Agency Office of Air Quality Planning and Standards (189)
- Lawrence Livermore National Laboratory (Department of Energy) (161)
- Regscan, Inc. (150)
- Army Institute of Environmental Medicine (149)
- National Institute for Occupational Safety and Health (Cincinnati, OH) (148)
- National Park Service Water Resources Division (131)
- Environmental Protection Agency Office of Prevention, Pesticides and Toxic Substances (118)
- General Accounting Office (107)
- Environmental Protection Agency (Washington, DC) (106)
- Pacific Northwest National Laboratory (Department of Energy) (95)
- National Institute for Occupational Safety and Health (Pittsburgh, PA) (91)
- National Toxicology Program (88)
- U.S. Geological Survey (85)
- Edgewood Chemical Biological Center, Aberdeen Proving Ground (85)
- National Institute for Occupational Safety and Health Office of Surveillance, Hazard Evaluations and Field Studies (Cincinnati, OH) (82)
- Agency for Toxic Substances and Disease Registry, Division of Health Assessment and Consultation (82).

These 1999–2007 reports were predominantly addressing a range of toxicology and environmental and occupational health issues as indicated by the 20 most frequently used control vocabulary terms and classification codes provided by technical support personnel indexing entries into the database. The topical nature of the reports retrieved in this time cohort are revealed by the specific controlled vocabulary terms and classification codes more frequently used to index these reports (and the number of citations indexed by them are parenthetic notations). The ten most frequently used controlled vocabulary terms and classification codes indexing toxicology-related technical reports in the *NTIS* database are (Controlled Vocabulary Terms):

- Toxicity (1712)
- Occupational Health and Safety (1721)
- Public Health (1533)
- Ground Water (1205)
- Air Pollution (1187)
- Water Pollution (1146)
- Recommendations (1133)
- Risk Assessment (994)
- Hazardous Materials (921)
- Water Quality (918).

During the period between the third and fourth editions of this book, there has been a continuation of the production of a number of series of toxicology-related technical reports issued by specific agencies and departments:

- EPA's series, *Aquatic Life Ambient Water Quality Criteria*, and supporting ambient water quality criteria standards and preparation guidelines
- Agency for Healthcare Research and Quality's *Evidence Report/Technology Assessment* Series, including environmental and public health topics
- National Institute for Occupation Safety and Health's *NIOSH Health Hazard Evaluation Report* Series
- New, revised, and updated to public health assessment reports and toxicological profiles prepared by the Agency for Toxic Substances and Disease Registry.

The completion of the Human Genome in 2000 paved the way for a tremendous surge in the production of genomics data and the creation of a new generation of genomic, proteomic, metabolomic, and other biological-sequence databases forming the nexus of data archives, and data retrieval and management tools of the emerging field of bioinformatics. As applied to the fields related to toxicology, the term 'Toxicogenomics' is one of recent addition to the toxicology lexicon, and one continuing to evolve as toxicology is pursued at molecular levels. These databases are described in more detail in this book's chapter of databases, while the emergence of the technical report literature in this field is mentioned here.

Toxicogenomics and the various toxicologic overlaps with 'The New Biology' of bioinformatics, genomics, proteomics, and other spin-off disciplines from molecular and structural biology and genetics is the newest topic of interest to toxicology and environmental and occupational health and medicine. Numerous documents in -omic-related disciplines may be identified by consulting the NTIS database. The following is a list of the most relevant technical reports extracted from the NTIS database and the Federal entities responsible for their production) on this new and emerging topic.

NTIS at a Crossroads

Since publication of the third edition of this current work, the General Accountability Office (formerly the Government Accounting Office) published two reports on NTIS. The first report (U.S. Government Accounting Office 2000) 'cast doubt on the long-term viability of NTIS, due to the increasing availability of

reports on the Internet and insufficient funds to cover operating costs.' In response, NTIS cut staff and costs. A second GAO report (U.S. Government Accounting Office, 2001) acknowledged NTIS changes, and concluded 'that the role of NTIS should be explored in the context of broader issues associated with the dissemination of government information in the Internet age.' Additional comments about the current operation of NTIS and future directions are suggested (Drake 2006).

The U.S. Congress directed the National Commission on Libraries and Information Science (NCLIS) to conduct a study on the proposal to close NTIS. Their study produced two reports: a *Preliminary Assessment of the Proposed Closure of the NTIS* (March 2000) and a *Comprehensive Assessment of Public Information Dissemination* (January 2001). These NCLIS reports reiterated NTIS's value-added features as contributing to the 'public good' (the collection, organization, dissemination, and permanent public availability of federally funded scientific and technical information). They further emphasized the impact NTIS has on the national economy and suggested appropriations of $5 million per year (a very small fraction of the total annual budget for federal research). Completion of these NCLIS reports and study 'coincided with the change in both the Presidential administration and Congress,' and noted that 'the George W. Bush administration and the 108th Congress have not taken action on this report. At the end of 2003, the National Technical Information Service remains in the Department of Commerce, but the agency has received no regular appropriated funds since the completion of the study.' (Nickum 2006).

The apparent demise of NTIS is also reflected in the manner by which the Environmental Protection Agency is making access to its technical reports 'more accessible,' but not in any sort of a systematic, unified manner (Nickum 2006). There are many ways within the EPA environmental information management system to locate appropriate technical reports. However, there is no single or central database or federated search function to assure the ability to search across all of the EPA technical reports. Should this practice (the management of publication within subunits of Federal agencies) continue, the loss of a central authority control will represent a significant loss in the identification of technical report literature.

Regardless of the current status of NTIS, it is the future that holds great unknowns not only for NTIS but for the generation and dissemination of corpus of technical report literature generated on the accounts of the Federal government. The U.S. Congress will be presented the challenge of overseeing the future of NTIS. According to the U.S. General Accounting Office:

> In light of developments in report dissemination through the Internet, the Congress may wish to reexamine how scientific, technical, and engineering information is disseminated to the public. In this reexamination, the Congress could specifically look at how this information is defined; whether there is a need for a central repository of this information, such as at NTIS; and, if a central repository is maintained, whether all information should be retained permanently, and what business model should be used to manage it.
>
> (U.S. General Accounting Office 2001)

While individual departments and agencies within the Federal government may boast about easier and improved access to their reports and documents to meet demands of their user groups and constituencies, the significant loss of bibliographic controls over the full body of technical report literature represents a tremendous negative impact on the ability to identify, locate, obtain, use, evaluate, synthesize, and share this body of primary research information. This in turn demands new approaches for users who are seeking comprehensive access to technical report literature that largely has been the historical role of NTIS for nearly a half century. Development of appropriate bibliographic finding tools lags significantly, and represents a disturbing trend in the world of digital access.

NATIONAL ACADEMIES

The National Academy of Sciences is an honorific society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. It has been expanded over the years to include the National Research Council, the National Academy of Engineering, and the Institute of Medicine. The National Academies Press (NAP) was created by the National Academies to publish the reports issued by each of the Academies.

The Board on Environmental Studies and Toxicology (BEST) is the body that oversees a vast amount of the toxicology-related work of the National Academies. BEST's mission is to 'provide independent expert assistance to the federal government and advice to the nation on matters of science and technology affecting public policy on important environmental and ecological problems.'

COUNCIL ON ENVIRONMENTAL QUALITY

The Council on Environmental Quality (CEQ) is responsible for developing national policies related to ensuring the quality of the environment and for determining the environmental impact of federal government programs and initiatives. CEQ is also responsible for overseeing implementation and enforcement of NEPA.

Environmental Quality, last prepared by CEQ in 1997, was one of the most important government documents bridging the scientific and technical underpinnings with the policy and decision-making aspects related to assuring the quality of our national and global commitments to environmental quality.

NATIONAL TOXICOLOGY PROGRAM (NTP)

The NTP is an interagency program that evaluates toxic agents of public health by research for developing and applying tools of modern toxicology and molecular biology. NTP publishes a variety of reports and government documents (see: http://ntp.niehs.nih.gov/), including the following reports.

- NTP 2006: Current Directions and Evolving Strategies (pdf) provides an overview of plans as well as a description of the NTP Centers, Report on Carcinogens (11th Edition is complete and 12th edition under review in 2008), and outreach. Previous NTP Current Directions – 2005, 2004, 2002, 2001, 2000, 1999, and 1998.
- The 11th *Report on Carcinogens* (RoC) was released on January 31, 2005. The 11th RoC contains 246 entries, 58 of which are listed as known to be human carcinogens and with the remaining 188 being listed as reasonably anticipated to be human carcinogens.

NTP also provides access to NTP Study Reports:

- Long-Term Toxicology and Carcinogenesis Studies
- Short-Term Toxicity Studies
- Genetically Modified Model Studies
- Immunology Toxicity
- Developmental
- Special Drinking Water
- Reproductive Assessment by Continuous Breeding
- NIEHS AIDS Therapeutics Toxicity Reports.

NTP provides access to various 'Reports and Monographs' and 'Journal Publications' from its Center for the Evaluation of Risks to Human Reproduction (CERHR), including reports for a variety of chemicals.

GOVERNMENT PRINTING OFFICE

Accessing the literature of the U.S Government Printing Office is achieved by several platforms. The *Catalog of U.S. Government Publications* (CGP) is one of the most widely used finding-tool for U.S. Federal government publications in electronic and digital formats. The online version, which is available free to the public (http://catalog.gpo.gov/F) provides direct access to both print and online government documents from several sources:

- National Bibliography of U.S. Government Publications
- Congressional Serial Set Catalog
- Congressional Publication
- GPO Access Publications
- Internet Publication
- Periodicals
- Serials.

There are some 1400 depository libraries and 53 regional libraries in the Federal Depository Libraries Program (FDLP). They are required to retain documents permanently to ensure the availability of archival collections.

When examining the content of the *CGP* it was apparent that an all-too-familiar trend was observed. Between the years from the mid-1990s to the present (2007) there has been a steady decline in the number of government documents retrieved. It warranted further examination. Figure 65.3 is a representation of toxicology-related information (of the same broad toxicology, pollution, and occupational and environmental health parameters) used in generating the NTIS output shown in Figure 65.1. It is noted here that there is rather incomplete inventorying of retrospective in the *CGP*, as noted above, so the numbers prior to 1976 are skewed to significantly lower entries (if any at all).

As stated in the description of this observation and trend with the *NTIS* database, much more in-depth analysis is need to determine all of the factors contributing to this decline, including: internal policies and actions with the U.S. GPO, Federal funding priorities over time with regard to toxicology-related issues and topics, shifting research and development priorities within departments and agencies, issues related to the new sense of national security and terrorist threats, and migration of bibliographic data away from the traditional bibliographic utilities and to the data and information management activities of individual departments and agencies within the U.S. government.

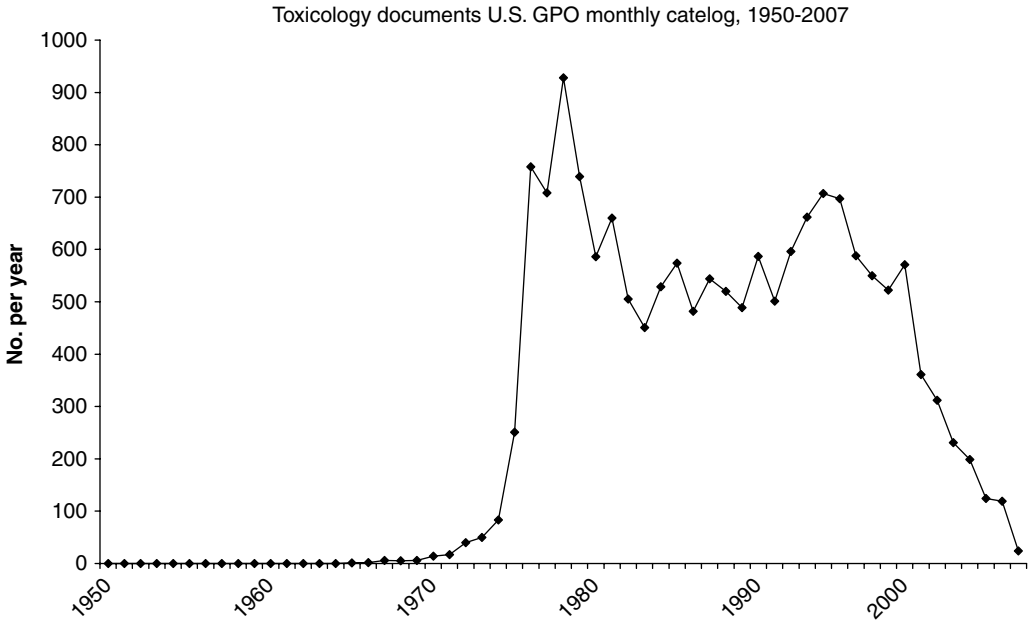

FIGURE 65.3 Production of U.S. Federal Government Documents retrieved from the *Catalog of U.S. Government Publications* from 1950 (more accurate representation from 1976) to 2007

LIBRARY OF CONGRESS

The Library of Congress maintains a website on technical reports and standards (see: www.loc.gov/rr/scitech/trs/trsover.html). This site provides an overview of technical reports, access to its collections of technical reports and standards, guidelines for locating and obtaining technical reports, and a large inventory of 62 publicly available (free) and nine commercially available (subscription) databases and electronic resources, including: *AGRICOLA* (U.S. Department of Agriculture), *Arctic Science and Technology Information System*, *ACSE Civil Engineering Database*, *DTIC's Technical Reports Collection*, *IncyWincy*, the Naval Research Laboratory's *NRL Database*, Virtual Technical Reports Center database, and the Windows Live Academic database.

The Library of Congress still maintains relevant Science Traces Bullets (brief guides to the literature for *Asbestos & Asbestosis*, *Chemical and Biological Warfare*, *Pesticides and Food*, and *Poisonous Plants*), Selected Internet Resources in Science and Technology (*Animal Welfare, Companion Animals, and Veterinarian Science*; *Avian Influenza (bird flu)*, *Bovine Spongiform Encephalopathy (BSE) or Mad Cow Disease*; *Chemical and Biological Warfare*; and *Health and Medical Information*); Science Reference Guides (*Human Genome Project*, *Rachel Carson: Selected Reading List*, and *Ricin [Toxic Substance]*).

LOCATING THE HARD-TO-FIND

The *GrayLIT Network* provided access to the gray literature of U.S. Federal Agencies easily accessible over the Internet by tapping into the search engines of distributed gray literature collections. The *GrayLIT Network* was the world's most comprehensive portal to Federal gray literature. Sadly, this database of government information no longer exists. *The GrayLIT Network* 'retired' on October 31, 2007. *Science.gov* (http://www.science.gov/) or the *Science Accelerator* (http://www.scienceaccelerator.gov/) databases replace the *GreyLIT Network* and search across collections of the U.S. Department of Energy's (DOE's) scientific and technical information. As a free public service, searches will include research and development results, project descriptions, accomplishments, technical reports, and more, via resources made available by the Office of Scientific and Technical Information (OSTI), U.S. DOE.

JUDICIAL AND LEGAL INFORMATION

Legal research is a precise and specialty area in librarianship. Like matters dealing with medical situations involving real bona fide situations of a legal matter, individuals should seek the qualified counsel of a professional lawyer or paraprofessional for preliminary inquires regarding legal environmental compliance,

health status, or other issues related to toxic and chemical products or situations. Many law schools, such as at the University at Buffalo, have law libraries that provide subject guides and guides to library research pertaining to the environment.

Nancy Kubasek and Gary Silverman have recently published the sixth edition of their textbook, *Environmental Law* (Upper Saddle River, NJ: Pearson Prentice Hall, 2008). This work provides an overview of the American legal system and the historical sources of environmental law in the U.S. It describes the litigation process and other tools for resolving environmental disputes, including a review of administrative law and its impact on the environment. Specific application of environmental law and policy is made for air-quality control, water-quality control, controlling toxic substances, waste management, and hazardous releases. Legal aspects of energy, natural resources, and international environmental law are also covered.

Regina S. Axelrod, David Leonard Downie, and Norman J. Vig contributed to the creation of a second edition of their book, *The Global Environment: Institutions, Law, and Policy* (Washington, DC: CQ Press, 2005). It provides a nice overview of the issues of environmental issues, many of which deal with environmental health and hazardous materials. Jean Macchiaroli Eggen also provides an updated version of her book, *Toxic Torts in a Nutshell, 3rd Ed.* (St. Paul MN: Thomson/West Publishers, 2005).

A synopsis of the basic information tools for environmental law is provided by the librarians in the Charles B. Sears Law Library at the University at Buffalo (see: http://law.lib.buffalo.edu/departments/info-services/research/bibliographies/federal/Envt.pdf):

The University at Buffalo Law Library also maintains a special Environmental Law Research Guide (see: http://law.lib.buffalo.edu/departments/infoservices/research/webguides/environment.asp) that provides links to representative bibliographic and research databases (see: Law – United States at http://law.lib.buffalo.edu/departments/info-services/research/webguides/environment.asp and Law – Foreign and International at http://libweb1.lib.buffalo.edu/infotree/resourcesbysubject.asp?subject=Law+-+Foreign+and+International), and also links to various web-based resources.

The primary database for legal research including judicial issues at all levels of government (in the U.S.) from local to Federal levels in the subscription-based *LexisNexis Academic* (for universities and colleges). *LexisNexis Academic* provides articles (full-text) and reports from more than 6000 magazines, newspapers, wire services, legal resources, reference books, and government publications from around the world. For details see: http://academic.lexisnexis.com/online-services/academic-content.aspx. This database consists of five major segments: News Library: news stories and articles from magazines, newspapers, wire services, legal resources, and specialized newsletters, with strong international coverage, broadcast transcripts from popular radio and television news/interview programs; Legal Library: a large collection of federal and state laws, regulations, and court cases, together with law review articles; Business Library: business news, company profiles, financial statements, bankruptcy reports, accounting pronouncements, investment analysis, business directories, etc.; Reference Library: biographies, country profiles, quotation dictionaries, public opinion polls, and the World Almanac; and Medical Library with specialized medical and pharmaceutical newsletters, including the F.D.C. Pink Sheet.

The Transactional Records Access Clearinghouse (TRAC) recorded in December 2007, 20 federal prosecutions of environmental law (according to enforcement data from the Justice Department). This is down from 39 in the previous month, and represents the fourth consecutive month for which a decline in prosecutions can be seen. Among the statutes included in such prosecutions are 16 USC 703 (taking, killing, or possessing migratory birds) and 33 USC 1319 (Water Pollution Enforcement), both of which show significant declines in this time period. For reports on the latest enforcement trends, see: http://trac.syr.edu/tracreports/bulletins/.

GENERAL ACCOUNTABILITY OFFICE

The U.S. Government Accountability Office (GAO, formerly the Government Accounting Office) is known as 'the investigative arm of Congress' and 'the congressional watchdog.' GAO supports the Congress in meeting its constitutional responsibilities and helps improve the performance and ensure the accountability of the federal government for the benefit of the American people. GAO is an independent, nonpartisan agency that works for Congress. Often called the 'congressional watchdog,' GAO investigates how the federal government spends taxpayer dollars. The head of GAO, the Comptroller General of the United States, is appointed to a 15-year term by the President from a slate of candidates Congress proposes. GAO's work includes oversight of federal programs; insight into ways to make government more efficient, effective, ethical, and equitable; and foresight of long-term trends and challenges. GAO's work is mandated by

requests of congressional committees or subcommittees or is mandated by public laws or committee reports, and they undertake research under the authority of the Comptroller General. GAO supports congressional oversight by:

- auditing agency operations to determine whether federal funds are being spent efficiently and effectively;
- investigating allegations of illegal and improper activities; reporting on how well government programs and policies are meeting their objectives;
- performing policy analyses and outlining options for congressional consideration; and
- issuing legal decisions and opinions, such as bid protest rulings and reports on agency rules.

For details about GAO and access to its full-text reports and testimonies go to: http://www.gao.gov/.

A brief sample of recent GAO reports follows:

TOXIC CHEMICALS: EPA's New Assessment Process Will Increase Challenges EPA Faces in Evaluating and Regulating Chemicals, GAO-08-743T

Chemical Regulation: Approaches in the United States, Canada, and the European Union, GAO-06-217R

CHEMICAL REGULATION: Actions Are Needed to Improve the Effectiveness of EPA's Chemical Review Program, GAO-06-1032T

PROTECTION OF CHEMICAL AND WATER INFRASTRUCTURE: Federal Requirements, Actions of Selected Facilities, and Remaining Challenges, GAO-05-327

TOXIC CHEMICAL RELEASES: EPA Actions Could Reduce Environmental Information Available to Many Communities, GAO-08-128

ENVIRONMENTAL RIGHT-TO-KNOW: EPA's Recent Rule Could Reduce Availability of Toxic Chemical Information Used to Assess Environmental Justice, GAO-08-115T

IDENTIFYING STATE, COUNTY, AND LOCAL SOURCES OF TECHNICAL REPORTS

The rapid assimilation of data and information on the Internet and the World Wide Web (WWW) is reflected in the development of these electronic services by state and tribal, county and parish, local municipalities (towns, villages, cities), and other subnational agencies, departments, offices, bureaus, and intergovernmental bodies. The content of state and territorial, tribal, county, and local government web pages varies considerably. Information about health and the environment are among the most frequently posted resources by subnational government bodies (Stoss 2001).

It is well beyond the scope of this current work to inventory all of the relevant technical report literature produced by state, tribal, county, and local government agencies. It is also most unfortunate that there is not nearly as much attention given the bibliographic content of reports from subnational sources. They are rarely covered by the traditional, mainstream bibliographic databases. There are scores of state documents that are not identified by traditional bibliographic utilities, and are identified only after painstaking bibliographic data-mining among many individual state websites or department and agency catalogs. Some suggestions for easing this process have been updated from previously published work (Stoss 2001).

An inventory of online, World Wide Web Sites for identifying state, tribal, county, and local government sources of information, including that related to toxicology, and environmental and occupational health is provided below.

Readers are encouraged to check university websites of law schools, schools or departments of public health, environmental sciences and engineering. University library inventories of Internet resources by subject are fertile sources of such subnational information and should be consulted in addition to academic department pages.

The organizations and associations listed below also produce directories for their constituencies. These professional and trade associations for subnational levels of government also have publications, especially newsletters, serving as bibliographic surrogates for reports published at subnational levels of government. Availability of these resources, typically published as technical reports, is achieved by entering the title(s) in a desired library's online public access catalog (OPAC) or electronic catalog.

List of World Wide Web Sites for Locating State, County, Tribal, and Local (City) Government Sources of Information

Environmental Health and Safety Online
Dunwoody, GA, EHSO, Inc.
Web: www.ehso.com

Environment WebDirectory – Government, States, Counties
Web: http://www.webdirectory.com/Government/

Internet Resources for State and Local Government
Washington, DC, Congressional Quarterly, Inc.
Web: www.governing.com

Scorecard Environmental Defense
Web: www.scorecard.org

State and Local Governments
Washington, DC, Library of Congress
Web: http://www.loc.gov/rr/news/stategov/stategov.html

State and Local Government on the Net
Web: www.statelocalgov.net

USA City Link
Web: www.usacitylink.com/

World Wide Web Virtual Library, Law: State Government Links
(browse by information source)
Web: www.law.indiana.edu/v-lib

Selected Governmental Associations, Leagues, Councils, and Other State, County, or Municipal Organizations

Association of State and Territorial Health Officials
Web: www.astho.org

Coalition of Northeastern Governors
Web: www.coneg.org

Council of State and Territorial Epidemiologists
Web: www.cste.org

Council of State Governments
Web: http://www.csg.org

International Council for Local Environmental Initiatives: Local Governments for Sustainability
Web: www.iclei.org

Midwestern Governors Association
Web: www.midwestgovernors.org

National Association of Clean Air Agencies
(Formerly STAPPA and ALAPCO, State and Territorial Air Pollution Program Administrators & Association of Local Air Pollution Control Officers)
Web: www.4cleanair.org

National Association of Counties (NACo)
Web: www.naco.org

National Association of County and City Health Officials
Web: www.naccho.org

National Conference of State Legislatures
Web: www.ncsl.org

National Governors Association
Web: www.nga.org

National League of Cities
Web: www.nlc.org

Southern Governors' Association
Web: www.southerngovernors.org

US Conference of Mayors
Web: www.usmayors.org

Western Governors Association
Web: www.westgov.org

NON-GOVERNMENTAL ORGANIZATION REPORTS

Non-governmental organizations (NGOs) are a growing source of technical reports on a wide range of subjects including the health effects of chemicals. NGO reports are often done by experienced scientists or area experts. NGOs can often produce fast state of the knowledge reports without having to be subject to extensive interagency review or political challenge. Most NGOs have a report section on their websites and these reports are usually available for free. These reports may also examine an issue with a reference to a government position, for example the National Resources Defense Council report entitled *Arsenic and Old Laws A Scientific and Public Health Analysis of Arsenic Occurrence in Drinking Water, Its Health Effects, and EPA's Outdated Arsenic Tap Water Standard* (2000) (http://www.nrdc.org/water/drinking/arsenic/aolinx.asp). These reports provide an important perspective on health-related issues. Similar NGO reposts may also address areas outside government or industry mandates such as the June 2004 Environmental Defense released a report, *Orphan Chemicals in the HPV Challenge: A Status Report*, which examined the lack of health-related information on high-production-volume (HPV) chemicals (http://www.environmentaldefense.org/documents/3810_HPVorphansReport_062004.pdf).

Organizations that represent health effects groups also produce excellent reports that highlight current issues. For example, the Breast Cancer Fund produces a report State of the Evidence 2006: *What Is the Connection between the Environment and Breast Cancer?*, which addresses current evidence on the causes of breast cancer (http://www.breastcancerfund.org/). Other interesting reports address local issues such as the *Seattle Precaution Principle White Paper* produced by the Seattle Precautionary Principle Working Group (http://washington.chenw.org/PPgroup.html) or the San Francisco white paper *The Precautionary Principle and the City and County of San Francisco* March 2003

(http://www.sfenvironment.org/downloads/library/13precprinwhitepaper.pdf). NGOs have also reanalyzed government-generated information to make a different such as *Chemical Trespass – Pesticides in Our Bodies and Corporate Accountability* a 2004 report by Pesticide Action Network North America (PANNA) uses CDC data to analyze pesticide body burdens in the U.S. population (http://panna.org/campaigns/docsTrespass/chemicalTrespass2004.dv.html). In summary, NGOs produce a wide range of reports that offer interesting perspective on current toxicological issues, many of which are available on the World Wide Web.

There is no single effective database serving as a dedicated resource for collecting, sharing, and disseminating bibliographic data for technical reports produced by non-profit organizations and institutions. If the research providing the basis for the technical report is funded or conducted on behalf of the United States government, that report should be included among the resources of the National Technical Information Service. Some tools partially fill this STM literature gap. *GuideStar* is an organization linking the non-profit sector on many fronts and is a resource worth noting since its founding in the late 1990s. In particular is *GuideStar's* partnership with hundreds of thousands of individuals and organizations working with and within the non-profit sector. There is a simple search interface for searching basic information about non-profit organizations, including their report literature; however, this is not a robust searching system for this literature. Free registration is required for using the resource. Value-added components are available for purchase. See: http://www.guidestar.org/.

Other examples of NGO reports include *Exhausted by Diesel: How America's Dependence on Diesel Engines Threatens Our Health* (1998; National Resources Defense Council; http://www.nrdc.org/air/transportation/ebd/ebdinx.asp) and *Out of Control and close to Home: Mercury Pollution from Power Plants* (2003; Environmental Defense; http://www.environmentaldefense.org/documents/3370_MercuryPowerPlants.pdf).

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CHAPTER

66

Audiovisual and Non-Print Resources

FRED STOSS, STEVEN G GILBERT, AND PHILIP WEXLER

INTRODUCTION

Al Gore's Academy Award Winning documentary film, *An Inconvenient Truth*, serves as a dramatic example of the overwhelming power of visual images in communicating complex and controversial environmental issues to a broadly defined audience. The production of this documentary was sparked by another form of audiovisual resource, the traditional slide show, which itself evolved from 35-mm photographic slides to today's PowerPoint and KeyNote presentation software. Some popular environmental-themed DVDs of 2007 include: *Global Warming: The Rising Storm*, *Global Warming in the Arctic*, *The Great Warming*, *In the Company of Butterflies*, *A Life among Whales*, *Miracle Planet*, *Plagues and Pleasures on the Sultan Sea*, *Solar Energy: Saved by the Sun*, *State of the Ocean's Animals*, and *Swim for the River*.

An Inconvenient Truth reinforces the importance of audiovisual materials as time-honored and popular formats for delivery of information. Non-print resources come in a wide variety of formats from printed posters and placards to digital downloadable files. Their purpose ranges from simple entertainment to serious study and legal certification. However, the availability of such resources in videotape, audiotape, CD-ROM, and DVD formats is a recent phenomenon. The combination of sight, sound, and motion can be a very effective medley for understanding information and for stimulating and sustaining interest in a topic. Another advantage of these new electronic and digital formats, particularly with the availability of highly portable hardware, is that they provide a convenience to the viewer in both time and place.

RESOURCES

A few reference resources for locating audiovisual resources, primarily DVDs, include the following.

Amazon.com
Web: http://www.amazon.com

IMDb (Internet Movie Database)
Web: http://www.imdb.com/

LOCATOR plus (from the National Library of Medicine)
Web: http://www.nlm.nih.gov/locatorplus

Contains bibliographic records of audiovisual and non-print materials cataloged by the National Library of Medicine.

National Information Center for Educational Media (NICEM)
Web: http://www.nicem.com

Bibliographic data on videos, audios, software, filmstrip, slides and assorted educational media through a variety of means including online, CD-ROM and print.

Online Computer Library Center (OCLC)
Web: http://www.oclc.org

Provides access to the holdings of more than 15 000 libraries participating in the OCLC Network.

WorldCat /WorldCat.org
Web: http://www.worldcat.org/

The WorldCat or WorldCat.org database allows searching for books, DVD, and CD on a wide range of topics including toxicology.

DVDs and Videos: Making available Movies and TV Programs

Major Motion Picture Releases

Movie studios remain enthralled by true and fictional accounts of toxic chemicals or threats. *Erin Brockovich*, based on a true story, was released by Universal Pictures and Columbia Pictures in late 1999. Starring Julia Roberts, as Erin Brockovich and Albert Finney as Ed Masry, the plotline involves contamination of drinking water with hexavalent chromium.

Erin Brockovich (and many other feature films and educational films in video or increasingly in DVD formats) is readily available for purchase from sites such as amazon.com (http://www.amazon.com), any video chain store such as Blockbuster or Hollywood Films, Netflix, or other online video/DVD rental or distribution sites.

A few more recently produced feature films include: *Chain Reaction* (2002, Gemstone Entertainment), *A Civil Action* (2001, 1999, Paramount Pictures), *Dandelion Dead* (2002, HBO Home Video), *Eight Legged Freaks* (2002, Warner Brothers Pictures), *Gas-s-s-s* (2007, Twentieth Century Fox), *The Invitation* (2001, 2003), *Right at Your Door* (2008, Lions Gate), *The Simpson's Movie* (2007, 20th Century Fox), *Toxic Crusaders: The Movie* (2002, Troma Entertainment, Inc), and *Venomous* (2001, 20th Century Fox).

Audio Files

The MEDIAFLY™ Network (http://www.mediafly.com/Welcome.aspx) is a source for personalized podcasts, news, science, medicine, technology, and more, delivered to your PC or mobile device. MEDIAFLY Network gets its audio feeds from a variety of sources, such as print and broadcast media stories and news alerts or releases from non-profit groups and from syndicated broadcast media.

National Public Radio (NPR; http://www.npr.org) and Public Radio International (PRI; http://www) provide audio feeds from NPR News programs, such as Morning Edition or All Things Considered, and featured programs such as the National Press Club, feature themes related to toxicology and toxic or hazardous chemicals in our environment. PRI also provides audio feed and podcasts from its programs, including Living on Earth, This American Life, Living Green, and The World.

Informa Healthcare ToxiCast™ (http://toxicast.com/) provides podcasts on different issues of toxicology, highlighting published books.

The EnvironMinute (http://www.environminute.com/), which focuses on the steps individuals and corporations can take to better the environment.

PodcastDirectory.com is another Internet-based finding tool. From this directory, you can search for blogs and commentary sites, podcasts, Internet radio sites, or vidcasts (video podcasts) in a wide variety of fields including science and health.

The Centers for Disease Control and Prevention (CDC) provides podcasts for easy downloading on more medically based features (http://www2.cdc.gov/podcasts/).

USA.gov provides a comprehensive inventory of podcasts created by or on the account of U.S. Federal government departments and agencies (http://www.usa.gov/Topics/Reference_Shelf/Libraries/Podcasts.shtml).

The U.S. Environmental Protection Agency (www.epa.gov) is the source of a growing number of podcasts both nationally and at regional websites.

National Library of Medicine podcasts are accessible at http://www.nlm.nih.gov/medlineplus/directorscomments.html.

Public Educational Media Producers and Distributors

A major factoring influencing the popularity of electronic and digital formats is the demand by students, teachers, parents, and youth leaders for quality information in formats that not only communicate ideas and teach concepts, but resources that do so in an entertaining manner. Using the WorldCat database, with a librarian's assistance, on the free version of WorldCat.org (http://www.worldcat.org) one can easily identify libraries holding TV series, for example, and in some cases, shed some light on episodes where toxic chemicals or toxicology issues are a central theme.

Companies that produce and distribute DVDs (some available as videos) that are related to the environment, natural resources, and wilderness themes are listed below. Each provides free catalogs of their offering (many of which are found in public and school library collections).

Bullfrog Films
Email:bulfrog@igc.apc.org
Web: http://www.bullfrogfilms.com/

Films for the Humanities and Science
Web: http://www.films.com

Hawkhill Video
Web: http://www.hawkhill.com

Public Broadcast System/PBS Home Video
Web: http://www.pbs.org/

The Video Project
Web: http://www.videoproject.org

Access to Visual Resources in the Social Networks

The YouTube-Phenomena takes the availability of visual information in the form of digital video images to new and sometimes chaotic dimensions. As with many other aspects of diving for information in the uncharted seas of the Internet, searching for visual information can be frustrating and fruitful at the same time. YouTube (http://www.youtube.com) is likely to make further inroads into the scientific arena but the viewer needs to scrutinize retrieved information carefully for accuracy and relevance.

A step beyond the two-dimensional visual landscape is offered by SecondLife (http://secondlife.com/), a 3-D virtual world created by its residents. This digital world is filled with people, entertainment, experiences, and opportunity, where you can even build your own house. Residents retain intellectual property rights in their digital creations, and can buy, sell and trade with other residents. In this virtual world, you create your own persona, known as an *avatar*. It is a fascinating concept, but the extent to which it will have applications to science, and be utilized by the scientific and toxicological community remains to be seen.

Digital Data and Images

Accessing data resources has become easier through the use of information technologies and a need within the STM community to have ready access to such data. The national digital science library (NDSL) is an information portal for science and technology (see: http://nsdl.org/) and gathers digital data for use in classrooms from K-12 to colleges and universities. Records retrieved through the NDSL include Cornell University's Environmental Inquiry Toxicology guide for high-school students. Other national digital library initiatives in the U.S. Federal government are proposed, but funding support has become more scant in recent years. The National Agricultural Library effort to create the National Digital Library for Agriculture will contain a wide variety of data of interest to a broadly defined agriculture community (see: http://www.nal.usda.gov/ndla/about.shtml).

Innovations and advances in the secure delivery and archival capacity by networked environments allow for the transfer of high-resolution technical images (photographs, illustrations, etc.) via the Internet. Logical Images (http://www.logicalimages.com/) is a new company based in Rochester, New York providing such services for the medical community. They provide diagnostic training tools via their proprietary *VisualDx* software for clinicians, first responders (including bioterrorism responders), and other healthcare professionals. These services assist in clinical diagnoses, treatments, and patient education. For bioterrorism, high-resolution photographs are provided for such biological agents such as: cutaneous anthrax and inhalational anthrax; botulism; bubonic plague, pneumonic plague, septicemic plague; smallpox; tularemia, and viral hemorrhagic fevers. Additional areas covered include public health and emergency medicine.

Fotosearch (http://www.fotosearch.com/) is a private company providing a reliable search engine to identify stock images from a database of more than 2.5 million images from 100 stock-photography, stock-illustration, and stock-video publishers. Acclaim Images (http://www.acclaimimages.com/search_terms/toxicology.html) is another stock photography supplier providing images related to toxicology.

U.S. Government Agencies

Federal, state and local (county, parish, municipal) agencies, such as the U.S. EPA (http://www.epa.gov) and the U.S. Chemical Safety Hazard and Investigation Board (http://www.csb.gov/index.cfm) may have relevant audiovisual resources covering issues related to toxicology. Toxicology audiovisuals (as well as books and journals) with a medical bent may also be identified via the U.S. National Library of Medicine's (NLM) LocatorPlus (http://locatorplusv2.nlm.nih.gov/). Although not the first group to foray into this arena, NLM is also working on an extensive, high quality, database of pill images.

Non-Government Professional Training Resources

Both for-profit and NGO environmental health and safety (EH&S) and occupation health and safety (OHS) sectors create and/or distribute a variety of audiovisual products. These stress on-the-job safety measures, hazardous materials handling, regulatory compliance, and dedicated and ongoing training in areas related HAZWOPER (hazardous wastes operations), transportation and storage of toxic and hazardous materials or compliance with specific federal regulations and guidelines (especially those related to the Occupational Safety and Health Administration, Environmental Protection

Agency, Department of Transportation). In some instances, these materials may be available for specific states. Such non-print materials come in formats such as posters and wall placards, VHS videos (decreasing dramatically in recent years), DVDs, and more recently in a variety of video streaming formats, most notably, variations of Shockwave. Listed here are some suppliers of environmental compliance courses and training workshops and safety posters and placards.

Action Training Systems, Inc.
Web: http://www.action-training.com/

American Safety Training
Web: http://www.trainosha.com/

Coastal Technologies Corp.
Web: http://www.coastal.com/site/training-categories/safety-environmental-homepage/

Compliance Solutions
Web: http://www.csregs.com/index2.html

Craig Safety
Web: http://www.craigsafety.com/

EduWhere
Web: http://www.eduwhere.com/index.php

Emergency Film Group
Web: http://www.efilmgroup.com/

HazMat Student
Web: http://hazmatstudent.com/index.html

Human Relations Media
Web: http://www.hrmvideo.com/

J.J. Keller, Inc.
Web: http://www.jjkeller.com/

Lion Technology Inc.
Web: http://www.lion.com/

Mastery Technologies, Inc.
Web: http://www.masterytech.com/

National Association of Safety Professionals
Web: http://shop.naspstore.com/

National Environmental Health Association
Web: http://www.neha.org/

National Environmental Trainers
Web: http://www.natlenvtrainers.com/main.htm

National Safety Compliance
Web: http://www.osha-safety-training.net/index.html

OSHA Training Classes Online
Web: http://www.osharegulationsafetytrainingonline.org/index.html

Pipeline and Hazardous Materials Safety Administration (U.S. Department of Transportation)
Web: http://www.phmsa.dot.gov/ (scroll down to "Encouraging Compliance" and select)

Pure Safety
Web: http://www.puresafety.com/public/index.asp

Safety DVDs
Safety Video
Web: http://www.safetydvd.com

Safety Head
Web: http://safetyhead.com/

Safety Services Company
Web: http://www.safetyservicescompany.com/
Blog: http://blog.safetyservicescompany.com/

Safety Unlimited
Web: http://www.safetyunlimited.com/default.asp

Safety Video Direct.com
Web: http://www.safetyvideodirect.com/

Trinity Workplace Learning
Web: http://www.twlk.com/twlk/

Triumvirate Environmental
Web: http://www.triumvirate.com/index.html

A Few Toxicology Public Outreach Videos of Note

Intergovernmental Forum on Chemical Safety (IFCS)
Web: http://www.who.int/ifcs/forums/four/video/en/index.html

Chemical Safety in a Vulnerable World
Toxicology Education Foundation, TEF
Web: http://www.toxedfoundation.org/

Is it Safe? Evaluating Chemical Risks (produced by the Toxicology Education Foundation, TEF and co-sponsored by the U.S. National Institute of Environmental Health Sciences, NIEHS) (available in English and Latin American Spanish, with a Japanese version in process).

Video Jug
Web: http://www.videojug.com/tag/toxicology
Toxicology: With Dr. Barry Ginsberg

PART

IV

Internet and Digital Tools

CHAPTER

67

The Internet: Recent Trends

STEVEN G. GILBERT, ASISH MOHAPATRA, PERTTI J. HAKKINEN, AND PHILIP WEXLER

INTRODUCTION

The Internet has radically changed the organization and access to toxicology and other information. The Internet will continue to evolve and the current chapter offers a snapshot of some of the tools now available. Many terms used to describe features of the Internet, such as blog, portal, and discussion forum can be used quite loosely, with standardized definitions hard to come by and sometimes changing over time. The web's future transformation continues to be variously predicted. One model considers the process moving from Web 1.0 (connecting information) to Web 2.0 (connecting people) to Web 3.0 (connecting knowledge) and ultimately to Web 4.0 (connecting intelligence) (http://colab.cim3.net/file/work/SICoP/2007-04-25/InternetTo2020.pdf). The challenge for toxicology and the environmental health sciences will be to integrate the ever-expanding data on hazard with exposure, to facilitate better decision making to protect the environment and human health. Key characteristics of Internet-based sources of information relevant to toxicology will be presented here.

SEARCH ENGINES

The first crude search engines started in 1993, shortly after the World Wide Web (or 'web') began its tremendous growth in the number and size of its sites. For a history of search engines see http://www.searchenginehistory.com/. There are now many different types of search engines that attempt to find either general sources of information or specialize in finding specific types of information. Google (http://www.google.com) has become such a common worldwide entry point to web-based information that having 'Googled' is understood as having searched the web using one or more specified search words, perhaps without even using Google! That is, Google has become to searching as 'Kleenex' is to tissues. Google's global ambitions are attested to by the ever-expanding list of languages with which it can be searched. It should be noted, however, that some countries do restrict searches and web access to certain sites.

Further, Google's various tools include Google Scholar (http://scholar.google.com/intl/en/scholar/about.html), offering searching across many disciplines and sources: peer-reviewed papers, theses, books, abstracts and articles, from academic publishers, professional societies, preprint repositories, universities and other scholarly organizations, and as such is a useful tool for toxicology. Similarly, Scirus (http://www.scirus.com/), by Elsevier Science is another product of value to the resourceful toxicologist. Elsevier calls it 'the most comprehensive scientific research tool on the web. With over 450 million scientific items indexed (as of mid-2008), it allows researchers to search for not only journal content but also scientists' homepages, courseware, pre-print server material, patents and institutional repository and website information.'

Vivisimo (http://www.vivisimo.com) offers Clusty (http://clusty.com/about), which Vivisimo states 'queries several top search engines, combines the results, and generates an ordered list based on comparative ranking. This 'metasearch' approach helps raise the best results to the top and push search engine spam to

the bottom.' Clusty is noted by Vivisimo as grouping 'similar results together into clusters, which help you see your search results by topic so you can zero in on exactly what you're looking for or discover unexpected relationships between items.'

Toxseek (http://toxseek.nlm.nih.gov) is an example of a government-sponsored toxicology-focused metasearch and clustering engine. Available from the (U.S.) National Library of Medicine (NLM), it enables simultaneous searching of many different information resources on the web. The ToxSeek user interface allows selection of resources from a wide range of authoritative sources from all over the world. It uses natural language processing and artificial intelligence to retrieve, integrate, rank, and present search results as coherent and dynamic sets. It searches across diverse biomedical and environmental health resources and so provides a way to efficiently locate information resources on topics related to toxicology and environmental health.

Newer search engines exist that strive to answer questions and draw inferences from various layers of information and databases by using semantic web informatics capabilities to a search engine. More information about this is provided in the semantic web section of this chapter.

TOOLS FOR OBTAINING NEWS

Online newspapers and newsletters (the latter which is discussed in the Journals and Newsletters chapter of this book) are now widely used by toxicologists and others. A relatively new feature of the Internet is tools that aggregate articles or other information. The results are usually provided in condensed form, including a short description and link to a longer article (often as all or part of a web page). Really Simple Syndication (RSS) uses web-based programs to constantly scan the contents of websites for new content. This information is then delivered to subscribers' desktops or mobile devices through an RSS feed, often called a news feed.

For example, *Environmental Health News* (www.EnvironmentalHealthNews.org) is an aggregator that offers continuously updated lists and summaries of news articles from around the world. They offer a daily e-letter, *Above the Fold*, which allows customization of news feeds. All content on EnvironmentalHealthNews.org is available for syndication. This means that EnvironmentalHealthNews.org provides the means for webmasters to post news directly on their own websites. Once implemented, content is delivered to the recipient's website. New content usually appears daily, depending upon news coverage.

RSS feeds are available from numerous news sources and scientific journals. For example, the tables of contents from Toxicological Sciences (http://toxsci.oxfordjournals.org/rss/), Toxicology and Industrial Health (http://tih.sagepub.com/rss/), and American Chemical Society publications (http://pubs.acs.org/alerts/rss/index.html) are available as RSS feeds.

Topix has emerged as a key consolidator of news, and their toxicology site is http://www.topix.com/med/toxicology.

BLOGS

A blog (short for web log) is a means for an individual or group to post information of any kind, e.g., news or personal opinions. Blogs can be part of discussion forums and message boards, as these older technologies have evolved.

There are sites devoted to blogs covering a wide range of subjects, while some organizations include blogs as one of a range of information sources. For example, the National Institute for Occupational Safety and Health (NIOSH) has its own blog at http://www.cdc.gov/niosh/blog, with the goal 'to further communicate the scientific issues related to NIOSH's research and recommendations, and to stimulate discussion on those issues.' The American Chemical Society offers a blog described as an 'open forum.' Named the Chemical Research in Toxicology blog (http://acspublications.blogs.com/crtopenforum/), it allows for toxicology-focused communication among participants.

Examples of toxicology-focused blogs developed by individuals include 'Environmental Health and Safety (It's my day job).' Others, as of mid-2008, are the 'Angry Toxicologist' and 'ToxicoDiary,' which bills itself as an 'Environmental Toxicology Blog, and Courses: Exposure, Toxicity, Metabolism.' Readers will be able to easily locate these types of blogs via a search engine such as Google (http://blogsearch.google.com/) or Bloglines (http://www.bloglines.com/), a free online service for searching, subscribing, creating and sharing blogs, news feeds, and other web content. Many blogs, particularly personal ones, are of a transient nature.' Intentions are usually good, but users need to be wary. As with the web in general, there is untold good information, but it takes a critical eye to discern.

OPEN ACCESS PUBLISHING

Greater access to toxicology and other types of information is benefiting from policy changes encouraging or mandating open access to peer-reviewed articles

over the Internet. This change is having a dramatic affect, with global implications, on the availability of recent research in the toxicological sciences. For example, the journal *Environmental Health Perspectives* (EHP) (http://www.ehponline.org/) has made all previously published articles available, and current articles are immediately available from the EHP website. Further, the (U.S.) National Institutes of Health (NIH) has instituted a policy on Enhancing Public Access to Archived Publications Resulting from NIH-Funded Research (Public Access Policy). The Public Access Policy ensures that the public has access to the published results of NIH-funded research, no later than one year after publication in a journal. It requires scientists to submit final peer-reviewed journal manuscripts that arise from NIH funds to the digital archive PubMed Central (http://www.pubmedcentral.nih.gov/). The Policy requires that these final peer-reviewed manuscripts be accessible to the public on PubMed Central to help advance science and improve human health.

Some universities, e.g., Harvard University's Law School, are also moving toward open access to all publications by faculty and students. The Harvard Law School faculty voted unanimously in 2008 to commit to a mandatory open access policy to faculty publications (http://cyber.law.harvard.edu/).

Examples of other websites relevant to open access include:

Public Library of Science (PLoS)
Web: http://www.plos.org/journals/journals.php

PLos is a non-profit organization where scientists and researchers publish open access articles in a series of journals. The commitment of this organization is to make scientific and medical literature a freely available public resource.

Science Commons
Web: http://sciencecommons.org/

Science Commons is another authoritative open access data-sharing and networking platform. By making scientific research 're-useful,' it helps people and organizations open and mark their research and data sets for reuse. By integrating fragmented information resources on the web, Science Commons helps researchers find, analyze, and use data from disparate sources by marking and integrating the information with a common, computer-readable language.

Open Directory Project
Web: http://www.dmoz.org.

This project is a comprehensive human-edited directory of the web. It is constructed and maintained by a vast global community of volunteer editors. As of mid-2008, a simple search with the keyword 'toxicology' (http://search.dmoz.org/cgi-bin/search?search=toxicology) provides several toxicology-related websites.

Supercourse
Web: http://www.pitt.edu/~super1/

Supercourse is a global repository of lectures on public health and prevention. As of mid-2008, it has a network of over 55 000 scientists in 174 countries sharing for free a library of 3455 lectures in 26 languages. As noted in the Supercourse website, the concept of the Supercourse and its lecture style has been described as both the 'Global Health Network University' and the 'Hypertext Comic Books.'

PODCASTING

Podcasts are digital voice recording (or video as Vodcasts) that can be downloaded or streamed off the Internet for listening to (and possibly watching) a speaker at a more convenient time. University lectures are being taped and then posted to the web for students to review, and radio station interviews are also commonly podcast. The (U.S.) National Institutes of Health has begun to use both podcasts and vodcasts (http://nihrecord.od.nih.gov/newsletters/2007/08_10_2007/story4.htm). This material is also becoming increasing searchable, e.g., see the (U.S.) National Public Radio (http://www.npr.org) and Apple's iTunes (http://www.apple.com/itunes/). Books sellers are also starting to use podcasts for education and marketing, e.g., Informa Healthcare (http://www.toxicast.com/). Short podcasts on specific toxicology issues or chemicals are also being developed,e.g., see one on caffeine at http://www.toxipedia.org/display/toxipedia/Caffeine#Caffeine-TeachingResources. SciVee (http://www.scivee.tv/) 'invites scientists to make their research known by combining their published scientific article with a corresponding video into an online presentation called a "SciVee pubcast."' These new approaches take advantage of the incredible flexibility of the Internet to communicate and share knowledge.

WIKIS

Toxicology, as well as many branches of science, labors under the burden of increased specialization. Most researchers spend their time learning more and

more about a focused area of science, which creates the challenge of sharing this knowledge with the public, decision makers, and the media in meaningful ways. Wiki-based sites offer one possible solution to sharing scientific and toxicological information (http://www.toxipedia.org). Wiki sites allow the user to easily create, edit, format text, incorporate pictures, and link web pages. The precursor to modern wiki sites was developed in 1994 by Ward Cunningham and called WikiWikiWeb ('wiki' is the Hawaiian word for 'quick'). Wikis are used to create collaborative websites for use by the public and increasingly for internal corporate or institutional sites for knowledge management. The most toxicologically oriented wiki site is Toxipedia (www.toxipedia.org), started in 2007 by a non-profit institute to be the 'free toxicology encyclopedia and resource center that welcomes everyone to help contribute to a healthier world.' It serves as a source of information about the health effects of chemicals, risk assessment, ethics, history, and society, and also includes a teaching resources section. The ability of wiki technologies to encourage the sharing of information by specialists is just beginning to be explored. Other wikis of possible interest to toxicologists include:

Encyclopedia of Earth
Web: http://www.eoearth.org/

Encyclopedia of Earth is an electronic reference about the Earth, its natural environments, and their interaction with society.

DBpedia
Web: http://www.dbpedia.org

DBpedia's website calls DBpedia 'a community effort to extract structured information from Wikipedia and to make this information available on the Web.' DBpedia allows users to ask sophisticated queries about Wikipedia's contents, and to link other datasets on the web to Wikipedia data. The dataset is a large multi-domain ontology which has been derived from Wikipedia. As of mid-2008, the DBpedia dataset currently describes 2.18 million 'things' with 218 million 'pieces of information.' DBpedia's search capabilities could be applied to toxicology, risk assessment, environmental, and public health information.

Wikipedia
Web: http://en.wikipedia.org/

Wikipedia is a free encyclopedia with, as of mid-2008, almost 2.5 million articles in English, and has some level of Wikipedia information available in 123 other languages.

SOCIAL NETWORKING

Social networks are Internet-based software systems that allow people who share interests and activities to easily communicate. These sites provide various ways for users to interact, such as chat, messaging, email, video, voice chat, file sharing, blogging, and discussion groups. Social networking is already being used by millions of people around the world and is revolutionizing the way we share information and communicate. Two of the most popular general social networking sites are MySpace and Facebook. More organizations are establishing a presence on social networking sites. For example, Toxipedia has a Facebook page (http://www.facebook.com/group.php?gid = 2422634471) that is used to share information and communicate about changes in Toxipedia. While there is no specific toxicology-focused networking, this has been considered and will no doubt be in place by the next edition of this book. A more business-oriented social networking site is LinkedIn. A list of social networking sites can be found at http://en.wikipedia.org/wiki/List_of_social_networking_websites.

Social networking meets 3-D virtual reality in *Second Life* (http://secondlife.com/), where 'residents' create graphical representations of themselves known as 'avatars,' who conduct their lives according to self-contained rules and economies, in an online environment of individuals and communities. Virtual worlds such as this (*Second Life* is the first, largest, and best known, but not the only one) may have arisen from the gaming community, but are being widely utilized for professional enterprises. *Second Life* is populated by libraries, schools, government, health organizations, and businesses of all kinds.

SEMANTIC WEB

The Semantic web is an evolving extension of the web in which the semantics of information and services on the web is defined, making it possible for the web to understand and satisfy the requests of people and machines to use the web content (Berners-Lee, Tim; James Hendler and Ora Lassila, May 17, 2001. 'The Semantic Web.' Scientific American Magazine.; W3C Semantic Web Frequently Asked Questions. http://www.w3.org/2001/sw/SW-FAQ). It can be defined as a set of formats and languages that find and analyze data on the web, allowing consumers and businesses to understand all kinds of useful online information (Feigenbaum et al 2007, in a Scientific American article, 'The Semantic Web in Action').

The Semantic web is not going to replace the traditional web, but it complements the current web structure and web technology as machines and machine learning become much effective in processing and 'understanding' the data that they merely display at present. Scientific researchers are developing advanced semantic web applications, including a system that identifies genetic causes of heart disease, and another system that explores the early stages of a disease outbreak (e.g., influenza). Other examples of the application of the semantic web include:

Environmental Health, Public Health, Emergency Preparedness and Response

Web: http://www.w3.org/2001/sw/sweo/public/UseCases/UniTexas/

The healthcare industry deals with massive quantities of information. To effectively make a decision to protect human health and public health, effective data integration and knowledge dissemination and translation are required. The Semantic web holds promise in this direction. In 2004, the University of Texas Health Science Center at Houston used the Semantic web to develop better detect, analyze, and respond to emerging public health problems at the onset of Hurricane Katrina. The system, called *SAPPHIRE (Situational Awareness and Preparedness for Public Health Incidences using Reasoning Engines*), integrated a wide range of data from local healthcare agencies, hospitals, environmental protection agencies, and scientific literature. It allowed public health officials to assess the public health, environmental health, and environmental toxicological information through different layers, degrees of focus, and perspectives (http://www.w3.org/2001/sw/sweo/public/UseCases/UniTexas/).

DSSTOX

Web: http://www.epa.gov/ncct/dsstox/index.html

The Distributed Structure-Searchable Toxicity (DSSTox) Database Network is a project of U.S. EPA's National Center for Computational Toxicology, helping to build a public data foundation for improved structure–activity and predictive toxicology capabilities. The DSSTox website provides a public forum for publishing downloadable, structure-searchable, standardized chemical structure files associated with toxicity data.

Unified Medical Language System (UMLS), National Library of Medicine (NLM), National Institutes of Health (NIH)

Web: http://www.nlm.nih.gov/research/umls/

The purpose of NLM's Unified Medical Language System® (UMLS) is to facilitate the development of computer systems that behave as if they 'understand' the meaning of the language of biomedicine and health.

Pubmed-Hakia

Web: http://pubmed.hakia.com

Hakia, a semantic search engine, announced in June 2008 that it had expanded its health and medical search capabilities by adding more than ten million abstracts from Pubmed, the medical database maintained by the U.S. National Library of Medicine.

CHAPTER

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Web-Based Databases

ASISH MOHAPATRA AND PHILIP WEXLER

INTRODUCTION

The transformation of information processing since the latter portion of the 20th century, catalyzed by the dramatic impact of the Internet, has significantly changed the practice and application of science and technology. It would have been difficult to imagine how far reaching those changes would be, when the first edition of *Information Resources in Toxicology* was published in 1982. The transformation of online databases, bibliographic, numeric, biosequence, and others, has played a pivotal role in identifying, creating, gathering, organizing, disseminating, and archiving data. Online databases have both driven and been a beneficiary of information technology breakthroughs.

Long gone are the days when a researcher in need of a literature search would make an appointment with a librarian subject specialist, trained in mastering the various nuances of bibliographic databases. Many of today's databases are, de rigeur, 'user-friendly,' at the same time often allowing, but not requiring, the use of complex search instructions or Boolean logic. The near total embrace of the online environment does away with the need, in many instances, to offer print counterparts to databases.

This chapter will highlight some of the more prominent databases in toxicology and related fields, both free and fee-based. 'Databases' is here used in its broadest, or loosest, context. Some of these resources would be readily recognized as typical digital databases. Others are more in the nature of reports, but are highlighted because of their significance and because they are structured online in a manner to allow efficient searching within the body of the document(s). Still others are more in the way of portals or gateways to sources of information, or programs. More database references are scattered throughout this book, most prominently in the chapter on Organizations and the specialized subject chapters.

DATABASES WITH A FOCUS ON TOXICOLOGY AND RELATED SUBJECTS

3E Company
Web: http://www.3ecompany.com/

3E Company's suite of fee-based data products and information services enable improved compliance with global Environmental Health & Safety (EH&S) requirements related to the safe manufacturing, distribution, transportation, usage and disposal of chemicals and hazardous products. Includes Ariel products and services and its massive aggregation of global regulatory content.

Agency for Toxic Substances and Disease Registry (ATSDR)
Web: http://www.atsdr.cdc.gov/

ATSDR provides health information to prevent harmful exposures and disease related to toxic substances. Its databases include:

- ATSDR Toxicological Profiles – For hazardous substances found at National Priorities List (NPL) sites. These hazardous substances are ranked based on frequency of occurrence at NPL sites, toxicity, and potential for human exposure. ATSDR also prepares toxicological profiles for the Department of Defense

(DOD) and the Department of Energy (DOE) on substances related to federal sites. Drawn from the Toxicological Profiles are: (1) Public Health Statements taken from the Profile's Chapter 1 and providing the information in a more succinct question and answer format and (2) ToxFAQs – even briefer and easier to understand guides taken from the same source material. Both Public Health Statements and ToxFAQs are available in English and Spanish.
- HazDat Database – Contains information about waste sites where ATSDR has been active, including a list of contaminants and links to site documents.
- National Exposure Registry (NER) – The NER is a long-term effort to collect information on the potential impact of hazardous substances on human health. It is a listing of persons exposed to hazardous substances, and contains subregistries for specific substances. Four subregistries were active as of mid-2008 – trichloroethylene (TCE), trichloroethane (TCA), benzene, and dioxin.

Other ATSDR databases include:

- Case Studies in Environmental Medicine
- Interaction Profiles
- Minimal Risk Levels
- Priority List of Hazardous Substances

Canadian Centre for Occupational Health and Safety (CCOHS)
Web: http://ccinfoweb.ccohs.ca/

CCOHS offers online access to data collections such as Material Safety Data Sheets (MSDSs), CHEMINFO, CHEMpendium™, RTECS® (Registry of Toxic Effects of Chemical Substances), OSH References, Canadian *enviro*OSH Legislation *plus* Standards.

Some of the databases (e.g., MSDS, CHEMINFO, CHEMPendium, RTECS, OHS references and Canadian enviroOSH Legislation and Standards) on CCOHS website are for subscribers only, while others are free.

Among the latter are OHS answers, INCHEM, ILO encyclopedia, Fatality reports, Chemindex, WHMIS classifications and Workplace Health Promotion Resources. INCHEM is produced in cooperation with the International Programme on Chemical Safety (see below under IPCS).

Centers for Disease Control and Prevention, U.S. (CDC) National Report on Human Exposure to Environmental Chemicals
Web: http://www.cdc.gov/exposurereport/report.htm

Provides an ongoing assessment of the U.S. population's exposure to environmental chemicals using biomonitoring, by measuring the chemicals or their metabolites in human specimens such as blood or urine.

Clinical Toxinology Resources
Web: http://www.toxinology.com

The Clinical Toxinology Resources website offers information on venomous animals and poisonous animals, plants, and mushrooms. It covers the whole world, with both general information and information about particular organisms, located through a searchable database that allows users to look for an animal, plant, or mushroom, based on a common name, a scientific name or family, a country or region.

Cornell University Poisonous Plants Informational Database
Web: http://www.ansci.cornell.edu/plants/

This is a reference that includes plant images, pictures of affected animals and presentations concerning the botany, chemistry, toxicology, diagnosis, and prevention of poisoning of animals by plants and other natural flora (fungi, etc.). The information presented here is not a complete database of all plants that are poisonous, but attempts to cover many of the plants that grow in the U.S. that may be poisonous to livestock.

Environmental Protection Agency, U.S. (EPA)
Web: http://www.epa.gov/epahome/Data.html

The U.S. EPA offers an embarrassment of riches, when it comes to databases relevant to toxicology, environmental health, and ecotoxicology, and the environment in general. To list a few:

- ECOTOX – A source for locating single chemical toxicity data for aquatic life, terrestrial plants, and wildlife. It integrates three previously independent databases – AQUIRE, PHYTOTOX, and TERRETOX – into a system which includes toxicity data derived predominately from the peer-reviewed literature, for aquatic life, terrestrial plants, and terrestrial wildlife, respectively.
- Global Endocrine Disorder Research Inventory – This compilation of ongoing research projects related to endocrine disruptions was assembled following the recommendation of the Intergovernmental Forum on Chemical Safety (IFCS) and the 1997 Declaration of the Environment Leaders of the Eight on Children's Environmental Health.
- HPV Voluntary Challenge Chemical List – The U.S. high-production-volume (HPV) chemicals are those which are manufactured in or imported into the United States in amounts equal to or greater than one million pounds per year. The U.S. HPV chemicals were identified through information collected

under the Toxic Substances Control Act (TSCA) Inventory Update Rule (IUR). Organic chemicals that are manufactured in, or imported into, the United States in amounts equal to or exceeding 10 000 pounds per year are subject to reporting under the TSCA IUR. Reporting is required every four years.
- Integrated Risk Information System (IRIS) – Accessible via the EPA site as well as the National Library of Medicine. See latter, below, for description.
- National Emissions Inventory – EPA's Emission Inventory and Analysis Group prepares a national database of air emissions information with input from numerous state and local air agencies, from tribes, and from industry. This database contains information on stationary and mobile sources that emit criteria air pollutants and their precursors, as well as hazardous air pollutants (HAPs). The database includes estimates of annual emissions, by source, of air pollutants in each area of the country, on an annual basis.
- Pesticide Product Information System (PPIS) – Contains information concerning all pesticide products registered in the United States.
- Safe Drinking Water Information System (SDWIS) – The Safe Drinking Water Information System (SDWIS) contains information about public water systems and their violations of EPA's drinking water regulations. These statutes and accompanying regulations establish maximum contaminant levels, treatment techniques, and monitoring and reporting requirements to ensure that water provided to customers is safe for human consumption.
- STORET – The STORET Legacy Data System (LDC) contains historical water-quality data dating back to the early part of the 20th century and collected up to the end of 1998. The current STORET contains data collected beginning in 1999, along with older data that have been properly documented and migrated from the LDC. Both systems contain raw biological, chemical, and physical data on surface and ground water collected by federal, state, and local agencies, Indian Tribes, volunteer groups, academics, and others.
- Toxics Release Inventory – Accessible via the EPA site as well as the National Library of Medicine. See latter, below, for description.

European Commission

The European Chemical Substances Information System (ESIS) (http://ecb.jrc.europa.eu/esis/) searches the following databases:

- EINECS (European Inventory of Existing Commercial chemical Substances) O.J. C 146A, 15.6.1990
- ELINCS (European List of Notified Chemical Substances) in support of Directive 92/32/EEC, the 7th amendment to Directive 67/548/EEC
- NLP (No-Longer Polymers)
- BPD (Biocidal Products Directive) active substances listed in Annex I or IA of Directive 98/8/EC or listed in the so-called list of non-inclusions
- PBT (Persistent, Bioaccumulative, and Toxic) or vPvB (very Persistent and very Bioaccumulative)
- C&L (Classification and Labeling), substances or preparations in accordance with Directive 67/548/EEC (substances) and 1999/45/EC (preparations)
- Export and Import of Dangerous Chemicals listed in Annex I of Regulation (EEC) No 304/2003
- HPVCs (High Production Volume Chemicals) and LPVCs (Low Production Volume Chemicals), including EU Producers/Importers lists
- IUCLID Chemical Data Sheets, IUCLID Export Files, OECD-IUCLID Export Files, EUSES Export Files
- Priority Lists, Risk Assessment process and tracking system in relation to Council Regulation (EEC) 793/93 also known as Existing Substances Regulation (ESR).

The new European Chemicals Agency (ECHA) (http://echa.europa.eu) will likely be a source for additional databases in the future. One of their first online ventures is the REACH-IT portal, the main channel for companies to submit data to ECHA.

ExPub

Web: http://www.expub.com

A fee-based service focusing on global chemical information. Offers content from the U.S Environmental Protection Agency (EPA), the National Toxicology Program (NTP), the National Library of Medicine (NLM), the National Technical Information Service (NTIS), the Agency for Toxic Substances and Disease Registry (ATSDR), the National Cancer Institute (NCI), the European Chemicals Bureau (ECB), the U.S Department of Defense (DOD), the World Health Organization (WHO), and others.

EXTOXNET

Web: http://extoxnet.orst.edu/

The EXTension TOXicology NETwork (EXTOXNET) is an effort of University of California, Davis, Oregon State University, Michigan State University, Cornell University, and the University of Idaho. Information includes discussions of toxicological issues of concern (TICs); toxicology newsletters; other resources for toxicology information; toxicology fact sheets; Pesticide Information Profiles (PIPs); and Toxicology Information Briefs (TIBs).

ICON EHS Database
Web: http://cohesion.rice.edu/centersandinst/icon/research.cfm

A product of the International Council on Nanotechnology (ICON), the ICON Environmental, Health and Safety (EHS) database contains summaries (abstracts) and citations for research papers related to the EHS implications of nanoscale materials.

International Agency for Research on Cancer (IARC)
Web: http://www.iarc.fr/en/Index-of-IARC-sites/Databases

IARC offers a number of useful tools of relevance to cancer and carcinogenesis, not all, strictly speaking databases, but worth consulting. They include the IARC Monographs Database on Carcinogenic Risk to Humans, the IARC Cancer Epidemiology Database, the IARC TP53 Database, and CAREX (International Information on Occupational Exposure to Carcinogens).

International Program on Chemical Safety (IPCS)
Web: http://www.who.int/ipcs/en/

IPCS is a joint program of three agencies – World Health Organization (WHO), International Labour Organization (ILO), and United Nations Environment Program (UNEP). Below are two of its major web-based chemical safety tools.

INCHEM
Web: http://www.inchem.org/

Consolidates information from a number of intergovernmental organizations whose goal it is to assist in the sound management of chemicals. A Web site and search engine provided in cooperation with the Canadian Centre for Occupational Health and Safety (CCOHS) (see above) provides individual or combined access to:

- Concise International Chemical Assessment Documents (CICADs)
- Environmental Health Criteria (EHC) Monographs
- Harmonization Project Publications
- Health and Safety Guides (HSGs)
- International Agency for Research on Cancer (IARC) – Summaries and Evaluations
- International Chemical Safety Cards (ICSCs)
- IPCS/CEC Evaluation of Antidotes Series
- Joint Expert Committee on Food Additives (JECFA) – Monographs and Evaluations
- Joint Meeting on Pesticide Residues (JMPR)
- Pesticide Documents (PDs)
- Poisons Information Monographs (PIMs)
- Screening Information Data Set (SIDS) for High Production Volume Chemicals.

INTOX
Web: http://www.intox.org/

A tool for poison centers and related units concerned with preventing, recording, evaluation, diagnosing, treating, and reporting on chemical emergencies. It is a databank of consolidated, authoritative information on toxic agents and the management of toxic exposures; an information management tool for poison centers and others dealing with toxic exposures; the gateway to a global electronic network of poison centers and other users of the package; and, it provides a forum for collaboration between experts and those responding to emergencies concerning toxic exposures.

MSDS Online
Web: http://www.ilpi.com/msds/

MSDS' (Material Data Safety Sheets) contain a wealth of toxicity and related data, and are plentiful online. MSDS Online is a good source for consolidating this information and leading the MSDS database collections.

National Institute for Occupational Safety and Health Databases and Information Resources
Web: http://www.cdc.gov/niosh/database.html

Includes Immediately Dangerous to Life and Health, Health Hazard Evaluations, etc.

National Library of Medicine, U.S. (NLM), TEHIP
Web: http://sis.nlm.nih.gov/enviro.html

NLM, the largest medical library in the world, is a part of the U.S. National Institutes of Health. Its Toxicology and Environmental Health Information Program (TEHIP) is one of the world's major purveyors of toxicological information. Many of these are accessible through the TOXNET system (http://toxnet.nlm.nih.gov). Among NLM's offerings are:

- Dietary Supplements Labels Database – Offers information about ingredients in more than two thousand selected brands of dietary supplements. It enables users to determine what ingredients are in specific brands and to compare ingredients in different brands. Information is also provided on the health benefits claimed by manufacturers. The Database can be searched by brand names, uses noted on product labels, specific active ingredients, and manufacturers. Warnings and Recalls from the U.S. Food and Drug Administration (FDA), related to specific ingredients and supplement brands have also been provided.
- Carcinogenic Potency Database (CPDB) – Reports analyses of animal cancer tests on 1547 chemicals. CPDB includes 6540 chronic, long-term animal

tests, both positive and negative for carcinogenicity, from the general published literature as well as the National Cancer Institute and the National Toxicology Program. NLM offers a link to CPDB, which has been developed by the Carcinogenic Potency Project at the University of California, Berkeley and the Lawrence Berkeley National Laboratory.

- Chemical Carcinogenesis Research Information System (CCRIS) – From the National Cancer Institute with information on carcinogenicity, mutagenicity, tumor promotion, and tumor inhibition test results, for some 10 000 chemicals.
- Drug Information Portal – A gateway to selected drug information from the National Library of Medicine and other key government agencies. Includes links to individual resources with potential drug information, including summaries tailored to various audiences. Resources include the NLM search systems useful in searching for a drug, NLM research resources, resources organized by audience and class, and other NIH and government resources such as FDA and CDC.
- GENE-TOX – An EPA database, no longer updated, on genetic toxicology.
- Hazardous Substances Data Bank (HSDB) – With over 5000 chemical-specific records, and the recent inclusion of radionuclide information, this peer-reviewed databank extensively covers many aspects of toxicology and related fields, including human, animal (including ecotox) toxicity, chemical and physical properties, emergency medical treatment, chemical safety and handling, environmental fate, and considerably more.
- Haz-Map – An occupational health database designed for health and safety professionals and for consumers seeking information about the health effects of exposure to chemicals and biologicals at work. It links jobs and hazardous tasks with occupational diseases and their symptoms.
- Household Products Database – Links thousands of consumer brands to health effects from Material Safety Data Sheets (MSDS) provided by manufacturers and allows scientists and consumers to research products based on chemical ingredients. Users can determine which products contain specific ingredients, manufacturers of products and their contact information, acute and chronic health effects of such ingredients, and how to link to other NLM databases with information on the chemicals.
- Integrated Risk Information System (IRIS) (from the U.S. EPA) – IRIS data, focusing on hazard identification and dose–response assessment, is reviewed by work groups of EPA scientists and represents EPA consensus. Among the key data provided in IRIS are EPA carcinogen classifications, unit risks, slope factors, oral reference doses, and inhalation reference concentrations.
- International Toxicity Estimates for Risk (ITER) – Compiled by Toxicology Excellence for Risk Assessment (TERA), ITER, contains over 650 chemical records with key data from the Agency for Toxic Substances & Disease Registry (ATSDR), Health Canada, National Institute of Public Health & the Environment (RIVM) – The Netherlands, U.S. Environmental Protection Agency (EPA), the International Agency for Research on Cancer (IARC), NSF International, and independent parties whose risk values have undergone peer review. ITER provides a comparison of international risk assessment information in a side-by-side format and explains differences in risk values derived by different organizations.
- LactMed – A database of drugs and other chemicals to which breastfeeding mothers may be exposed. It includes information on the levels of such substances in breast milk and infant blood, and the possible adverse effects in the nursing infant.
- Radiation Event Medical Management (REMM) – REMM offers guidance to healthcare providers, primarily physicians, without formal radiation medicine expertise, about clinical diagnosis and treatment during mass casualty radiological/nuclear events. It also provides web-based information that is downloadable in advance, to be used during an event if the Internet is not available.
- Toxics Release Inventory – An EPA database, established under the Emergency Planning and Community Right to Know Act of 1986 (EPCRA). TRI's data, beginning with the 1987 reporting year, cover air, water, land, and underground injection releases, as well as transfers to waste sites and, since 1991, source reduction and recycling data.
- TOXLINE – Containing over 3 million bibliographic citations, TOXLINE encompasses the biochemical, pharmacological, physiological, and toxicological effects of drugs and other chemicals. TOXLINE is created by merging a variety of subfiles – records from NLM's own MEDLINE, International Labour Office, Toxic Substances Control Act Test Submissions, Toxicology Research Projects from NIH's CRISP database, the Swedish National Chemicals Inspectorate's RISKLINE database, Pesticides Abstracts, International Pharmaceutical Abstracts, etc. Some of these subfiles are ongoing and others are archival, in the sense that they have ceased publication or NLM has ceased, after a certain date, carrying their data in TOXLINE.
- TOXMAP – A Geographic Information System (GIS) that uses U.S. maps to help users visually explore

data from the U.S. Environmental Protection Agency (EPA)'s Toxics Release Inventory (TRI) and Superfund Program.
- ToxMystery – For the elementary school age and younger set, an animated program teaching about chemical hazards. Spanish version available.
- ToxTown – A program using color, graphics, sounds, and animation to add interest to learning about connections between chemicals, the environment, and the public's health. ToxTown's target audience is students above elementary-school level, educators, and the general public. Spanish version available.
- ToxLearn – A modular tutorial teaching the basics of toxicology. Prepared in partnership with the U.S. Society of Toxicology, it replaces ToxLearn. Modules, beginning with fundamentals, and progressing to more specialized topics, will be released gradually.
- Wireless Information System for Emergency Responders (WISER) – A system designed to assist first responders in hazardous material incidents. WISER provides a wide range of information on hazardous substances, including substance identification support, physical characteristics, human health information, and containment and suppression advice.
- World Library of Toxicology, Chemical Safety, and Environmental Health (WLT) – A global, multilingual portal to sources of information, compiled by Country Correspondents from around the world. Will enable users to identify government and non-government organizations, universities, professional societies, poison control centers, etc. on a country-by-country basis, as well as link to globally oriented information on legislation, news, etc. "The WLT, sponsored and supported by NLM, is hosted by Toxipedia, in partnership with the International Union of Toxicology. It is accessible at http://www.wlfox.org."

More resources under development:

- TOX-REF, (Toxicity Reference File) contains data on the NORMAL/THERAPEUTIC, TOXIC, and LETHAL levels of chemicals, heavy metals and drugs. The values are from journals and other credible sources containing reference values.
- Databases on liver toxicity, and pill identification, are also in the works.

National Toxicology Program
Web: http://ntp.niehs.nih.gov/

NTP Study Reports – Covering studies in carcinogenesis and long-term toxicology, short-term toxicity, genetically modified models, immunology, developmental effects, drinking water, reproductive assessment by continuous breeding, and AIDS Therapeutics Toxicity Reports.

Report on Carcinogens (RoC) – The RoC is an informational scientific and public health document first ordered by Congress in 1978 that identifies and discusses agents, substances, mixtures, or exposure circumstances that may pose a hazard to human health by virtue of their carcinogenicity.

Organization for Economic Co-Operation and Development (OECD)

e-Chem Portal
Web: http://webnet3.oecd.org/echemportal/

A project still under development, but accessible in stages online, e-Chem Portal provides free public access to information on chemical properties and direct links to collections of information prepared for government chemical review programs at national, regional, and international levels. Access is currently provided to portions of the Japanese Chemical Risk Information Platform (CHRIP), the European Chemical Substances Information System (ESIS), EPA's High Production Volume Information System (HPVIS), the International Program on Chemical Safety's (IPCS) INCHEM system, the Australian National Industrial Chemicals Notification and Assessment Scheme (NICNAS) Priority Existing Chemical Assessment Reports, the Organisation for Economic Cooperation and Development (OECD) High Production Volume (HPV) Database, the Screening Information Data Sets (SIDS) export files in for High Production Volume (HPV) Chemicals in International Uniform Chemical Identification Database (IUCLID) format as maintained by the OECD, and the OECD Initial Assessment Reports for HPV Chemicals including Screening Information Data Sets (SIDS) as maintained by United Nations Environment Programme (UNEP) Chemicals.

PAN Database
Web: http://pesticideinfo.org/

The PAN database brings together a diverse array of information on pesticides from many different sources, providing human toxicity (chronic and acute), ecotoxicity and regulatory information for pesticide active ingredients and their transformation products, as well as adjuvants and solvents used in pesticide products. Produced by the Pesticide Action Network of North America, one of five PAN Regional Centers worldwide, which works to replace pesticide use with ecologically sound and socially just alternatives.

ProQuest/CSA Illumina
Environmental Sciences and Pollution Management Collection
Web: http://www.csa.com/factsheets/envclust-set-c.php

A multidisciplinary database, provides wide coverage of the environmental sciences. Abstracts and citations are drawn from over 6000 serials including scientific journals, conference proceedings, reports, monographs, books, and government publications. Specific databases include ASFA 3: Aquatic Pollution and Environmental Quality, Bacteriology Abstracts, Ecology Abstracts, Environmental Engineering Abstracts, Health and Safety Science Abstracts, Human Population and Natural Resource Management, Industrial and Applied Microbiology Abstracts, Pollution Abstracts, Risk Abstract, Sustainability Science Abstracts, Toxicology Abstracts, and Water Resources Abstracts.

Pubmed-Hakia
Web: http://pubmed.hakia.com

Hakia, a semantic search engine, announced in June 2008 that it had expanded its health and medical search capabilities by adding more than 10 million abstracts from Pubmed, the medical database maintained by the US National Library of Medicine and the National Institute of Health. By using semantic web informatics capabilities, Hakia has provided an efficient search engine where literature can be effectively connected and inferences can be drawn.

Reprotox
Web: http://www.reprotox.org

An information system developed by the Reproductive Toxicology Center for its members. REPROTOX contains summaries on the effects of medications, chemicals, infections, and physical agents on pregnancy, reproduction, and development. The REPROTOX® system was developed as an adjunct information source for clinicians, scientists, and government agencies.

Risk Assessment Information System (RAIS)
Web: http://rais.ornl.gov/

The RAIS provides a world wide web-based integrated system of toxicology and risk-related information as well as online tools for performing real-time calculations for chemical and radiological environmental risk assessments under EPA CERCLA and RCRA guidance. Toxicity data in the RAIS include current non-radionuclide and radionuclide toxicity values that are fully searchable in a parsed database structure, in addition to toxicological profiles developed specifically for RAIS.

Scorecard
Web: http://www.scorecard.org

Provides extensive information on pollution problems and chemical releases. Developed by the Environmental Defense Fund, Scorecard, is now managed by the Green Media Toolshed.

Skin Deep: Cosmetic Safety Database
Web: http://www.cosmeticdatabase.com/

Skin Deep pairs ingredients in thousands of products against toxicity and regulatory databases. Produced by The Environmental Working Group (EWG) (http://www.ewg.org/), a non-profit organization that advocates for environmentally related health protective policies.

Syracuse Research Corporation's (SRC) Environmental Fate Databases (EFDB)
Web: http://www.srcinc.com/what-we-do/product.aspx?id=132

SRC offers a suite of files with information on the environmental fate of chemicals:

- DATALOG is a bibliographic file containing 18 types of environmental fate data.
- BIOLOG, or the Microbial Degradation/Toxicity File, provides sources of microbial toxicity and biodegradation data.
- CHEMFATE is a data value file containing 25 categories of environmental fate and physical/chemical property information on commercially important chemical compounds.
- BIODEG contains experimental values relating to biodegradation subjects.
- BIODEG SUMMARY provides summary evaluation and reliability codes for different test methods, as well as summaries for biodegradability under aerobic and anaerobic conditions.

Thomson/Micromedex Poisindex System
Web:http://www.micromedex.com/products/poisindex/

Poisindex, a mainstay of the poison control/information community, is a fee-based service which identifies ingredients for hundreds of thousands of commercial, pharmaceutical, and biological substances. Each substance is linked to one or more management document(s) providing information on clinical effects, range of toxicity, and treatment protocols for exposures involving the substances. POISINDEX information includes Product/Substance Identification for

- common household products (cleaners, personal care, insect protection)
- industrial chemicals (manufacturing agents)
- industrial products (cleaners, protective agents)
- pharmaceutical products (prescriptions, generic, trade, OTC, veterinary)
- biological entities (botanic, zoologic, food poisoning)

- and more than 1000 detailed toxicologic management protocols.

Toxicant and Disease Database
Web: http://database.healthandenvironment.org/

From the Collaborative on Health and the Environment (CHE), the Toxicant and Disease Database is a searchable database that summarizes links between chemical contaminants and approximately 180 human diseases or conditions.

Wildlife and Contaminants Online
Patuxeat Wildlife Research Center
Web:http://www.pwrc.usgs.gov/contaminants-online/

Consisting of Biological and Ecotoxicological Characteristics of Estuarine and Coastal Terrestrial Vertebrates, Contaminants Exposure and Effects – Terrestrial Vertebrates Database, and Utility and Vulnerability Ranking Program for Terrestrial Vertebrates.

Toxicology Excellence for Risk Assessment
Web: http://www.tera.org

TERA offers, via its website, as well as on the NLM TOXNET system, International Toxicity Estimates for Risk, a free database of human health risk values and cancer classifications for over 600 chemicals of environmental concern from multiple organizations worldwide. ITER presents risk data in a tabular format for easy comparison, along with a synopsis explaining differences in data and a link to each organization for more information. Also available on the TERA site, and slated for implementation on NLM's TOXNET system, is the prototype of RiskIE, The Risk Information Exchange (RiskIE), which contains notifications about a variety of human health risk assessment projects that are in progress or recently completed. This web-based system enables users to publicly share and track the progress of projects and can be used to identify opportunities for collaboration in the health protection efforts among organizations.

STATE INFORMATION

A number of states offer valuable toxicity fact sheets and other chemical information on their websites. These may serve as databases, in effect. Consider particularly New Jersey's Right to Know Hazardous Substance Fact Sheets (http://web.doh.state.nj.us/rtkhsfs/indexfs.aspx) and California's Hazard Evaluation System and Information Service (HESIS) Publications (http://www.cdph.ca.gov/programs/hesis/Pages/Publications.aspx#factsheetschem).

The Environmental Information Exchange Network (http://www.exchangenetwork.net/) is a partnership among states, tribes, and the U.S. Environmental Protection Agency that is creating a new way to exchange environmental information. Partners on the Exchange Network share data efficiently and securely over the Internet. This new approach is providing real-time access to higher-quality data while saving time, resources, and money for partner states, tribes, and territories.

FOCUS ON TOXICOGENOMICS

The completion of the decoding of the human genome has provided scientists and researchers great challenges and potential opportunities in identifying the genetic basis of diseases, cures for cancer, and progress in personalized genetic medicine in the 21st century. Research in bioinformatics, genomics, proteomics, systems biology and a host of other '-omics' and related informatics disciplines, including toxicogenomics and toxicoinformatics, is a natural progression from traditional disciplines of molecular biology, structural biology, genetics, computational toxicology, and information technology. Following is a select list of websites and databases in these areas. See the genomics chapter for additional information and tools.

Web Portals and Information Resources

Center for Toxicoinformatics, U.S. Food and Drug Administration (FDA)

A gateway for toxicogenomic research in the U.S. FDA's National Center for Toxicological Research (http://www.fda.gov/nctr/science/centers/toxicoinformatics/).

Array Track
Web:http://www.fda.gov/nctr/science/centers/toxicoinformatics/ArrayTrack/index.htm

This is a free bioinformatics resource for DNA microarray and systems biology, which allows for the management, analysis, and interpretation of -omics data within a single package. It is used by FDA for the review of genomic data submissions.

Department of Energy and the National Institutes of Health, U.S.
Web: http://www.genome.gov/10001772

About the Human Genome Project.

Oak Ridge National Laboratory
Web: http://www.ornl.gov/sci/techresources/Human_Genome/home.shtml

About the Human Genome Project.

National Academy of Sciences
Web: http://www.nas.edu

The U.S. National Research Council's Committee on Emerging Issues and Data on Environmental Contaminants (established in 2001) has focused on toxicogenomics as a major scientific and technical issue (see http://dels.nas.edu/emergingissues/). It has conducted a number of workshops and research studies and published several reports available from the U.S. National Academies Press (see inclusion of toxicogenomics in this book's Chapter on Technical Reports and Government Documents).

Some examples are:

- Applications of Toxicogenomic Technologies to Predictive Toxicology and Risk Assessment (2007)
- Validation of Toxicogenomic Technologies: A Workshop Summary (2007).

A recommendation of the first report notes that, 'Current public databases are inadequate both to manage the types and volumes of data expected to be generated by large-scale applications of toxicogenomic technologies and to facilitate mining and interpretation of the data,' and calls for the creation of extensive effort to develop and maintain a 'national, publicly available toxicogenomics database.'

National Cancer Institute–The Cancer Genome Anatomy Project (CGAP)
Web: http://cgap.nci.nih.gov/

The goal of the NCI's Cancer Genome Anatomy Project is to determine the gene expression profiles of normal, precancer, and cancer cells, leading eventually to improved detection, diagnosis and treatment for the patient. By collaborating with scientists worldwide, CGAP seeks to increase its scientific expertise and expand its databases for the benefit of all cancer researchers. (Excerpted from the CGAP website.)

National Center for Toxicogenomics, National Institute of Environmental Health Sciences
Web: http://www.niehs.nih.gov/research/atniehs/nct.cfm

Environmental Genome Project

Humans differ in their susceptibility to environmental contaminants exposure and these susceptibilities may change over time. To deal with these issues from a genomics perspective, the NIEHS developed the Environmental Genome Project (EGP) in 1997. The long-term goal of the EGP is to characterize how specific human genetic variations, or polymorphisms, contribute to environmentally induced disease susceptibility.

Toxicogenomics Research Consortium

NIESH supports the research efforts undertaken by the Toxicogenomics Research Consortium (http://www.niehs.nih.gov/research/supported/centers/trc/). The NIESH Microarray Group and five academic centers (Duke University, Massachusetts Institute of Technology, Oregon Health and Science University, University of North Carolina at Chapel Hill, and the University of Washington) comprise this consortium.

National Genome Research Institute, NIH

Genome.Gov-ENCODE Project
Web: http://www.genome.gov/10005107

The National Human Genome Research Institute (NHGRI) launched a public research consortium named ENCODE, the **Enc**yclopedia **O**f **D**NA **E**lements, in September 2003, to carry out a project to identify all functional elements in the human genome sequence.

International HAPMAP PROJECT
Web: http://www.genome.gov/10001688

The haplotype map, or 'HapMap,' will be a tool that will allow researchers to find genes and genetic variations that affect health and disease. The HapMap should be a powerful resource for studying the genetic factors contributing to variation in response to environmental factors, in susceptibility to infection, and in the effectiveness of and adverse responses to drugs and vaccines.

National Library of Medicine's (U.S.) Special Information Services (SIS)

Enviro-Health Links – Toxicogenomics
Web: http://sis.nlm.nih.gov/enviro/toxicogenomics.html

An extensive collection of toxicogenomic information including sources of overview information and bibliographic searches from NLM's PubMed and TOXLINE databases.

The Genomics and Bioinformatics Group

Laboratory of Molecular Pharmacology
Center for Cancer Research
NIH, DHHS

Web: http://discover.nci.nih.gov/index.jsp

The Genomics and Bioinformatics Group (GBG) website offers useful bioinformatic program packages, microarray data analysis information, and molecular databases for genomic and proteomic research. (Excerpted from the website.)

Toxicogenomic Databases

In addition to the standard or more traditional types of genetic toxicology databases, a new generation of gene expression database has evolved in response to the rapid development of microarray technologies and the subsequent generation of gene expression data. For a brief overview of such gene expression databases see: Walker JR, Wiltshire T (2006) Databases of free expression Mamm. Genome 17(12): 1141–1146.

The NLM-National Center for Biotechnology Information (NCBI) maintains the Gene Expression Omnibus (GEO), a gene expression repository supporting MIAME (minimum information about microarray experiments, a metadata accounting protocol) compliant data submissions, and a curated, online resource for gene expression data browsing, query and retrieval (http://www.ncbi.nlm.nih.gov/geo/).

Below is a short list of genomic or specific toxicogenomic databases relevant to toxicology and human health risk assessment.

Chemical Effects in Biological Systems (CEBS) (from NIEHS)

This is an integrated public repository for toxicogenomics data. The CEBS Knowledgebase can be accessed at http://cebs.niehs.nih.gov/cebs-browser/cebsHome.do For a description of the efforts in building the database configuration of CEBS see Nucleic Acids Res. 2008 Jan; 36(Database issue): D892–900. Epub 2007 Oct 25.

Comparative Toxicogenomics Database (CTD)
Web: http://ctd.mdibl.org/

A publicly available database from Mount Desert Island Biological Laboratory developed in collaboration with NIH-NLM. The CTD website provides details of a dedicated database devoted to genes and proteins of toxicological significance.

DbZach
Web: http://dbzach.fst.msu.edu/

A toxicogenomic information management system, built on a relational database storing various data generated or otherwise relevant to the Zacharewski lab at Michigan State University.

Endocrine Disrupter Knowledgebase Database (EDKD) (from the FDA)
Web: http://edkb.fda.gov/

This consists of a biological activity database, relevant literature citations, computational models, and ultimately, models for risk assessment. It is designed to help research and regulatory scientists, and other interested parties set priorities for testing of endocrine-disrupting compounds, make use of the existing body of knowledge, and reduce dependency upon slow and expensive animal experiments.

Gene Ontology (GO) Database
Web: http://www.geneontology.org/index.shtml

A relational database housing both the Gene Ontology and the annotations of genes and gene products to terms in the GO. The advantage of housing both ontologies and annotations in a single database is that powerful queries can be performed over annotations using the ontology.

Genomes online database (GOLD) version 2.0
Web: http://www.genomesonline.org
A web resource for comprehensive access to information regarding complete and ongoing genome projects, as well as metagenomes and metadata, around the world.

GeneSNPs Database {from NIEHS}
Web: http://www.niehs.nih.gov/research/supported/programs/egp/genesnps/index.cfm

Developed as a web-based, publicly available graphical display of the newly identified SNPs discovered through resequencing environmentally responsive genes (ERGs) by the University of Washington. High-quality, well-validated SNP data relevant to the NIEHS-listed ERGs are imported from other publicly available web resources. The imported data are then converted to a graphical display developed by the University of Utah and made available to the public through the web-accessible GeneSNPs database (http://www.genome.utah.edu/genesnps/).

HuGE Navigator
Web: http://www.hugenavigator.net/

A continuously updated knowledge base in human genome epidemiology, including information on population prevalence of genetic variants, gene–disease associations, gene–gene and gene–environment interactions, and evaluation of genetic tests.

Online Mendelian Inheritance in Man (OMIM)
Web: http://www.ncbi.nlm.nih.gov/omim

'OMIM is a comprehensive, authoritative, and timely compendium of human genes and genetic phenotypes.

The full-text referenced overviews in OMIM contain information on all known Mendelian disorders and over 12,000 genes. OMIM focuses on the relationship between phenotype and genotype. It is updated daily, and the entries contain copious links to other genetic resources.' (Excepted from the NCBI website.)

The Pharmacogenetics and Pharmacogenomics Knowledge-Base (PharmGKB)
Web: http://www.pharmgkb.org/

'… links genomic, phenotypic, and clinical information collected from ongoing pharmacogenetic studies, high-density tissue microarray data associated with pathology and clinical outcomes, and separate published efforts to combine the results generated from gene expression analysis with data collected from toxicology or molecular pharmacology experiments.'

Pharmacogenetic Effect Database (PharmGED)
Web: http://bidd.cz3.nus.edu.sg/phg/

Described by Zheng CJ, et al (2007) PharmGED: Pharmacogenetic Effect Database. Nucleic Acids Res. 35 (Database issue): D794–799. Epub 2006 Dec 6.

ToxCast
Web: http://www.epa.gov/ncct/toxcast

The U.S. EPA launched the agency's *ToxCast* program in the early autumn of 2007; the first summit has been planned for May 2009. ToxCast is the EPA's efforts in building a database to predict chemical toxicities based on a variety of factors, including genomic data. The initial release of ToxCast included 340 chemicals that have undergone extensive toxicology tests. These candidate chemicals will undergo additional bioassay testing with the hopes of generating an analytical tool to predict (Dix et al 2007).

SCIENTIFIC DATABASES CONTAINING TOXICOLOGY INFORMATION

AGRICOLA
Web: http://agricola.nal.usda.gov/

Produced by the National Agricultural Library, AGRICOLA contains bibliographic records of materials acquired by the National Agricultural Library and cooperating institutions in agricultural and related sciences. Records come from the NAL Online Public Access Catalog and NAL's Article Citation Database.

Elsevier
Web: http://www.elsevier.com

A major publisher, and purveyor of scientific databases, such as:

- EMBASE (http://www.embase.com/) – A broad-based scientific gateway to biomedical and pharmacological literature, with over 18 million records, from about 1800 priority journals, including both EMBASE and MEDLINE records. Portal to SCIRUS search engine. Links from molecular sequence numbers to NCBI information.
- Science Direct (from Elsevier) (http://www.sciencedirect.com/) – Covers a substantial portion of the world's full-text scientific, technical and medical (STM) literature.
- Scirus (http://www.scirus.com) – An extensive web-based scientific research tool. Allows researchers to search for not only journal content but also scientist's homepages, courseware, pre-print server material, patents and institutional repository and website information.
- Scopus (http://www.scopus.com) – A major abstract and citation database of scientific research literature and quality web sources. Developed in close collaboration with librarians and researchers from over 30 institutions around the world and continued with guidance from the Scopus Content Selection and Advisory Board, a global body representing every major scientific discipline. Scirus Topic Pages form a topic-centered communication and collaboration platform for scientists.

National Library of Medicine
Web: http:www.nlm.nih.gov

In addition to the more specialized toxicology database under NLM's listing above, NLM is the purveyor of vast amounts of other specialized and more general biomedical information, much of it of high relevance to the toxicologist. A few of these other products are:

- ClinicalTrials.gov – A registry of federally and privately supported clinical trials conducted around the world. Provides information on the trial's purpose, who may participate, locations, and phone numbers for more details.
- DailyMed – DailyMed provides high-quality information about marketed drugs. This information includes FDA-approved labels (package inserts). This website provides health information providers and the public with a standard, comprehensive, up-to-date, look-up and download resource of medication content and labeling as found in medication package inserts.
- Human Genome Resources (http://www.ncbi.nlm.nih.gov/genome/guide/human/resources.shtml) – An integrated, one-stop, genomic information

resource for data that promise to provide new insights into human biology and new approaches for combating disease. Databases fall into the following subject areas: Genes and Human Health (including RefSeq, a database of reference sequences of chromosomes, genomic contigs, mRNAs, and proteins for human and major model organisms), reagent, the genomic sequence, maps and markers, transcribed sequences, cytogenetics, and comparative genomics.

- MedlinePlus – Brings together authoritative information from NLM, the National Institutes of Health (NIH), and other government agencies and health-related organizations. Preformulated MEDLINE searches are included in MedlinePlus and give easy access to medical journal articles. MedlinePlus also has extensive information about drugs, an illustrated medical encyclopedia, interactive patient tutorials, and latest health news.
- PubChem – Provides information on the biological activities of small molecules. It is a component of NIH's Molecular Libraries Roadmap Initiative.
- PubMed – MEDLINE is an NLM bibliographic database of citations and abstracts (over 5000 biomedical journals covered), published globally. With over 17 million citations from MEDLINE and other life science journals for biomedical articles dating back to the 1950s, PubMed includes links to full-text articles and other related resources, such as in-process (pre-indexing) citations, citations preceding the date that the journal was selected for MEDLINE indexing, out-of-scope citations from MEDLINE journals, etc.
- RxNorm – Provides standard names for clinical drugs (active ingredient + strength + dose form) and for dose forms as administered to a patient. It provides links from clinical drugs, both branded and generic, to their active ingredients, drug components (active ingredient + strength), and related brand names. NDCs (National Drug Codes) for specific drug products (where there are often many NDC codes for a single product) are linked to that product in RxNorm. RxNorm links its names to many of the drug vocabularies commonly used in pharmacy management and drug interaction software, including those of First Databank, Micromedex, MediSpan, Gold Standard Alchemy, and Multum. By providing links between these vocabularies, RxNorm can mediate messages between systems not using the same software and vocabulary.

SciFinder

(from Chemical Abstracts Service) (http://www.cas.org/products/scifindr/) – A research discovery tool that allows exploration of CAS databases that contain literature from many scientific disciplines, including biomedical sciences, chemistry, engineering, materials science, and agricultural science.

Thomson/Reuters

- BIOSIS Previews and Biological Abstracts (http://www.biosis.org/) – Interdisciplinary life sciences information.
- ISI Web of Knowledge (http://www.isiwebofknowledge.com/) – A multidisciplinary platform including information from high-quality and relevant journals, patents, proceedings and evaluated web content in the sciences, social sciences, arts, and humanities.
- http://www.thomsonreuters.com/product_services/scientific/Web_of_Science

Unigene Database

Web: http://www.ncbi.nlm.nih.gov/unigene

Unigene is an organized view of the transcriptome. Each Unigene entry is a set of transcript sequences that appear to come from the same transcription locus (gene or expressed pseudogene), together with information on protein similarities, gene expression, cDNA clone reagents, and genomic location. (Excerpted from the Unigene website.)

CHAPTER

69

Software Tools for Toxicology and Risk Assessment

CHARLES PITTINGER AND ASISH MOHAPATRA

INTRODUCTION

This chapter covers software tools of interest to toxicologists. The first section focuses on Quantitative Structure Activity Relationships (QSAR)-related software tools. In addition, the QSAR-related approaches used by various regulatory agencies are highlighted. The second section of this chapter covers non-QSAR software tools and resources useful for work in toxicology and risk assessment.

QSAR TOOLS

Structure–activity relationships (SARs) and quantitative structure–activity relationships (QSARs) are theoretical models that can be used to predict the physicochemical, biological, and environmental properties of substances. A SAR is an (qualitative) association between a chemical substructure and the potential of a chemical containing the substructure to exhibit a certain biological property or effect. A QSAR is a mathematical model that quantitatively relates a quantitative numerical measure of chemical structure (e.g., a physico-chemical property) to a physical property or to a biological effect (e.g., a toxicological endpoint).

QSARs are tools commonly used in the absence of available data for prioritization, classification, and screening level risk assessment. A broad range of QSAR models can readily fill data gaps for assessing chemicals, particularly for fundamental physical–chemical properties, in an expedient and cost-effective manner. QSAR-based evaluations can provide a systematic and consistent approach to chemical evaluations involving large numbers of chemicals. Certain (Q)SARs and other types of theoretical models have gained broad acceptance by regulatory institutions and the private sector. Predictive models can reduce costs, time, and concerns related to conducting toxicity bioassays. Input data requirements are generally modest and increasingly available through public and computerized databases.

THE BROAD UNIVERSE OF QSARS

An SAR model qualitatively compares structurally similar chemicals for which a measured toxicological or environmental property or endpoint ('the activity') is available to estimate the same property/endpoint for an analogous, untested chemical. In QSAR models, the endpoint is quantitatively related to a series of structurally similar chemicals (which are often related). The relationship may be continuous or categorical, and is typically developed by regression methods, classification methods (e.g., discriminant analyses and decision trees), or neural networks.

The broadest array of QSAR models is available for endpoints related to physical and chemical properties of chemicals, such as solubility, hydrophobicity, adsorptivity, and volatilization. Fewer are available for biological processes such as biodegradability and toxicity to non-mammalian organisms. Still fewer are QSARs for predicting mammalian and/or human health effects. This is due to several factors. Prediction of physical–chemical parameters often relies upon relatively well-characterized physical and chemical principles and processes. These may require less complex mechanistic understanding than biological processes

involving enzyme kinetics and physiological interactions among multiple organs and organ systems (e.g., adsorption, distribution, metabolism and elimination (ADME) pathways). In addition, physical–chemical endpoints typically have a longer history of study, such that more homogeneous data sets are available for a broader range of chemicals.

QSAR APPLICATIONS FOR CHEMICAL SCREENING, PRIORITIZATION, AND REGULATORY AND CORPORATE DECISION-MAKING

QSAR predictions are used by regulatory authorities, private corporations, and institutions in three major contexts: priority-setting, hazard classification and labeling, and screening for health and ecological risks of chemicals. Regulatory uses of QSARS include: (1) supporting priority setting of chemicals; (2) guiding experimental design of regulatory tests or testing strategies; (3) providing mechanistic information; (4) grouping of chemicals into categories based on similarity; (5) filling a data gap needed for classification and labeling; and (6) filling a data gap needed for risk assessment. Each application carries unique considerations for QSAR, with the most stringent considerations placed upon QSARs used for 'high regulatory impact,' for example, risk assessments under mandated regulatory programs.

QSAR RELIABILITY AND VALIDITY

The reliability of the results of QSAR estimates varies both with application and endpoint. Environmental fate endpoints based on predictions of physical/chemical parameters are the most common and best validated uses of QSAR, and results are relatively well accepted. Systemic toxicity endpoints are more complex, as toxicity is the net expression of multiple biological processes including ADME. Reliability of QSAR predictions for human health endpoints is generally regarded as less than those for non-mammalian (e.g., fish and invertebrates) toxicity endpoints, partly due to the limited availability of high quality data availability. (Non-mammalian species such as fish and aquatic invertebrates (e.g., *Daphnia, Ceriodaphnia*) and algae are typically less expensive to test, and the bioassays carry fewer legal and ethical concerns.)

In order to be considered for regulatory use, it is widely agreed that QSARs need to be assessed for scientific validity. Importantly, QSARs are generally not used as the sole information source upon which to base regulatory decisions. Empirical data, if available, are considered first and have greater reliability than QSAR predictions, unless there are explicit reasons to consider the data erroneous. QSAR predictions are considered in the context of the weight of evidence from multiple sources (e.g., empirical bioassay data, monitoring, epidemiology, etc.). The collective evidence is often weighed on a case-by-case basis by trained experts, applying the best professional judgment.

Risk assessments with 'high regulatory impact' (e.g., enforceable standards such as new chemical registrations or litigation over contaminated sites) must be legally defensible, transparent, and unbiased. Many commercial QSAR packages (e.g., TOPKAT, DEREK, MCASE) maintain proprietary and confidential training sets, algorithms, and software. As such, they can be challenged as legally indefensible in a court of law, due to lack of transparency.

QSAR packages developed by public organizations, such as the US Environmental Protection Agency's (EPA's) EFAST and EPISUITE models, are typically more transparent. In many cases, they apply the same or similar peer-reviewed databases and algorithms used in commercial QSAR packages. There is currently a need for well-validated, public domain QSAR models for broad regulatory applications and decision support systems.

QSAR APPLICATIONS

Predicting Physical–Chemical Properties of Chemicals

Physical–chemical QSAR models are available to predict a range of chemical properties including: melting point, boiling point, water solubility, biodegradability, vapor pressure, Henry's law constant, sediment adsorptivity, octanol–water partition coefficient, and half-life in the environment. These and other parameters can be readily predicted by EPISUITE (see Relevant Websites section), and enables batch data entry based on Chemical Abstract Service (CAS) numbers or SMILES notations.

Predicting Environmental Fate and Transport

The physical–chemical parameters listed above are often used to estimate fate and transport of chemicals in the environment, a critical aspect of exposure analysis in chemical risk assessments. QSAR model predictions of physical and chemical properties of chemicals, together with empirical data, can be used

as inputs to more sophisticated environmental fate models to predict chemical concentrations in source waters and drinking waters. Models such as EFAST (e.g., the Exposure and Fate Assessment Screening Tool, at the EPA website) are capable of incorporating multiple parameters in predicting fate and transport processes including wastewater treatment from point-source emissions, fate in the environment, concentration at drinking water intakes, atmospheric deposition, land runoff, soil leaching, groundwater migration, etc.

QSAR models for biodegradation are more limited in scope and accuracy than packages that predict physical–chemical parameters. The 'PBT Profiler' (Persistent, Bioaccumulative and Toxic) is a public domain QSAR package developed through the U.S. EPA. EPISUITE and the PBT Profiler include estimates of biodegradability based on chemical similarity. More sophisticated but narrower models such as CATABOL (see Relevant Websites section) require mechanistic understanding of enzyme-mediated processes, similar to those available for predicting toxicity.

Predicting Ecological Effects

QSARs for the prediction of toxicity to aquatic organisms, including fish, invertebrates, and algae, are relatively well developed for a broad range of chemical classes. More than 100 SARs for 55 chemical classes are available in a free, downloadable model called ECOSAR from the EPA website, based on test data and assumptions from test data. Aquatic toxicity endpoints include; reproduction, growth and mortality, such as acute toxicity to fish, invertebrates, and algae. The PBT Profiler also estimates chronic toxicity to fish by means of the ECOSAR model; it compares the fish chronic value to maximum water solubility, in order to estimate potential for aquatic risk.

Predicting Human Health Effects

A variety of QSAR models have been developed for human health endpoints and 'packaged' into user-friendly commercial or public-use programs. Human health hazard endpoints commonly predicted by QSAR models include: mutagenicity, carcinogenicity, teratogenicity, neurotoxicity, reproductive and developmental toxicity, skin/eye sensitization and irritation, and systemic toxicity. The more popular commercial QSAR packages for human health include The Open Practical Knowledge Acquisition Toolkit (TOPKAT), Multicase (MCASE), and the Deductive Estimation of Risk from Existing Knowledge (DEREK). Two general types of models can be distinguished: statistically based models such as TOPKAT, and rule-based models such as MCASE. Concise characterizations of these and other QSAR packages appear on the OECD website.

INTERNATIONAL USES OF QSARS BY REGULATORY AUTHORITIES

The OECD has recently published several pivotal documents summarizing QSAR applications worldwide. Their 'Guidance Document on the Validation of (Quantitative) Structure–Activity Relationships ((Q)SAR) Models (ENV/JM/MONO(2007)2)', available at www.oecd.org/ehs/, discusses OECD Principles for the Validation, for Regulatory Purposes, of (Q)SAR Models. It provides guidance on how individual regulatory agencies can evaluate specific (Q)SAR models with respect to those principles.

OECD's 'Report on the Regulatory Uses and Applications in OECD Member Countries of (Q)SAR Models in the Assessment of New and Existing Chemicals' (ENV/JM/MONO(2006)25) compiles case studies on current regulatory applications and prospective uses of (Q)SARs received from Australia, Canada, Czech Republic, Denmark, Germany, Italy, Japan, the Netherlands, the United States, the United Kingdom, and the European Commission. This report is 'part of the OECD effort to develop guidance for regulatory applications of (Q)SAR models, and emphasizes the use of programme-specific case studies to highlight the importance of legal and practical constraints and information requirements of individual regulatory programmes within member countries in applying (Q)SAR approaches.'

An excellent website that overviews QSARs by country and by property or effect is maintained by the OECD, at: http://webdomino1.oecd.org/comnet/env/models.nsf. The following sections summarize QSAR applications by selected regulatory jurisdictions worldwide.

European Union

The European Union (EU), like the U.S. EPA, supports the use of QSARs for screening new chemicals. The EU's Technical Guidance Document provides extensive guidance for the use of QSARs (see Further Reading section). The European Commission's Joint Research Centre has a QSAR Group within the Institute for Health and Consumer Protection's European Chemicals Bureau (ECB). The mission of the QSAR Group is to promote the regulatory use of valid (Q)SARs and related estimation methods. In addition to coordinating the activities of the EU QSAR Working Group, the ECB has initiated a wide range of in-house

and collaborative activities in the area of non-testing approaches. Further information on ECB (Q)SAR activities can be found at the following website: http://ecb.jrc.it/QSAR/. The European Union's recently enacted REACH (**R**egistration, **E**valuation, **A**uthorisation, and Restriction of **CH**emicals) legislation manages new and existing chemicals in a single regulatory framework. REACH, which will be led by the European Chemicals Agency (ECHA), includes the fostering of research on the development and validation of alternative (non-animal) methods, including (Q)SAR models and in vitro test methods. Under REACH, non-testing methods, including (Q)SARs, read-across and chemical category approaches will be used more extensively and more systematically than under previous EU legislation on chemicals.

United States

A number of U.S. regulatory agencies currently employ QSARs broadly in chemical screening, prioritization, and decision-making. The New Chemicals Program in the U.S. EPA's Office of Pollution Prevention and Toxic Substances (OPPTS) uses a variety of methods to make predictions that include QSAR, nearest analog analysis, chemical class analogy, mechanisms of toxicity, chemical industry survey data, and professional judgment. The models are used to identify possible chemicals of concern, for which additional experimental data may be requested from the notifying company through the OPPTS Sustainable Futures Program, new chemical submitters may 'fast track' the review process by use of the Pollution Prevention Framework, incorporating The PBT Profiler. EPA's Office of Pesticides Programs (OPP) is exploring the use of QSARs for non-active (i.e., 'inert') components of pesticide formulations. The EPA has used QSAR on a discretionary basis under the Hazardous Waste Identification Rule to screen and prioritize some 4000 chemicals for PBT characteristics.

The TSCA Interagency Testing Committee (ITC) uses QSAR predictions, in combination with empirical data and professional judgment, to maintain a 'Priority Testing List.' Finally, ongoing investigative programs in EPA's Office of Research and Development (ORD) are in place to develop, validate, and apply QSARs for various health, ecological, and exposure-related endpoints. ORD's National Center for Environmental Assessment is using TOPKAT to predict health effects associated with drinking water disinfection by products, among others. ORD's National Health and Environmental Effects Research Laboratory is developing receptor-binding QSAR models to predict endocrine disruption. ORD's National Center for Environmental Research Star Grant Program supports academic research in QSAR development.

FDA's National Center for Toxicological Research (NCTR), Center for Toxicoinformatics has an established program for the investigation of (Q)SAR models to identify chemicals with endocrine-disrupter properties, at: http://www.fda.gov/nctr/science/centers/toxicoinformatics/edkb/.

Canada

Existing Substances

The Canadian Environmental Protection Act, 1999 (CEPA 1999) requires the Ministers of the Environment and Health to 'categorize' the substances on the Canadian Domestic Substances List (DSL). Each of the more than 23 000 substances on the Domestic Substances List (DSL), an inventory of chemicals and biological agents that were in commerce in Canada between January 1984 and December 1986, was categorized in 2006. The purpose of categorization was to determine which substances on the DSL may have the greatest potential for exposure to the general population or are persistent (P) or bioaccumulative (B) and inherently toxic (iT) to human beings or to non-human organisms. Environment Canada considers persistence, bioaccumulation, and inherent toxicity to environmental organisms while Health Canada considers greatest potential for exposure and inherent toxicity to humans.

New Substances

The New Substances Branch of Environment Canada is responsible for conducting the environmental risk assessment on all new industrial chemicals and polymers, while Health Canada conducts an evaluation of the risk to human health. The notification scheme is tiered, with increasing information requirements as the volume of import or manufacture increases. The risk assessments are conducted through an examination of effects and an assessment of environmental fate and exposure. The program requires the submission of physical/chemical and effects data, however, when adequately validated by the notifier and acceptable to the government evaluators, data generated using (Q)SARs are accepted as an alternative to test data and can be used as a basis for regulatory decision making.

More information on the assessment approaches used by Environment Canada and Health Canada can be found at the following websites:

- Health Canada Categorisation and Screening Health Risk Assessment (http://www.hc-sc.gc.ca/ewh-semt/contaminants/existsub/index_e.html)

- Environment Canada Categorisation and Screening Risk Assessment (http://www.ec.gc.ca/substances/ese)
- Health Canada Human Health Risk Assessment Protocols for Contaminated Sites (http://www.hc-sc.gc.ca/ewh-semt/contamsite/risk-risque-eng.php)
- Health Canada New Substances (http://www.hc-sc.gc.ca/ewh-semt/contaminants/chem-chim/index_e.html)
- Environment Canada New Substances (http://www.ec.gc.ca/substances/nsb/eng/index_e.htm).

Denmark

To support the self-classification process, the Danish EPA published an advisory list for self classification of dangerous substances. The list of suggested hazard classifications was derived by using predictions from (Q)SAR models obtained or developed by the Danish EPA for the following endpoints: acute oral toxicity, skin sensitization, mutagenicity, carcinogenicity, and danger to the aquatic environment. The models were used to make predictions for the approximately 47 000 discrete organic substances on the EINECS list. The Danish Advisory List contains 20 624 chemical substances with suggested classifications for one or more of the dangerous properties, and is searchable via the ECB website (http://ecb.jrc.it/QSAR).

Journal Articles (QSAR-Related)

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Vracko M, Bandelj V, Barbieri P, et al (2006) Validation of counter propagation neural network models for predictive toxicology according to the OECD principles. A case study. SAR QSAR Environ. Res. 17: 265–284.

KEY QSAR WEBSITES

European Commission, European Chemicals Bureau, Joint Research Centre's website on Computational Toxicology
Web: http://ecb.jrc.it/qsar/content1.php

European Chemicals Agency (ECHA)
Web: http://echa.europa.eu/reach_en.html

Organisation for Economic Cooperation and Development (OECD) QSAR Project
Web: http://www.oecd.org/document/23/0,3343,en_2649_34373_33957015_1_1_1_1,00.html

Environmental Protection Agency (EPA) website. Freely distributed EPISUITE QSAR program. SARs for 55 chemical classes are available in a free, downloadable model called ECOSAR
Web: http://www.epa.gov/oppt/exposure/pubs/episuitedl.htm

Website for PBT Profiler, a public domain QSAR package developed by the U.S. EPA and Syracuse Research Corporation
Web: http://www.syrres.com/esc/default.htm

The Open Practical Knowledge Acquisition Toolkit (TOPKAT): A popular commercial QSAR package for human health
Web: http://www.accelrys.com

Multicase website. Provides MCASE, a QSAR package
Web: http://www.multicase.com

NON-QSAR-RELATED SOFTWARE TOOLS

The above section of this chapter focused on QSAR-related software tools. In addition, the QSAR-related approaches are used by various agencies in assessing toxicological effects of chemicals were highlighted. In the section below, other software tools for use in toxicology and risk assessment are noted.

Web Sites

Predictive Toxicology Resources Online

Web: http://www.predictive-toxicology.org/programs.html

This website is an extension of the resources available in the book entitled, '*Predictive Toxicology*' (2005). The book includes techniques and systems currently utilized in predictive toxicology. It highlights a survey of strategies to characterize chemical structures and biological systems, and prediction methods and algorithms, sources of toxicity data, commercial and non-commercial predictive toxicology programs, and technologies in computational chemistry and biology, statistics, and data mining.

Some examples are provided below. For detailed information on the software, the readers are encouraged to refer to the Predictive Toxicology Web site.

Expert Systems

- DEREK Expert system for the prediction of toxicity (genotoxicity, carcinogenicity, skin sensitization, …)
- METAPC Windows based Metabolism and Biodegradation Expert System
- METEOR Expert system for the prediction of metabolic transformations
- OncoLogic Rule based expert system for the prediction of carcinogenicity

Data Driven Systems

- lazar Open source inductive database for the prediction of chemical toxicity
- MC4PC Windows based Structure-Activity Relationship (SAR) automated expert system
- PASS predicts 900 pharmacological effects, mechanisms of action, mutagenicity, carcinogenicity, teratogenicity and embryotoxicity.

- TOPKAT Quantitative Structure Toxicity Relationship (QSTR) models for assessing various measures of toxicity

Computational Chemistry Programs

- DRAGON is an application for the calculation of molecular descriptor.
- JOELib A Java based cheminformatics (computational chemistry) library (open source)
- OpenBabel A cross-platform program and library designed to interconvert between many file formats used in molecular modeling and computational chemistry (open source)

'Risk World' Software List

Web: http://www.riskworld.com/softsw001.htm
Risk world website has an extensive list of risk assessment related software. Readers are encouraged to review this list of software; however, as of mid-2008, several of the Web links to the software do not work and some of these software might have been discontinued.

Environmental Health and Safety Free Software Portal

Web: http://www.ehsfreeware.com/
A portal of on-line databases of information, downloadable software, and lots of other resources related to the environment, health and safety. Additional information resources are available at http://www.ehsfreeware.com/links.htm.

STATISTICAL AND RISK FORECASTING TOOLS

R Statistical Package

This is a free software environment for statistical computing and graphics. It is an integrated suite of software facilities for data manipulation, calculation and graphical display. Included is an effective data handling and storage facility; a suite of operators for calculations on arrays, in particular matrices; a large, coherent, integrated collection of intermediate tools for data analysis, graphical facilities for data analysis and display either on-screen or on hardcopy, and a well-developed, simple and effective programming language which includes conditionals, loops, user-defined recursive functions and input and output facilities (excerpted from http://www.r-project.org/).

Crystal Ball

Crystal Ball is a Microsoft® Excel®-based suite of analytical tools that includes Monte Carlo simulation, optimization, and forecasting and predictive modeling. These advanced analytical techniques can be used in standard spreadsheets modeling software to create predictions for effective outcomes in financial, environmental and other forecasting related projects. For additional information, refer to http://www.oracle.com/crystalball/index.html/.

Analytica

Analytica is a visual software package developed by Lumina Decision System, Inc. for creating, analyzing and communicating quantitative decision models. Analytica includes hierarchical influence diagrams for visual creation and view of models, intelligent arrays for management of multidimensional data, Monte Carlo simulation for analyzing risk and uncertainty, and a general modeling language. It is designed to enable the creation of models that are transparent, interpretable, extensible, and flexible. The design of Analytica is based on key ideas from the field of decision analysis. For additional information, refer to http://www.lumina.com/.

Risk Calc

"Risk Calc supports probability bounds analysis, standard fuzzy arithmetic, and classical interval analysis. Its applications are like those of Monte Carlo packages such as @Risk or Crystal Ball, but Risk Calc does not require you to specify precise details of statistical distributions and their dependency relationships when empirical data are lacking." (excerpted from http://www.ramas.com/riskcalc.htm)

United States Environmental Protection Agency (U.S. EPA)

National Centre for Environmental Assessment (NCEA)
Risk Tools – Human Health Risk Assessment
Web: http://cfpub.epa.gov/ncea/cfm/nceatools_human.cfm
Several risk assessment models and databases are provided to facilitate human health risk assessments. Some Emerging tools are Bench Mark Dose (BMD) Modeling and Physiological Based Pharmaco Kinetic (PBPK) modeling tools and frameworks.

Risk Tools – Ecological Risk Assessment
http://cfpub.epa.gov/ncea/cfm/nceatools_ecological.cfm
Several risk assessment models and databases are provided to facilitate ecological risk assessments. Models,

databases, methods and other tools and resources are provided on the Web page.

Bench Mark Dose (BMD) Modelling
Web: http://www.epa.gov/ncea/bmds/index.html
BMD methods involve the fitting of mathematical models to dose-response data and using the different results to select a BMD that is associated with a predetermined benchmark response (BMR), such as a 10% increase in the incidence of a particular lesion or a 10% decrease in body weight gain. The BMD software facilitates toxicological modeling operations by providing simple data-management tools and an easy-to-use interface to run multiple models on the same dose-response data set. The models are appropriate for the analysis of dichotomous (quantal) data (Gamma, Logistic, Log-Logistic, Multistage, Probit, Log-Probit, Quantal-Linear, Quantal-Quadratic, Weibull and Multistage-Cancer), continuous data (Linear, Polynomial, Power, and Hill) and nested developmental toxicology data (NLogistic, NCTR, and Rai & Van Ryzin). A beta version 2.0 as of June 28, 2008 is still at the experimental stage and has important changes and enhancements and a different graphical interface.

The following website has an extensive list of various environmental models available by United States Environmental Protection Agency (USEPA) http://www.epa.gov/epahome/models.htm

The following website has lists of USEPA databases and software Web: http://www.epa.gov/epahome/Data.html/.

The National Computational Toxicology Centre: Web: http://www.epa.gov/comptox/.

Detailed information on Databases and models such as ACToR (Aggregated Computational Toxicology Resource); Distributed Structure-Searchable Toxicity (DSSTox) Database Network; and ToxRefDB (Toxicity Reference Database) and ToxCast™ can be accessed at Web: http://www.epa.gov/comptox/databases.html.

Vapour Intrusion Risk Assessment Modelling Tools
Web: http://www.epa.gov/oswer/riskassessment/airmodel/johnson_ettinger.htm

Online modeling learning module – Petroleum Hydrocarbon Transport
Web: http://www.epa.gov/athens/learn2model/index.html

Journals

Environmental Modelling & Software
Publisher: Elsevier Publications
Environmental Modelling and Software publishes contributions, in the form of research articles, reviews, short communications as well as software and data news, on recent advances in environmental modeling and/or software. The aim is to improve our capacity to represent, understand, predict or manage the behaviour of environmental systems at all practical scales, and to communicate those improvements to a wide scientific and professional audience. (Excerpted from Web: http://www.elsevier.com/wps/find/journaldescription.cws_home/422921/description-description)

Organization

International Environmental Modelling and Software Society (IEMMS)
Web: http://www.iemss.org/
IEMMS is a not-for-profit organization that unites interested stakeholders dealing with environmental modeling, software and related topics. It strives to develop and use environmental modeling and software tools to advance the science and improve decision making with respect to resource and environmental issues. Further, it emphasizes on the interdisciplinarity and the development of generic frameworks and methodologies which integrate models and software tools. In addition, it promotes contacts between physical, social and natural scientists, economists and software developers from different countries and coordinate their activities. It improves the cooperation between the scientists and decision makers/advisors on environmental matters. It also improves the exchanges of information in the field of environmental modeling and software among scientific and educational organizations and private enterprises, as well as non-governmental organizations and governmental bodies.

Conclusion

This chapter has summarized some of the software and modeling frameworks for toxicology and ecological and human health risk assessments. There are other modeling tools and toxicology software available in the emerging areas of toxicology (e.g., toxicogenomics). The readers are encouraged to review those tools available from various research institutes and universities that are engaged in genomics research and analysis. Other emerging areas such as modeling complex diseases to understand gene-gene and gene-environmental interactions are currently carried out by agencies such as IARC (International Agency for Research on Cancer), various European and North American universities and agencies. Dose response (toxicology) and expose assessment modeling are important for health risk assessments, and the modeling tools and software are constantly being refined in these areas. The information provided in this chapter is by no means an exhaustive list of software tools; rather it is a condensed list of relevant software, models and other related tools available from various governmental and commercial organizations.

PART

V

Special Topics

CHAPTER

70

The Legal and Regulatory Framework

NEIL S. SHIFRIN AND E. MICHAEL THOMAS

INTRODUCTION

This chapter provides a general understanding of what/how chemicals are regulated in the U.S. and of compliance considerations for the regulated community. It represents conditions exclusive of the European Union's December 2006 passage of the Registration, Evaluation, Authorisation, and Restriction of Chemicals (REACH) legislation, which may change future U.S. chemical practices. Although many chemicals are regulated in the U.S. through environmental laws, this chapter will mainly focus on chemicals in commerce, not in wastes or as environmental contaminants.[1] Where possible or important, distinctions will be made between *products* and *constituents*, both of which may pose chemical exposures to people.

CHEMICALS VS PRODUCTS AND REGULATORY AUTHORITIES

Chemicals or products are generally not directly regulated in the U.S. Exceptions at the Federal level include pesticides, drugs, alcohol, some foods, materials regulated by the U.S. Environmental Protection Agency's (EPA's) Toxic Substances Control Act of 1976 (TSCA) and some special chemicals like High Production Volume (HPV) chemicals, fuel additives (e.g., tetraethyl lead and methyl tertiary-butyl ether (MTBE)) and ozone-depleting chemicals (e.g. fluorocarbons). At the State level, California's Proposition 65 (Safe Drinking Water and Toxic Enforcement Act of 1986), which has nationwide and worldwide impact, regulates (for label listing) all products containing carcinogens, mutagens, or reproductive toxicants.

Regulatory authority over chemicals in the U.S. stems from the intended use of the chemical, the intended purpose of the product in which the ingredient is used, and the claims that are made about chemical and product function. For example, a simple chemical like citric acid may be governed by several agencies depending on whether the end use is in a food, cosmetic, or drug product.

In contrast, for a non-pesticide consumer household product, an ingredient might be regulated by EPA under the Toxic Substances Control Act (TSCA), whereas the product might be governed by the Consumer Product Safety Commission (CPSC). If the ingredient was alcohol, then the Bureau of Alcohol, Tobacco, and Firearms (BATF) would govern it. EPA (under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)) would regulate citric acid or ethanol if used as an active ingredient of a pesticide or disinfectant.

The regulatory complexity of products, use, and chemicals is further exemplified by a synthetic surfactant derived from a petroleum product versus a soap (fatty acid salt) derived from natural sources (e.g., coconut oil). 'Soaps' for simple skin cleaning purposes are

[1]US environmental laws which specifically address chemicals include the Clean Water Act (Priority Pollutants and Water Quality Criteria), Safe Drinking Water Act (MCLs), Clean Air Act (NAAQS and NESHAPS), Resource Conservation and Recovery Act (Appendix IX Hazardous Constituents), the Comprehensive Environmental Response, Compensation, and Liability Act aka "Superfund" (Toxic Inventory List, among others), the National Environmental Policy Act, the Occupational Safety and Health Act, the Atomic Energy Act (radionuclides), and the Lead-Based Paint Poison Prevention Act.

exempted from U.S. Food and Drug Administration (FDA) regulations, but synthetic detergents for the same use are regulated by the FDA. If there are no claims for the product beyond 'cleaning' skin or other surfaces, the synthetic ingredient may be regulated by TSCA and the soap product is regulated by CPSC. However, if cosmetic claims are made (makes skin softer or more beautiful) or antibacterial claims (kills germs on skin), both the ingredient and the product are regulated by FDA as a cosmetic or over-the-counter (OTC) drug. In this circumstance, the FDA-regulated surfactant ingredient, and the product in which it is contained, would be exempt from many TSCA regulations.

Conversely, the same synthetic surfactant used in a household cleaning product without pesticidal claims is regulated by TSCA while the product would fall under CPSC jurisdiction. If pesticidal claims were made for this household product, then the active ingredient and the product must be registered with EPA under FIFRA. The complexity of the regulatory categorization and subsequent registration, notification, labeling, and compliance requirements stem from the basic intent of use, product type, and claims made about the material.

Similarly, if nutritional claims are made for a food component, then it is regarded as a food or food additive, depending on historical status. However, if drug claims are made for the same item (e.g., treats or improves a disease condition in humans or animals), it is regulated by FDA as a drug. In addition to FDA's drug *approval* powers, the 1994 Dietary Supplement Health and Education Act makes FDA regulate *substantiation* of claims made by manufacturers of 29 000 dietary supplements marketed in the U.S.

Being clear about product/chemical roles and how the regulatory boundaries are drawn is essential to knowing what regulatory arena applies. While many regulatory arenas are designed not to overlap (e.g., many parts of FDA, FIFRA, and TSCA), there are other regulatory arenas (e.g., Prop. 65, TSCA import certification regulations, Drug Enforcement Agency (DEA), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, commonly known as Superfund), Superfund Amendments and Reauthorization Act (SARA), Centralized Waste Treatment (CWT), and Clean Air Act (CAA)) in which there are no such barriers and chemicals are subject to the regulation, no matter what their function or form. Nanotechnology, as used in products, is beginning to be regulated (e.g., by EPA in 2006 for environmental risks).

Regulatory or legal expertise is needed to ensure compliance and to meet product or ingredient regulatory requirements. Beyond this general guide, consultation with appropriate legal or regulatory experts is advised to ensure noting new requirements and changes in laws and regulations.

LAWS, AGENCIES, AND REGULATIONS

Manufacturers, distributors, exporters, and importers must determine if the chemicals in their commerce must be registered, labeled, or reported. U.S. EPA's TSCA, California's Proposition 65, and FDA's authorities are the most far-reaching laws governing chemicals in commerce. Table 70.1 lists laws, associated agencies, and their scope of chemical and product regulation.

Table 70.2 shows the historical development of some of these key laws.

The Toxic Substances Control Act (TSCA), enacted into law in 1976, is the broadest federal legislation applicable to chemical manufacturing, use, import, export, distribution, and disposal. Existing chemicals (on the TSCA Inventory List) have limited reporting and testing requirements while new chemicals coming onto market have more stringent requirements for testing, safety assessment, and risk management. A new chemical substance is defined to be 'any chemical substance which is not included in the chemical substance list compiled and published' under TSCA, a list known as the TSCA Inventory.[2]

As a general matter, under TSCA Title I, Section 5, no person may manufacture any new chemical substance or manufacture or process any chemical substance for a significant new use without first submitting to EPA a notice of intent (the Pre-Manufacture Notice or PMN) to manufacture or process such chemical substances. The PMN must be accompanied by sufficient information, as determined by EPA, to allow a reasoned evaluation of the health and environmental effects of the chemical substance.[3] TSCA Section 5 also contains an extensive list of exemptions and exclusions under which a new chemical substance or significant new use of an existing chemical substance may be excused from the PMN requirement.[4] EPA may require that

[2]42 U.S.C. § 2602(9). The TSCA Inventory contains more than 70,000 chemicals that, by virtue of their presence on the Inventory, are considered to be "existing chemical substances." Information about accessing the TSCA Inventory is available at www.epa.gov/opptintr/newchems/pubs/invntory.htm.

[3]42 U.S.C. § 2604.

[4]Exclusions from the definition of chemical substance are found at 42 U.S.C. § 2602(1)(B)(i) – (1)(B)(v), and include such items as pesticides, tobacco, tobacco products, special nuclear material, food, drugs and cosmetics. Exemptions from the requirement to file a PMN are defined at 42 U.S.C. § 2604(h)(1) – (h)(5), including material manufactured in small quantities solely for purposes of scientific experimentation or analysis for chemical research for the development of a product.

TABLE 70.1 Laws and oversight agencies governing product chemicals

Law	Agency	Requirements/scope
Federal		
Consumer Product Safety Act, 1972	CPSC	Safety of consumer products not regulated under FDA, FIFRA, etc. Power to recall. Research
Hazardous Substances Act,	CPSC	Labeling and definitions of consumer products containing chemicals (e.g., antifreeze). Response to consumer concerns. Required reporting of hazards
Poison Prevention Packaging Act,	CPSC	Packaging/testing requirements to prevent childhood tampering of specific pharmaceuticals or household products
Flammable Fabrics Act	CPSC	Testing standards and banning authority from flammable hazards of clothing
Toxic Substances Control Act, 1976	EPA	Testing/information requirements for substances on TSCA inventory. Premanufacturing Notice requirements and EPA control prior to commercialization of new chemicals. Bans of identified hazardous chemicals (e.g., PCB, asbestos)
Federal Insecticide, Fungicide, & Rodenticide Act	EPA	Registration, safety and efficacy testing, packaging, labeling, use, restriction, and banning authority over all pesticides (active ingredients and formulations) marketed in US or exported
Safe Drinking Water Act, 1974	EPA	Drinking water standards for specific chemicals and requirements for reporting by water supply companies/agencies
Food Quality Protection Act, 1996	FDA	Safety standards for residues in raw and processed foods; allows for pesticide residues
Food, Drug & Cosmetic Act	FDA	Approval of new drugs and their safety, labeling, efficacy, stability, packaging, and advertising, including during investigation (Kefauver-Harris Amendments) and generics. Regulation of food, food additives, cosmetics, and medical devices including grandfathering commonly used additives generally regarded as safe (GRAS) and Delaney Clause (no safe carcinogen level) exclusions
Fair Packaging and Labeling Act	FTC	Truth in labeling, advertising, and packaging all consumer products
Occupational Safety & Health Act	OSHA	Protection of worker safety during manufacturing, including classification of carcinogens, hazard assessment standards, research, and chemical product information via material safety data sheets (MSDS)
Controlled Substances Act	DEA	Identifies and controls/prevents distribution/use of illicit drugs
Domestic Chemical Diversion Act	DEA	Controls import/export of illicit drug precursors or solvents
State		
California Proposition 65 (Safe Drinking Water and Toxics Enforcement Act)	Office of Environmental Health Hazard Assessment	Requires labeling/warning and allows citizen suits to identify/protect from 1/100,000 cancer risk or 1,000 × safety factors for mutagens or teratagens covering currently about 700 listed chemicals in products made or sold in California or in drinking water. New chemicals added by Science Advisory Board
New Jersey Right to Know	NJ DEP	Labeling and worker notification of the top 5 ingredients of all mixtures in bulk containers in certain industrial facilities

additional testing and data collection be conducted in connection with the PMN. Moreover, under separate sections of Title I, if EPA determines that the manufacture, processing, distribution in commerce, use or disposal of a chemical substance or mixture presents or will present an unreasonable risk of injury to health or the environment, EPA may require additional testing of the chemical substance to generate sufficient data to determine the risk,[5] and may impose one or more of a suite of restrictions on the manufacture, processing or distribution in commerce, including prohibitions, limitations in quantities, markings or warnings, recordkeeping, use restrictions, or other limitations. These restrictions must be applied to the extent necessary to protect adequately against the risk posed by the chemical substance, but must also use the least burdensome requirements.[6]

Title I also imposed a ban on the manufacture and distribution of polychlorinated biphenyls (PCBs) and authorized the EPA to regulate the use of existing PCBs and to exempt certain PCB manufacturing and distribution if EPA determines it will not present an unreasonable risk.[7] The other three TSCA titles impose specifically tailored requirements on asbestos-containing material,

[5]42 U.S.C. § 2603.

[6]42 U.S.C. § 2605.

[7]42 U.S.C. § 2605(e).

TABLE 70.2 Historical evolution of US laws and agencies governing product chemicals

Current law	Prior, related laws/versions
Consumer Product Safety Act, 1972 (CPSC)	Poison Prevention Packaging Act, 1970 Child Protection Act, 1966 Federal Hazardous Substances Act, 1960 Flammable Fabrics Act, 1953 Caustic Poison Act, 1927
Food Quality Protection Act, 1996 (FDA)	Tamper-Resistant Packaging Regulations, 1982 Infant Formula Act, 1980 Saccharin Study and Labeling Act, 1977 Medical Device Amendments, 1976 Regulation of Biologics (vaccines, etc.), 1972 OTC Drug Review, 1972 Radiation Control For Health & Safety Act, 1968 Animal Drug Amendments, 1968 Fair Packaging and Labeling Act, 1966 Kefauver-Harris Drug Amendments, 1962 Color Additive Amendment, 1960 Food Additive Amendment (Delaney Clause), 1958 Pesticides Amendment, 1954 Durham-Humphrey Amendment (prescriptions), 1951 Federal Food Drug & Cosmetic Act, 1938 Certified Color Regulations, 1907 Food and Drug Act, 1906 Biologics Control Act, 1902
Toxic Substances Control Act, 1976 (EPA)	Safe Drinking Water Act, 1974 Federal Insecticide, Fungicide, and Rodenticide Act, 1947 Other environmental laws, e.g., CERCLA, RCRA, CWA

indoor radon emissions, and exposure to lead in soils and lead-based paint.[8]

The scope of chemicals governed and excluded by TSCA is best described from EPA's documentation (from http://www.epa.gov/opptintr/chemtest/pubs/mtlintro.htm):

> The TSCA Inventory currently contains over **70,000 existing chemicals,** many of which are produced or imported at low or negligible volumes, while others are polymers which, because of their physical size (e.g., high molecular weight) and other characteristics, are unlikely to present significant risk concerns. By excluding low volume chemicals (~25,000 chemicals produced or imported in amounts less than 10,000 pounds per year) and polymers (which tend to be poorly absorbed by organisms and therefore typically exhibit low toxicity), the remaining TSCA Inventory is comprised of about 15,000 non-polymeric chemicals produced/imported at levels above 10,000 pounds per year.
>
> Of these 15,000 non-polymeric chemicals, there are 3,000–4,000 chemicals that are produced/imported in amounts over 1 million pounds per year; these chemicals are considered by EPA to be U.S. High Production Volume (HPV) chemicals. **EPA has identified this 15,000 chemical subset as being the broad focus "universe" of the TSCA Existing Chemicals and Chemical Testing Programs with the primary focus placed on the 3,000–4,000 HPV chemicals**.

This arrangement of chemicals according to TSCA is shown graphically in Figure 70.1 (taken from http://www.epa.gov/opptintr/chemtest/pubs/mtlchem1.htm). Actually, as of 2003, there were 81 000 chemicals on the TSCA Inventory, as noted by Batelle (2003), which is a good overview of TSCA. Chemicals on the Inventory are handled by EPA differently than new chemicals coming onto market in that more rigorous testing and safety information is required for the latter. Thus EPA's original 'TSCA Inventory,' (http://www.chemicalspolicy.org/usfederal.shtml) was a list of all chemical substances in commerce prior to December, 1979 (about 60 000 substances, more than 99% by volume of what is on the market today), and was in a way grandfathered from the requirements of new chemicals coming onto market. Many safety initiatives also are run by EPA through TSCA, such as the High Production Chemicals Initiative and the Voluntary Children's Chemical Evaluation Program (VCCEP).

Pesticides are regulated in the United States at the federal level primarily under FIFRA[9], the Federal Food, Drug and Cosmetic Act (FFDCA)[10] and the

[8]TSCA Titles, II, III and IV, respectively, 42 U.S.C. § 2641 et seq, 42 U.S.C. § 2661 et seq, 42 U.S.C. § 2681 et seq.

[9]7 U.S.C. §§ 136–136y.

[10]21 U.S.C. §§ 321–346a.

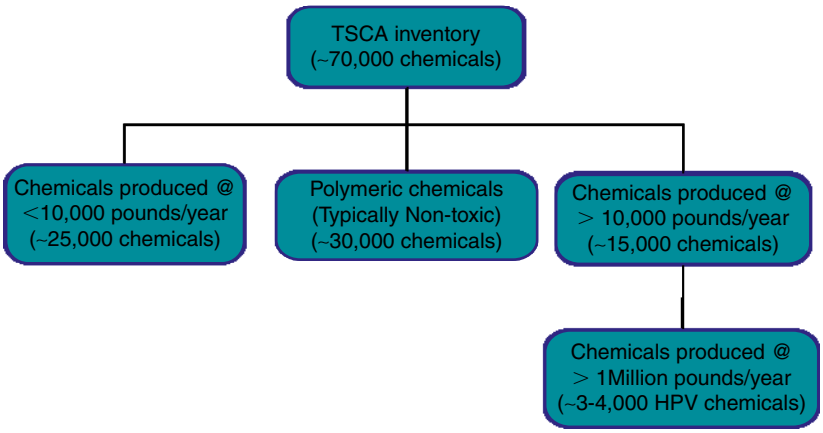


FIGURE 70.1 Regulation under TSCA

Food Quality Protection Act (FQPA).[11] A pesticide is defined in FIFRA as 'any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest, … intended for use as a plant regulator, defoliant or desiccant, and … any nitrogen stabilizer.'[12] FIFRA prohibits the distribution or sale of any pesticide that is not registered with EPA.[13] The FIFRA registration process requires the submission of data on the toxicity and environmental impacts of the pesticide sufficient for EPA to determine that it will perform its intended function without unreasonable adverse effects to the environment when used in accordance with common practice.[14] FIFRA also requires that pesticide products bear labels approved by the EPA which include the approved use for the pesticide, directions for use necessary to effect its approved use, its active ingredients and such warnings as EPA deems necessary to protect health and the environment.[15] It is a violation punishable by civil or criminal penalties to 'misbrand' a pesticide with an inadequate label or to use a pesticide in a manner inconsistent with its label.[16]

The pesticide provisions of the FFDCA authorize EPA to set maximum pesticide residue levels in food and feed crops. Any pesticide residue in or on a food is deemed under FFDCA to be unsafe unless a pesticide residue tolerance level has been established by EPA for the pesticide and the residue is within an applicable tolerance level established by EPA or unless the residue is otherwise exempt from the tolerance requirements.[17] A pesticide residue at a given tolerance level may be deemed by EPA to be 'safe' if EPA has 'determined that there is a reasonable certainty that no harm will result from aggregate exposure to the pesticide chemical residue, including all anticipated dietary exposures and all other exposures for which there is reliable information.'[18] Foods that have pesticide residue levels that exceed EPA-specified tolerances are deemed to be 'adulterated' and may not be sold in interstate commerce or imported into the United States.[19]

In 1996, the FQPA amended FIFRA and FFDCA to impose more stringent pesticide residue tolerance levels especially to limit the exposure of infants and small children to pesticide residues on food. The FQPA necessitated commencement of an ongoing reevaluation of the tolerance levels previously established under the FFDCA and a reregistration under FIFRA. The FQPA repealed the previous standard for setting pesticide residue tolerances which had included consideration of the impact of tolerances on the 'production of an adequate, wholesome, and economical food supply' and replaced it with the current standard which is solely based on health impacts.

A regulatory program with a unique impact on regulation of chemicals in the United States is the Proposition 65 program in California. Proposition 65 was a citizen initiative petition placed on the ballot in California and enacted into law in 1986. Proposition 65 prohibits the discharge or release into water or onto or into land of any chemical known to the state to cause

[11]The FQPA amended both FIFRA and FFDCA in 1996 to correct certain inconsistencies between the two regulatory programs and to impose more stringent standards for pesticide residues in food. Pub. L. 104–170, 110 Stat. 1489 (1996).

[12]7 U.S.C. § 136(u).

[13]7 U.S.C. § 136a(a).

[14]7 U.S.C. § 136a(c)(5)(C).

[15]7 U.S.C. § 136(p).

[16]7 U.S.C. §§ 136j, 136l.

[17]21 U.S.C. § 346a(a)(1).

[18]21 U.S.C. § 346a(b)(2)(A).

[19]21 U.S.C. § 334.

cancer or reproductive toxicity and precludes intentionally exposing any individual to such chemicals without first giving clear and reasonable warning to the individual.[20] By its terms it applies only to activities in California but, because California is such a large portion of the market for goods in the United States, its impact is quite extensive as any enterprise seeking to do business in California must comply with its terms for its activities within the California border, which often has a spill-over effect on the non-California markets targeted by such enterprises.

Proposition 65 requires the Governor to publish and annually maintain a list of chemicals known to the state to cause cancer or reproductive toxicity.[21] The warning requirements of Proposition 65 apply to all businesses with 10 or more employees unless the business can prove that the exposure falls below certain risk-derived limits.[22] Proposition 65 authorizes private individuals to bring suit to enforce its provisions and to collect a portion of any penalties (of up to $2500 per day per violation) recovered in such an enforcement action, which has prompted a significant amount of entrepreneurial litigation by plaintiff's lawyers and environmental groups.[23]

'SAFE' LISTS

Some chemicals can be used without regulatory intervention if they are 'generally recognized as safe' (GRAS) for specified uses or any for use or grandfathered as such via the TSCA Inventory (i.e., documented as used prior to TSCA, 1977). FDA maintains a GRAS list for food ingredients and specific uses, has published Monographs for ingredients' safe uses (e.g., sunscreens, antimicrobials, over-the-counter (OTC) products), and maintains a process for adding food materials to its GRAS list via either regulatory notification or an external review process. The monographs specify product and chemical testing and use requirements, packaging, labeling, safe levels, and stability, efficacy, and safety testing for materials with a long history of safe use.

COMPLIANCE

If not allowed or exempted as noted above, many chemicals must be registered, petitioned, notified, or tracked and reported. Some of this compliance involves testing and some does not. FDA must be petitioned for new drug applications or new food additives. Pesticides must be registered with U.S. EPA under FIFRA. Environmental and safety assessments are required along with approval of usage, packaging, and labeling and companies must wait for affirmative responses from the agencies before putting the materials in commerce.

TSCA requires notification for any new chemical manufacture or import (PMN) in a product or mixture but an agency-affirmative response is not required. If the agency takes no action within 90 days of notification, the chemical can be commercialized without restriction. All available safety and property information must be submitted but many PMNs do not submit specific safety studies and EPA performs its own fate/effect modeling, often from structure–activity modeling. However, EPA does often require safety studies for high-volume, widely exposed chemicals. Sometimes EPA will stop the 90-day clock, asking for more safety data, or will approve limited uses with consideration of expanded uses via a Consent Order or 'significant new use rule' (SNUR) process. EPA maintains a list of chemical 'categories of concern' with recommended safety testing, which facilitates the notification review for new chemicals within those categories.

TSCA notification is somewhat relaxed for other chemical categories, including polymers, limited use or risk chemicals, and R&D chemicals.

REGULATION DEVELOPMENT

Earlier sections of this chapter have described the provisions of several of the most significant federal laws governing chemicals in the United States, e.g., TSCA, FFDCA, FIFRA. Each of these statutes either identifies an executive branch agency responsible for implementation of the statutory provisions or authorizes the President to designate such an agency.[24]

[20]Cal. Code § 25249.6.

[21]Cal. Code § 25249.8. The list of designated chemicals can be found at Cal. Code Regs. Tit. 22, § 12000.

[22]For carcinogens, the limit is the level of exposure expected to result in one excess lifetime case of cancer per 100 000. For reproductive toxins, the limit is the level of exposure that will have no observable effect assuming exposure at one thousand times the level in question, i.e., the exposure level limit is 1/1000th of the no observable effect level.

[23]Cal. Code § 25249.7 (authorizing 'actions brought by any person in the public interest' upon 60 days prior notice to the attorney general and the relevant district attorney or city attorney). See Cal. Code § 25192 (specifying apportionment of penalties collected under Proposition 65).

[24]For examples, see www.fda.gov/oc/mous/domestic/225-79-2001.html and www.fda.gov/oc/mous/domestic/225-85-8400.html.

In turn, each of the statutes either authorizes or requires the responsible agency to develop regulations that further articulate and make specific the general legal requirements set forth by Congress in the statute.[25]

Although the language of the laws passed by Congress is binding upon entities whose activities fall within the scope of the statutory language, that language may not be sufficiently detailed or specific to be apparent to such entities that their activities are subject to limitations under penalty of law. Thus, the executive agencies are charged with 'putting flesh onto the bones' of the general mandates articulated in statutes, translating them into very specific requirements which direct the regulated community to conduct its activities consistently with the regulations or face legal sanctions for violation of the statutes and their associated suite of regulations. The primary mechanism at the federal level for adopting and enforcing these regulations is the process of administrative agency rulemaking.

The most commonly employed rulemaking process, 'informal rulemaking,'[26] has three fundamental components: adequate notice of proposed regulations to those potentially affected by the rulemaking, receipt of comments from interested parties on the proposed rule and publication of the final rule with a statement of the basis and purpose of the rule.[27] First, an agency engaged in rulemaking is required to publish a 'notice of proposed rulemaking' in the Federal Register or otherwise provide actual advance notice to persons who would be subject to the contemplated rulemaking.[28] The notice must include the time, place, and nature of the rulemaking proceedings; it must identify the legal authority under which the rule is proposed; and it must describe the terms or substance of the proposed rule or the subjects or issues involved.[29] 'The rule of thumb is that the notice must "fairly appraise interested persons of the subjects and issues the agency was considering."' (Amon & Mayton, p. 49). The notice of proposed rulemaking must describe the substance of what is being proposed and the underlying factual, legal, and technical bases for the proposal.

The second element of informal rulemaking is the requirement that, '[a]fter [provision of the required] notice, the agency shall give interested persons an opportunity to participate in the rule making through submission of written data, views, or arguments with or without opportunity for oral presentation.'[30] This requires the agency to allow interested persons to comment on the proposed rule, usually during a specified period after the notice of proposed rulemaking during which the agency will accept written comments and submissions concerning the proposal. Solicitation of comments is intended to improve the rulemaking by providing the agency with the benefit of awareness of 'the actual values and interests of the people subject to the action [to] "assure[e] that the agency will have before it the facts and information relevant to a particular administrative problem, as well as suggestions for alternative solutions."' (Amon & Mayton, p. 54).

The third element of informal rulemaking is the requirement that '[a]fter consideration of the relevant matter presented, the agency shall incorporate in the rules adopted a concise general statement of their basis and purpose.'[31] Although this requirement is stated in rather spare terms, it has come to be viewed by agencies and courts reviewing rulemakings as requiring that the rulemaking agency provide a comprehensive description of the enacted rule, a detailed summary of the major comments and criticisms of the proposed rule submitted by interested persons, a detailed description of how the agency took into account or rejected the comments, a description of the factual and evidentiary basis for the rule, an explication of the agency's rationale and methodology for evaluating the impacts of the rule, a legal analysis of the statutory authority for the provisions of the rule and of how the rule effectuates the purposes of the statute and the rulemaking, and an explanation of how and why the final rule differs from the initial proposal, based on identified material made available for review during the rulemaking process. Thus, the 'concise general statement of … basis and purpose' has become an 'extremely demanding judicial definition' of comprehensive documentation required of the agency to justify being upheld by a court reviewing the agency's rulemaking process (Pierce, p. 440).

In summary, the process of informal rulemaking, through which the detailed regulations governing chemicals at the federal level in the United States are developed by executive branch agencies, requires fair

[25]For examples, see www.fda.gov/oc/mous/domestic/225-79-2001.html and www.fda.gov/oc/mous/domestic/225-85-8400.html.

[26]Informal rulemaking is the predominant form of rulemaking used by federal agencies. 'Formal rulemaking' is distinguished from informal rulemaking by addition of a formal hearing conducted by the agency to gather evidence and data which may include issuance of subpoenas, witness testimony taken under oath and other formal procedures akin to judicial hearings. Formal rulemaking, in the rare instances when it occurs, is usually specifically required by statute.

[27]These elements are set out in the Administrative Procedure Act, 5 U.S.C. §§ 551 et seq, §§ 553(b)(1), (2) and (3).

[28]5 U.S.C. § 553(b).

[29]5 U.S.C. §§ 553(b)(1), (2) and (3).

[30]5 U.S.C. § 553(c).

[31]5 U.S.C. § 553(C).

notice, a comprehensive announcement of the agency's intentions and bases for its intentions in the notice of proposed rulemaking. The process next requires acquiescence to a broad outreach requesting input to the agency's decision-making process from the public by soliciting, accepting, considering, and evaluating comments from all interested parties. Finally, the agency is required to make a demonstrably rational decision, by fully utilizing the information placed at its disposal through the comment process, carefully documenting and explaining the derivation or deviation of its rulemaking decision from the concerns expressed in all of the sources of information, data, analysis, and legal authority cited to it during the comment period.

INFORMATION RESOURCES

Table 70.3 is a list of agencies of the 50 States that oversee independently or by Federal authorization chemical or product issues, in addition to running environmental programs. In some cases, such as California under its Proposition 65 initiative, information related directly to chemical product safety is provided. In other cases, the State's environmental and public health agency information is provided.

Table 70.4 provides a list of national and federal agency information pertinent to chemical product safety issues.

TABLE 70.3 Information Resources: State Environmental and Chemical Protection Agencies

State	Agency Name	Phone Number	Website
AL	Dept. of Environmental Management	334-271-7700	www.adem.state.al.us/
AL	Dept. of Conservation and Natural Resources	334-242-3486	www.outdooralabama.com/
AK	Dept. of Environmental Conservation	907-465-5066	www.dec.state.ak.us/
AZ	Dept. of Environmental Quality	602-771-2300	www.azdeq.gov/
AZ	Game & Fish Department	602-942-3000	www.gf.state.az.us/
AR	Dept. of Environmental Quality	501-682-0744	www.adeq.state.ar.us/
CA	Air Resources Board	800-242-4450	www.arb.ca.gov/homepage.htm
CA	Dept. of Conservation	916-322-1080	www.consrv.ca.gov/index/
CA	Dept. of Toxic Substances Control	916-324-1826	www.dtsc.ca.gov/
CA	Dept. of Water Resources	916-653-5791	www.dwr.water.ca.gov/
CA	Environmental Protection Agency	916-323-2514	www.calepa.ca.gov/
CA	Integrated Waste Management Board	916-341-6000	www.ciwmb.ca.gov/
CO	Dept. of Public Health and Environment	303-692-2000	www.cdphe.state.co.us/index.html
CT	Dept. of Environmental Protection	860-424-3000	http://dep.state.ct.us/
DE	Dept. of Natural Resources and Environmental Control	302-739-9000	www.dnrec.delaware.gov/
DC	Dept. of Health, Environmental Health Administration	202-535-2500	http://doh.dc.gov/doh/cwp/view,a,3,q,573184,dohNav_GID,1802,dohNav,|33200|33215|.asp
FL	Dept. of Environmental Protection	850-245-2118	www.dep.state.fl.us/
GA	Dept. of Natural Resources	404-656-3500	www.gadnr.org/
GA	Environmental Protection Division	404-657-5947	www.gaepd.org/
HI	Dept. of Land and Natural Resources	808-587-0405	www.hawaii.gov/dlnr/
ID	Dept. of Environmental Quality	208-373-0502	www.deq.state.id.us/
ID	Dept. of Water Resources	208-287-4800	www.idwr.state.id.us/
IL	Environmental Protection Agency	217-782-7860	www.epa.state.il.us/
IL	Pollution Control Board	312-814-3620	www.ipcb.state.il.us/
IN	Dept. of Environmental Management	317-232-8603	www.ai.org/idem/
IN	Dept. of Natural Resources	317-232-4020	www.state.in.us/dnr/
IA	Dept. of Natural Resources	515-281-5918	www.iowadnr.com/
KS	Dept. of Health and Environment	785-296-1500	www.kdheks.gov/
KY	Environmental Quality Commission	502-564-2150 x194	www.eqc.ky.gov/
KY	Dept. of Natural Resources	502-564-6940	www.dnr.ky.gov/
KY	Dept. of Environmental Protection	502-564-2225 x196	www.dep.ky.gov/
LA	Dept. of Environmental Quality	225-219-5337	www.deq.louisiana.gov/portal/
ME	Dept. of Environmental Protection	207-287-7688	www.state.me.us/dep/index.shtml
MD	Dept. of the Environment	410-537-3000	www.mde.state.md.us/

(*Continued*)

TABLE 70.3 Continued

State	Agency Name	Phone Number	Website
MD	Dept. of Natural Resources	410-460-8367	www.dnr.state.md.us/sw_index_flash.asp
MA	Dept. of Environmental Protection	617-292-5500	www.mass.gov/dep/dephome.htm
MI	Dept. of Environmental Quality	517-373-7917	www.michigan.gov/deq
MN	Dept. of Natural Resources	651-296-6157	www.dnr.state.mn.us/index.html
MN	Pollution Control Agency	651-296-6300	www.pca.state.mn.us/index.cfm
MS	Dept. of Environmental Quality	601-961-5171	www.deq.state.ms.us/MDEQ.nsf/page/Main_Home?OpenDocument
MO	Dept. of Natural Resources	573-751-3443	www.dnr.mo.gov/
MO	Dept. of Conservation	573-522-4115	http://mdc.mo.gov/
MT	Dept. of Environmental Quality	406-444-2544	www.deq.state.mt.us/index.asp
MT	Natural Resource Information System/GIS Data Library	406-444-3115	http://nris.mt.gov/
NE	Dept. of Environmental Quality	402-471-2186	www.deq.state.ne.us/
NV	Division of Forestry	775-684-2500	www.forestry.nv.gov/
NV	Dept. of Conservation and Natural Resources	775-684-2700	http://dcnr.nv.gov/
NV	Division of Environmental Protection	775-687-4670	http://ndep.nv.gov/
NH	Dept. of Environmental Sciences	603-271-3503	www.des.state.nh.us/
NJ	Dept. of Environmental Protection	609-292-2885	www.state.nj.us/dep/
NM	Environment Dept.	505-827-2855	www.nmenv.state.nm.us/
NY	Dept. of Environmental Conservation	518-402-8540	www.dec.state.ny.us/
NC	Dept. of Environment and Natural Resources	919-733-4984	www.enr.state.nc.us/
NC	Div. of Pollution Prevention and Environmental Assistance	919-715-6500	www.p2pays.org/
NC	Geographic Information North Carolina	919-733-2090	www.cgia.state.nc.us/
ND	State Water Commission	701-328-2750	www.swc.state.nd.us/4dlink9/4dcgi/redirect/index.html
ND	Geological Survey Division	701-328-8000	www.state.nd.us/ndgs/
ND	Dept. of Health – Environmental Health Section	701-328-5150	www.health.state.nd.us/ehs/
OH	Environmental Protection Agency	614-644-3020	www.epa.state.oh.us/
OH	Air Quality Development Authority	614-224-3383	www.ohioairquality.org/
OK	Conservation Commission	405-521-2384	www.okcc.state.ok.us/
OK	Dept. of Environmental Quality	405-702-1000	www.deq.state.ok.us/
OR	Dept. of Environmental Quality	503-229-5696	www.deq.state.or.us/
OR	Dept. of Fish and Wildlife	503-947-6000	www.dfw.state.or.us/
PA	Dept. of Environmental Protection	717-783-2300	www.depweb.state.pa.us/dep/site/default.asp
PA	Dept. of Conservation and Natural Resources	717-787-2869	www.dcnr.state.pa.us/
RI	Dept. of Environmental Management	401-222-6800	www.dem.ri.gov/
SC	Dept. of Health and Environmental Control	803-898-3432	www.scdhec.net/
SC	Dept. of Natural Resources	803-734-4007	www.dnr.sc.gov/
SD	Dept. of Environment and Natural Resources	605-773-3151	www.state.sd.us/denr/denr.html
TN	Dept. of Environment and Conservation	615-532-0109	www.tennessee.gov/environment/
TX	Commission on Environmental Quality	512-239-1000	www.tceq.state.tx.us/
TX	City of Dallas Air Pollution Control	214-948-4435	www.dallasair.org/
UT	Dept. of Environmental Quality	801-536-4402	www.deq.utah.gov/
UT	Automated Geographic Reference Center	801-538-3665	http://agrc.its.state.ut.us/
VT	Agency of Natural Resources	802-241-3600	www.anr.state.vt.us/
VA	Dept. of Environmental Quality	804-698-4000	www.deq.virginia.gov/
WA	Dept. of Ecology	360-407-6000	www.ecy.wa.gov/
WA	Dept. of Natural Resources	360-902-1004	www.dnr.wa.gov/
WA	Dept. of Transportation's Environmental Services	360-705-7483	www.wsdot.wa.gov/environment/default.htm
WV	Dept. of Environmental Protection	304-926-0440	www.dep.state.wv.us/
WI	Dept. of Natural Resources – Environmental Protection	608-266-2621	www.dnr.state.wi.us/Environment.html
WY	Dept. of Environmental Quality	307-777-7937	http://deq.state.wy.us/

TABLE 70.4 Federal/National Environmental and Chemical Regulatory Information

Information	Organization	Phone	Web	Materials/Issues Covered
Product Safety Letter	Washington Business Information, Inc	703.247.3421	via Newsnet	CPSC biweekly update
Regulatory Watchdog Service	Washington Business Information, Inc	703.247.3421	via Newsnet	FTC weekly update
Inside EPA Risk Policy Report	Inside Washington Publishers	703.416.8500		EPA science and risk policies
FDA Week	Inside Washington Publishers	703.416.8500		FDA policy, regulations, and enforcement activities
The Rose Sheet	F-D-C Reports, Inc.	800-332-2181	http://www.fdcreports.com	FDA activities on toiletries, fragrances, and skin care industry
The Tan Sheet	F-D-C Reports, Inc.	800-332-2181		Nonprescription pharmaceutical and nutrition
The Pink Sheet	F-D-C Reports, Inc.	800-332-2181		Prescription pharmaceutical and biotechnology
Pesticide and Toxic Chemical News	CRC Press	202-887-6320		EPA – FIFRA and TSCA weekly tracking
Food Chemical News	CRC Press	202-887-6320		FDA – food chemical weekly update
Food Chemical News Guide	CRC Press	202-544-1980		FDA food and color additives with summary of regulatory status
Pesticide Chemical News Guide	CRC Press	202-887-6320		Tolerances, interim tolerances, action levels, and proposed tolerances for pesticide residues in food and feed
Food Labeling and Nutrition News	CRC Press	202-887-6320		Dietary supplements, dietary guidelines, packaging, and food regulatory issues
TSCA Compliance Guide and Service	John Wiley & Sons	212-850-6479		Rules and compliance guidance
Food and Drug Library	HIS Health Information	800-525-5539	http://www.ihshealth.com	Legislation, federal manuals, guidance documents, and warning letters for food, drugs, cosmetics and medical devices
FDLI's Compilation of Food and Drug Laws (1996)	Food and Drug Law Institute	202-371-1420	http://fdli.org	Major laws affecting the food and drug industry
Requirements of Laws and Regulations Enforced by the U.S. FDA ("Blue Book") (1997)	Government Printing Office	202-512-1800		Principal requirements of laws enforced by FDA
CTFA Cosmetic Ingredient Dictionary, 5th ed. (1996, November)	Government Printing Office	202-512-1800		Nomenclature for ingredient labels
Food Additive Petitions: Information and Guidance	Food and Drug Administration, Office of Premarket Approval	202-418-3100	http://www.cfsan.fda.gov/~dms/opa-guid.html	Regulations and agency guidelines on petitions for food and color additives and GRAS affirmation
Food Laws and Regulations Division	Institute for Food Technologies			Legislation, regulations, and guidance documents on food law
Toxic Substances & Pesticides Regulation Deskbook	Environmental Law Institute	800-433-5120		TSCA and FIFRA analyses and guidance, EPA documents and reference material
Chemicals in Progress Bulletin	Office of Pollution Prevention and Toxics (OPPT) – TSCA Assistance Office	202-554-1404	http://www.epa.gov/docs/opptintr/library/pubs/archive/cip/	EPA's TSCA and SARA activity updates
Chemical Substances Control	The Bureau of National Affairs	800-372-1003	http://bna.com or via LexisNexis	Compliance reference
Chemical Regulations Reporter	The Bureau of National Affairs	800-372-1003	http://bna.com or via LexisNexis	Rules and updates on federal and state activity
Index to Government Regulation	The Bureau of National Affairs	800-372-1003	http://bna.com or via LexisNexis	Index to all chemical federal regulations
Occupational Safety and Health Reporter	The Bureau of National Affairs	800-372-1003	http://bna.com or via LexisNexis	Rules and updates

(*Continued*)

TABLE 70.4 Continued

Information	Organization	Phone	Web	Materials/Issues Covered
Product Safety and Liability Reporter	The Bureau of National Affairs	800-372-1003	http://bna.com or viaLexisNexis	CPSC rules and updates
Toxic Substances and Control Primer: Federal Regulation of Chemicals in the Environment	The Bureau of National Affairs	800-372-1003	http://bna.com or viaLexisNexis	Major environmental chemical control laws and regulations
Environmental Law Index to Chemicals, 1996 ed.	Government Institutes	301-921-2300		Guide to regulations by chemical
Book of Lists for Regulated Hazardous Substances, 1996 Edition	Government Institutes	301-921-2300		90 regulatory lists covering RCRA, CERCLA, CAA, CWA, SDWA, TSCA, OSHA, and FIFRA
CFR Chemical Lists on CD-ROM	Government Institutes	301-921-2300		CD-ROM version of *Book of Lists*
Federal Insecticide, Fungicide, and Rodenticide Act: Compliance/Enforcement Guidance Manual	Government Institutes	301-921-2300		FIFRA guidance
Toxicology Handbook	Government Institutes	301-921-2300		EPA handbook for regional officers
Chemical Data for Workplace Sampling & Analysis (OSHA's Chemical Information File, 1996)	Government Institutes	301-921-2300		Database on 1400 regulated chemicals on disk
IRIS-CD: EPS's Integrated Risk Information System	Government Institutes	301-921-2300		EPA database with risk assessment information for 500 chemicals
Hazard Communication Guide	J.J. Keller & Associates	800-558-5011		
Right-to-Know Training Kit	J.J. Keller & Associates	800-558-5011		OSHA requirements
Prop.65 News	American Environmental Institute	800-277-6765	http:www.prop65news.com	Proposition 65 litigation, regulation, and issues
Proposition 65 Compliance	California Chamber of Commerce, 1994	916-444-6670		Proposition 65
International Chemical Regulatory Monitoring System (ICRMS)	Ariel Corporation	301-907-7771		Summary of chemical regulations searchable by name, CAS number, molecular formula, and synonym
Roytech	Ariel Corporation	301-907-7771		Updates of chemical regulations searchable by chemical name and CAS number
U.S. Code on CD-ROM	U.S. Government Information for Business Publications, Periodicals, Electronic Products	202-512-1800		All 50 titles
Managing Consumer Complaints: Responsive Business Approaches to Consumer Needs, 1992	U.S. Government Information for Business Publications, Periodicals, Electronic Products	202-512-1800		Procedures for reviewing and responding to consumer complaints, meeting federal and state regulatory requirements
Consumer Product Safety: Responsive Business Approaches to Consumer Needs	U.S. Government Information for Business Publications, Periodicals, Electronic Products	202-512-1800		Review of product safety and liability laws, regulation and guidance for a product safety program
Environmental Science and Methods Information	U.S. Government Information for Business Publications, Periodicals, Electronic Products	202-512-1800		EPA rules, chemicals, waste, environmental health, and enforcement
Code of Federal Regulations	Federal Government		http://www.gpoaccess.gov/cfr/index.html	
Consumer Product Safety Commission	Federal Government		http://www.cpsc.gov	
EPA	Federal Government		http://www.epa.gov	Environmental regulations and TSCA
TSCA Hotline	Federal Government	202-554-1404		TSCA information
Office of Prevention, Pesticides and Toxic Substances (OPPT)	EPA		http://www.epa.gov/oppt/	Administration of TSCA, pollution prevention, reducing chemical risk, educating public about chemical risk

(*Continued*)

TABLE 70.4 Continued

Information	Organization	Phone	Web	Materials/Issues Covered
Information Materials for the Food and Cosmetics Industry	FDA Center for Food Safety and Applied Nutrition			Catalog of publications and other materials available from the FDA and other agencies and nongovernmental sources
FDA's Food and Cosmetic Regulatory Responsibilities	FDA Industry Activities Staff	202-205-5251	http://vm.cfsan.fda.gov/~dms/regresp.html	Summary of regulation of manufacturing and distribution of food and cosmetic products within and imported to the United States
Cosmetic Handbook (August 1995)				

CHAPTER

71

Hazard Communication

Michele R. Sullivan

INTRODUCTION

Chemical information is the foundation of workplace chemical safety programs – without it, sound management of chemicals cannot occur. Hazard communication works to reduce chemical illnesses and injuries by ensuring that workers and those who provide protections for workers – physicians, nurses, industrial hygienists, safety engineers, and other professionals – have the information they need about chemicals to devise protections. Selection of appropriate engineering controls, personal protective equipment, and controls such as substitution, is predicated on knowing what chemicals are present, what form they are present in, and what their hazardous effects are, including physical and chemical characteristics.

Hazard communication is based on identification and transmittal of available information on chemical products. Over the last decades, the availability of chemical information in workplaces has increased dramatically, and the provision of labels and material safety data sheets (MSDS) with products has become a standard business practice. There is a whole generation of employers and employees now who have never worked in a situation where information about the chemicals in their workplace is not available. Initially, hazard communication focused on health and physical hazards and related information on safe handling. Gradually, the scope of hazard communication has broadened to include environmental hazards and regulatory information.

BACKGROUND

OSHA published its Hazard Communication Standard (HCS) on November 25, 1983. The OSHA HCS requires chemical manufacturers and importers to evaluate the hazards of the chemicals they produce and distribute. The information about the hazards and associated protective measures is required to be disseminated on container labels and MSDSs. All employers with exposed employees are required to provide access to the labels and MSDSs, and to train workers. While the HCS has been amended since 1983 to include all workers exposed to chemicals, as well as to reflect new technology in information dissemination and other developments, the basic approach is still the same.

Many other countries (Canada, Europe, Korea, etc.) have also developed hazard communication laws that require information about chemicals to be prepared and communicated via MSDSs/labels to those exposed to hazardous chemicals. The regulated chemicals, the hazard definitions, the MSDS/label requirements and the use of symbols and pictograms vary in these laws. The inconsistencies between the various hazard communication laws are substantial enough that different labels and MSDSs must often be developed for the same product when it is marketed in different countries. The diverse and sometimes conflicting hazard communication requirements can create confusion among those who seek to use hazard information effectively.

In 1992 the United Nations Conference on Environment and Development, also known as the 'Earth Summit,' called for development of a globally harmonized chemical classification and labeling system. This international mandate initiated an extensive effort to develop the Globally Harmonized System of Classification and Labeling of Chemicals (GHS). It involved numerous international organizations, many countries, and extensive stakeholder representation. The GHS includes harmonized provisions for classification of chemicals for their health, physical, and environmental effects, as well as for labels and MSDSs. While the GHS has been formally accepted by the United Nations, it is considered to be a living document that will be updated as necessary to reflect new technology and scientific developments, or provide additional explanatory text.

The GHS is currently in the process of being implemented by many countries. When adopted around the world, it is anticipated that the GHS, by harmonizing and standardizing hazard communication requirements, will improve the quality and consistency of chemical hazard information, including MSDSs/labels. Employers, employees and others should benefit from adoption of the GHS through better, more standardized, and consistent information about chemicals.

WHAT IS THE CORE OF HAZARD COMMUNICATION?

Hazard assessment (also called hazard determination or classification) is the starting point for all hazard communication, especially for MSDSs which present the known hazards of a material. The assessment involves the identification of the hazards of a material by assigning a type of hazard using defined criteria. The properties, characteristics, and composition of the material affect the hazards. Hazards are communicated by MSDSs, labels, and other documents. Regulatory information is often provided on MSDSs.

Generally hazard communication incorporates a three-pronged approach: labels on containers, development of material safety data sheets, and employee training. Each of these elements is interdependent – they do not stand alone as a mechanism to communicate information. A label is the immediate source of information. It is intended to be a visual reminder for workers that the materials are hazardous, and that more detailed information is also available on the MSDSs and in training. These three aspects work together to provide a complete approach to hazard communication, ensuring that the information is provided in different ways to reinforce and explain it to those exposed.

WHAT IS THE FIRST STEP IN COMMUNICATING HAZARDS?

The first step is to collect information about the material and its components including physical, chemical, and environmental characteristics, and toxicity information. The collected information is then evaluated to determine the potential physical, health, and environmental hazards associated with the material. Until the GHS is implemented worldwide, the hazard communication regulations for each country or region must be consulted for specific requirements pertaining to hazard classification and MSDSs.

The references and sources of information used in the hazard identification should be documented. This information will provide needed internal documentation. It will also help update the hazards and MSDS, answer inquiries, and provide a historical reference.

Once the physical, health, and environmental hazards have been identified, their impact on all sections of the MSDS must be evaluated. Each of the sections in the MSDS builds on or supports the hazards identified in the hazard assessment.

WHAT IS AN MSDS?

MSDSs are reference documents. They are basically a one-stop shopping source for everything you might need or want to know about a chemical product. They are used worldwide to transmit detailed information about a chemical product, how it should be used, its effects, how to protect against those effects, what regulations apply to the chemical, and other information.

The MSDS provides information about the hazards of a product and how the material can be safely handled, used, and stored. It includes information on physical and chemical properties, physical and health hazards, routes of exposure, precautions for safe handling and use, emergency and first-aid procedures, and control measures.

The MSDS acts as a reference for the management of hazardous chemicals in the workplace. Information on an MSDS aids in the selection of safe products, helps employers and employees to handle products safely, and serves as a regulatory framework.

Generally, an MSDS has 16 sections, each with a fixed heading name. According to the GHS, information in the MSDS should be presented using the following 16 headings:

1. Product and Company Identification
2. Hazard(s) identification
3. Composition/information on ingredients

4. First-aid measures
5. Fire-fighting measures
6. Accidental release measures
7. Handling and storage
8. Exposure controls/personal protection
9. Physical and chemical properties
10. Stability and reactivity
11. Toxicological information
12. Ecological information
13. Disposal considerations
14. Transport information
15. Regulatory information
16. Other information.

WHAT RESOURCES ARE NEEDED?

In order to have complete and accurate hazard identification and communication of hazard and regulatory information on MSDSs, reliable data sources are needed. This chapter provides information sources relevant to the hazard determination and preparation of MSDSs.

Table 71.1 lists references for each of the 16 MSDS sections. These references are useful for obtaining the information necessary to compose the various sections of an MSDS, including hazard determination and regulatory information. Citations for the references are also given in Table 71.1.

ARE THERE OTHER RESOURCES FOR HAZARD COMMUNICATION?

The Society for Chemical Hazard Communication (SCHC) is a unique organization in that it focuses solely on hazard communication. SCHC's purpose is to promote effective communication of chemical hazards. The Society is committed to sharing knowledge and resources to ensure a consistent and uniform approach to assessing and communicating chemical hazards on product labels, MSDS, and other product literature and documentation.

SCHC holds meetings to provide up-to-date information on current developments and offers professional development courses to educate and provide information on hazard communication.

SCHC maintains a website at www.SCHC.org. The site contains SCHC presentations, links to hazard communication and related websites, a list of hazard communication and translation resources, and updates on legislative and standards activity concerning hazard communication.

TABLE 71.1 Hazard Communication Resources by MSDS Section

Reference	MSDS Sections															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
3M, Respirator Select http://rsel.3m.com/rsel/								X								
29 CFR 1910.1200 (and Appendices) Hazard Communication Standard (OSHA MSDS Guidance)	X	X	X	X	X	X	X	X	X	X	X					
29 CFR 1910.1001 to 1096 OSHA Carcinogens		X									X					
29 CFR 1910.1000 to 1096, Subpart Z – Toxic and Hazardous Substances [OSHA Airborne Exposure Limits – Permissible Exposure Limits (PELs)]								X								
29 CFR 1910.133 Eye and Face Protection					X			X								
40 CFR 260-263 EPA Solid and Hazardous Wastes Regulations													X			
40 CFR 302.4 CERCLA Regulations – List of Hazardous Substances and Reportable Quantities (RQ)															X	
40 CFR 355, App. A & B [SARA TITLE III Section 302] – List of Extremely Hazardous Substances and their Threshold Planning Quantities (TPQ)															X	
40 CFR 370.4 SARA TITLE III Sections 311 & 312 – Hazard categories & reporting triggers															X	
40 CFR 372.65 SARA Title III (Section 313) – List of Extremely Hazardous Substances and their Threshold Planning Quantities (TPQ)															X	
40 CFR 700-799 TSCA Regulations															X	
49 CFR 100-199, 397 Hazardous Material Transportation														X	X	
Agrochemicals Desk Reference: Environmental Data Montgomery, J.H., Lewis Publishers, Inc, Chelsea, MI												X				

(*Continued*)

TABLE 71.1 Continued

Reference	MSDS Sections															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
American Chemical Society CAS National Chemical Inventory – fee based American Chemical Society, CAS Customer Service, 2540 Olentangy River Road, Columbus, OH, US, 43210-0012, Available: CDROM; available on-line at STN-ONLINE															X	
Ansell Edmont Chemical Resistance Guide www.ansell-edmont.com/download/Ansell_7thEditionChemicalResistanceGuide.pdf					X			X								
ANSI Z87.1 American National Standard Practice for Occupational and Educational Eye and Face Protection					X			X								
ANSI Z129.1 Hazardous Industrial Chemicals – Precautionary Labeling		X		X			X									X
ANSI Z400.1 Hazardous Industrial Chemicals-MSDSs-Preparation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Ariel Insight – fee/subscription Ariel Research Corporation, 8280 Greensboro Drive, Suite 400, McLean, Virginia 22102, 1 703-663-1400.		X	X						X					X	X	
Agency For Toxic Substances & Disease Registry (ATSDR): Medical Management Guidelines, ToxFAQs, Tox Profiles www.atsdr.cdc.gov				X							X					
Australian Hazardous Substance Information System (hazard classification, R&S phrases – similar to or identical to the European Union classifications) http://hsis.ascc.gov.au/Default.aspx															X	
Australian Inventory of Chemical Substances (AICS) the AICS may be searched at: www.nicnas.gov.au/Industry/AICS/Search.asp																
National Occupational Health and Safety Commission, Worksafe Australia, 92 Parramatta Road, Camperdown, NSW, Australia 2050, 011612025659555, 011612025659555															X	
Australian Transport of Dangerous Goods Regulations http://www.ntc.gov.au/ViewPage.aspx?documentid=01147														X		
Basic Physiology and Anatomy Chaffee, E.E. and Lytle, I.M., 4, J.P. Lippincott Co., Philadelphia, PA		X									X					
Best Manufacturing Company's Comprehensive Guide to Chemical Resistant Best Gloves http://www.bestglove.com/site/chemrest//?								X								
Book of Chemical Lists Business and Legal Reports, Inc., 39 Academy Street, Madison, CT, 06443, 800-727-5257		X													X	
California Proposition 65 Latest list: www.oehha.ca.gov/prop65/prop65_list/Newlist.html		X													X	
Canadian Domestic Substance List & Non-domestic Substance List (DSL & NDSL) may be searched at http://www.ec.gc.ca/substances/nsb/search/eng/cp-search-e.c fm															X	
Canadian Ingredient Disclosure List http://www.hc-sc.gc.ca/ewh-semt/alt-formats/hecs-sesc/pdf/occup-travail/whmis-simdut/1_999-eng.pdf																
http://www.hc-sc.gc.ca/ewh-semt/alt-formats/hecs-sesc/pdf/occup-travail/whmis-simdut/1000_1736-eng.pdf			X												X	
Canadian Transport of Dangerous Goods Regulations (TDG) www.tc.gc.ca/tdg/menu.htm.														X		
Canadian Workplace Hazardous Materials Identification System (WHMIS) www.hc-sc.gc.ca/ewh-semt/occup-travail/whmis-simdut/index_e.html/index.htm		X													X	

TABLE 71.1 Continued

Reference	MSDS Sections															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
CAS Registry File-fee based STN-ONLINE, American Chemical Society, CAS Customer Service, 2540 Olentangy River Road, Columbus, OH, 43210-0012.			X												X	
Casarett and Doull's Toxicology: The Basic Science Of Poisons, NY, NY; McGraw Publishing Co.		X									X					
Canadian Center For Occupational Health And Safety (CCOHS): MSDS Database, first aid information www.ccohs.ca http://www.ccohs.ca/products/publications/firstaid/	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
CHEMFATE (Environmental Fate Data Bases) Syracuse Research Corporation, Syracuse Research Corporation (SCR), U.S. EPA, Life and Environmental Science Division, Syracuse, NY, Available On-line at: http://www/syrres.com/*esc*												X				
Chemical Hazard Response Information System (CHRIS) US Coast Guard available on-line at: http://www.chrismanual.com/		X			X	X	X		X	X	X	X	X	X		X
Chemical Protective Clothing Performance Index 2nd Edition, Forsberg, K. and Keith, L.H., 1999, ISBN: 0-471-32844-8, Wiley Publishing					X			X								
Chemical Protective Clothing, Daniel H. Anna, PhD, editor, AIHA					X			X								
Chemicals in the Environment: OPPT Chemical Fact Sheets Available: On-line at: www.epa.gov/chemfact/												X				
CHEMIDPLUS – Access through National Library of Medicine – Specialized Information Services											X				X	
Chinese Chemical Inventory www.crc-sepa.org.cn/zhengding/edinggou.htm															X	
CIR (Cosmetic Ingredient Review [CTFA]) http://www.cir-safety.org/findings.shtml									X		X					
Clinical Toxicology of Commercial Products Acute Poisoning (Gosselin) Baltimore, MD: Williams and Wilkins		X		X							X					
Code for the Manufacture and Storage of Aerosol Products, NFPA 30B		X			X											
Condensed Chemical Dictionary 14th Edition, 2001-G. Hawley, John Wiley & Sons, 111 River Street, Hoboken, NJ 07030-5774 (201-748-6000)		X							X							X
Dangerous Chemical Reactions Cahner Publishing Co., Chicago, IL, US, ISBN: 0-934-16546-9					X	X	X			X		X				
Dangerous Properties of Industrial Materials (SAX's) Lewis, Richard J., Sr, 2004, 11th Edition, John Wiley & Sons, 111 River Street, Hoboken, NJ 07030-5774 (201-748-6000) – Available book (3 volumes) and CD-ROM		X			X	X	X	X	X	X			X	X		X
DATALOG Syracuse Research Corporation (SCR)-U.S. Environmental Protection Agency, Life and Environmental Science Division, Syracuse, NY												X				
Design of Industrial Ventilation Systems 5th Edition, Alden, J.L. and Kane, J.M., 5, 1982, ISBN 0-8311-1138-0, ACGIH					X			X								
Documentation of the Threshold Limit Values and Biological Exposure Indices American Conference of Governmental Industrial Hygiensts (ACGIH), 1330 Kemper Meadow Drive, Cincinnati, OH, 513-742-2020, 513-742-3355		X	X					X			X					

(*Continued*)

TABLE 71.1 Continued

Reference	MSDS Sections															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Drinking Water Criteria Documents, EPA www.epa.gov/waterscience/standards Available on-line at www.epa.gov/ecotox/						X					X	X				
Ecotoxicity of Chemicals to Amphibians, Handbooks of Ecotoxicological Data, Volume 1 Devillers, J. and Exbrayat, J.M., 1992, ISBN: 2-88124-872-1, Gordon and Breach												X				
Ecotoxicity of Chemicals to Photobacterium Phosphoreum, Handbooks of Ecotoxicological Data, Volume 2 Kaiser, K.L.E. and Devillers, J., 1994, ISBN: 2-88124-974-4, Gordon and Breach												X				
Ecotoxicology of Organic Contaminants Bacci, K., 1993, Lewis Publishers, Inc, Chelsea, MI, US, ISBN: 1-566-70022-1												X				
e-Medicine www.emedicine.com				X												
Emergency Responder/First Responder A Skills Approach (Canadian edition). Karren, K.J., et al., 2003, Brady/Prentice Hall, Toronto				X	X	X										
Encyclopedia of Chemical Technology Kirk-Othmer, 5th edition, 2004, ISBN: 0-471-48533-5, John Wiley & Sons, NY, NY		X			X	X	X		X	X			X			
Environmental Contaminant Reference Databook, Volumes I-III, Prager, J.C., 1998, ISBN: 0-471-131459-5, John Wiley and Sons, NY, NY												X				
Environmental Health Criteria Series, WHO www.inchem.org/pages/ehc.html						X					X	X				
EPA – Envirofacts Master Chemical Integrator(EMCI) www.epa.gov/enviro/html/emci/chemref/index.html												X				
EPA-Substance Registry System http://iaspub.epa.gov/sor_internet/registry/substreg/home/overview/home.do															X	
EPA – TSCA 8(e) www.epa.gov/oppt/tsca8e/											X					
European Chemicals Bureau – EU Chemical Substance Information System http://ecb.jrc.ec.europe.eu/esis/															X	
European Community (EC) Classifications, Symbols, Risk & Safety Phrases http://ecb.jrc.ec.europa.eu/esis/index.php?PGM=ora&DEPUIS=autre http://ecb.jrc.ec.europa.eu/classification-labelling/		X									X				X	
European Community (EC) Indicative Exposure Limits (Directive 2000/39/EC) http://eur-lex.europa.eu/LexUriServ/LexUri Serv.do?un=OJ:L:200:142:0047:0050:EN:PD:(2006/15/EC): http://eur-lex.europa.eu/Lex Uri Serv/Lex Uri Serv.do?uri=OJ:L:2006:038:0036:01:EN:HTML								X								
European Inventory of Existing Commercial Chemical Substances (EINECS/ELINCS) http://ecb.jrc.ec.europa.eu.esis/index.php?PGM=ora&DEPUIS=autre															X	
Explosibility of Metal Powders Jacobson, M., Cooper, A.R. and Nagy, J., MDL Information Systems Inc., Nashville Research & Development Center, 1420 Donaldson Pike, Suite A-18, Nashville, TX, 37217, 615-366-2000, 800-635-0064					X				X							
EXTOXNET Pesticide Information Profiles (PIPs) http://ace.orst.edu/info/extoxnet/pips/ghindex.html												X				

TABLE 71.1 Continued

Reference	MSDS Sections															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Fire Fighters' Handbook of Hazardous Materials Baker, C.T., 1990, Maltese Enterprises, Inc., Indianapolis, IN, ISBN: 0-962-70520-9			X		X	X	X			X			X			
Fire Protection Guide to Hazardous Materials, NFPA 49, 325, 491, 704 National Fire Protection Association, 1 Batterymarch Park, P. O. Box 9101, Quincy, MA, 02269-9101, 800-344-3555, 800-593-6372, or http://www.nfpa.org			X		X	X	X	X	X					X		X
First Responder, a Skills Approach Limmer, D., et al. 6th ed., 2002, Brady/Prentice Hall, Englewood Cliffs, NJ.				X	X	X										
Fisher Scientific MSDSs http://www.fishersci.com/wps/portal/CMSTATIC? pagename=msds		X	X	X		X	X	X	X	X	X	X	X	X	X	
Fundamentals of Industrial Hygiene ISBN 0-87912-082-7, National Safety Council, Itasca, IL			X		X			X								
General and Applied Toxicology, Volumes I and II 3rd Edition, Ballantyne, B., Marrs, T. and Turner P., 1999, Stockton Press, NY, NY, ISBN: 1-566-70498-7		X									X					
Globally Harmonized System of Classification and Labeling of Chemicals (GHS) www.unece.org/trans/danger/publi/ghs/ghs_welcome_e.html	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
EU GHS: http://ec.europa.eu/enterprise/reach/ghs/legislation/index_en.htm Japan GHS: http://www.safe.nite.go.jp/english/ghs_index.html New Zealand GHS: http://www.ermanz.govt.nz/hs/compliance/chemicals.html Goldfrank's Toxicologic Emergencies 7th ed. Goldfrank, L., et al., 2002, The McGraw-Hill Companies, Inc.				X												
Groundwater Chemicals Desk Reference Montgomery, J.H. and Welkom, L.M., 2000, Lewis Publishers, Inc, Chelsea, MI, ISBN: 1-566-70498-7						X						X	X			
Guide to Occupational Exposure Values, ACGIH								X								
Guide to Protective Clothing, ACGIH					X			X								
Handbook of Acute Toxicity of Chemicals to Fish and Aquatic Invertebrates Johnson, W.W., 1980, U.S. Dept. of the Interior, Fish and Wildlife Service, Washington, DC												X				
Handbook of Chemical Property Estimation Methods, Environmental Behavior of Organic Compounds Lyman, W.J., Reehl, W.F. and Rosenblatt, D.H., 1990, American Chemical Society, Washington, DC						X						X	X			
Handbook of Chemistry and Physics 85th Edition, 2004, ISBN: 0-841-21761-0, CRC Press, Boca Raton, FL									X							
Handbook of Ecotoxicology, 2nd Edition – Hoffman, et al												X				
Handbook of Environmental Data on Organic Chemicals Verschueren, K., 4, 2001, Wiley-Interscience												X				
Handbook of Environmental Fate and Exposure Data For Organic Chemicals. Vol I–V Lewis Publishers, Inc, Chelsea, MI												X				
Handbook of Reactive Chemical Hazards 6th Edition, Bretherick, L., 1999, ISBN: 0-750-63605-X, Butterworth & Co., London, England		X			X	X	X			X			X			
Handbook of Toxic and Hazardous Chemicals and Carcinogens 4th Edition, Sittig, M., 2002, ISBN: 0-815-51459-X, Noyes Data Corp., Park Ridge, NJ		X			X	X	X			X			X			

(*Continued*)

TABLE 71.1 Continued

Reference	MSDS Sections															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Handbook on the Toxicology of Metals, Vol. I & II Friberg, L., Nordberg, G.F. and Voul, V.B., 2nd Edition, 1986, Elsevier, Amsterdam, Netherlands		X									X					
Handbook on Toxicity of Inorganic Compounds Seiler, H.G., Sigel, H. and Sigel, A., 1987, Macel Dekker, Inc., NY, NY		X									X					
Hazardous Chemicals Database http://ull.chemistry.uakron.edu/erd/sources.html												X				
Hazardous Chemicals Desk Reference Lewis, R.J., 5th Edition, 2002, ISBN 0-471-44165-1, J. Wiley & Sons, NY, NY		X			X	X	X	X	X	X			X	X		X
Hazardous Materials Identification System (HMIS®) NPCA, 1500 Rhode Island Ave., NW, Washington, DC, 20005, 202-462-6272, Available through J.J. Keller and Associates, 3003 West Breezwood Lane, Neenah, WI 54956 – 877-564-2333.																X
Hazardous Substances Databank (HSDB®) http://toxnet.nlm.nih.gov/		X	X	X	X			X	X		X	X			X	
Illustrated Handbook of Physical-Chemical Properties and Environmental Fate for Organic Chemicals Volumes 1-5 Mackay, D., Shiu, W.Y. and Ma, K.C., 1997, Lewis Publishers, Inc, Chelsea, MI						X						X	X			
Industrial Hygiene and Toxicology Patty, F.A. (ed), 5th Edition, 2001, J. Wiley & Sons, NY, NY		X	X		X			X			X					
Industrial Hygiene Engineering Talty, J.T., 1989, ISBN 0-8755-1175-2, Noyes Publications					X			X								
Industrial Ventilation: A Manual of Recommended Practice, AIHA					X			X								
Industrial Ventilation: Engineering Principles Heinsohn, R.J., 1991, ISBN 0-471-63703-3, Wiley Publishing					X			X								
Integrated Risk Information System (IRIS), EPA www.epa.gov/iris/index.html http://www.toxnet.nlm.nih.gov/		X									X					
International Chemical Safety Cards http://www.cdc.gov/niosh/ipcs/nicstart.html http://www.cdc.gov/niosh/ipcs/icstart.html		X		X				X	X							
IUCLID Chemical Data Sheets Information System http://ecb.jrc.ec.europa.eu?esis/index.php? PGM = dat	X															
Mallinckrodt Bakes Material Safety Data Sheets http://www.mallbakes.com/changecountry.asp?back = /americas/catalog/default.asp	X	X	X	X	X	X	X	X	X		X		X	X	X	X
Japanese Ministry of International Trade & Industry (MITI) Existing & New Chemical Substances List http://www.safe.nite.go.jp/english/db.html http://www.safe.nite.go.jp/data/sougou/pkc_e_search-frm.html															X	
Korean Existing Chemical List (ECL) http://newchem.nier.go.kr/eng/notification/data/inventory.html?topmenu=B http://newchem.nier.go.kr															X	
LOLI®-fee/subscription ChemADVISOR, Inc., 811 Camp Horne Road, Suite 220, Stone Quarry Crossing, Pittsburgh, PA 15237, 412-847-2000		X	X		X	X	X	X	X					X	X	X
MAPA Professional Chemical Resistance Guide (gloves) www.mapaglove.com/ChemicalSearch.cfm?id=1							X									

TABLE 71.1 Continued

Reference	MSDS Sections															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Material Safety Data Sheets (MSDSs) http://www.fishersci.com?wps?potal/CMSTATIC? page name = msds http://www.mallbaker.com/changecentury.asp? back = /americas/catalog/default.asp http://hazard.com/msds/ www.ilpi.com/msds/ www.msdsonline.com www.msds.com http://hpd.nlm.nih.gov/health.htm www.sigmaaldrich.com/catalog/search/AdvancedSearchPage? TabSelection=Documents	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Medical Toxicology 2nd Edition, Ellenhorn, M.J. and Barceloux, D.G., 1997, Elsevier Science Publishing Company, Inc., NY, NY		X									X					
MeisterPro Crop Protection Handbook www.meisterpro.com					X	X		X				X	X			
The Merck Index 17th Edition, 1999, ISBN 911910-28-X, Merck & Co., Inc., Rahway, NJ, 07065		X			X	X	X	X	X		X			X		X
Michigan Critical Materials List www.michigan.gov/documents/MR12_090100_7760_7.pdf															X	
Monographs on the Evaluation of Carcinogenic Risks to Humans, International Agency for Research on Cancer (IARC)http:// monographs.iarc.fr/		X									X					
MSA Response® Respirator Selection Guide www.msanet.com/Response/								X								
National Library of Medicine http://gateway.nlm.nih.gov/gw/Cmd http://toxnet.nlm.nih.gov/												X				
National Toxicology Program (NTP) http://cerhr.niehs.nih. gov http://ntp.niehs.nih.gov/index.cfm?objectid=72016262- BDB7-CEBA-FA60E922B18C2540		X										X				
New Jersey Right to Know http://nj.gov/health/eoh/rtkweb/index.shtml		X		X	X	X	X	X	X	X	X		X		X	
New Zealand Invertory of Chemicals (NZIOC) http://www.ermanz.govt.nz/hs/compliance/invertory.html															X	
NFPA 480 Standard for the Storage, Handling and Processing of Magnesium Solids and Powders					X				X							
NFPA 481 Standard for the Storage, Handling and Processing of Titanium					X				X							
NFPA 482 Standard for the Storage, Handling and Processing of Zirconium					X				X							
NFPA 485 Standard for the Storage, Handling, Processing and Use of Lithium Metal					X				X							
NFPA 497 Classification of Gases, Vapors and Dusts for Electrical Equipment in Hazardous (Classified) Locations					X				X							
NFPA 499 Recommendations Practice for the Classification of Combustible Dusts in Hazardous (Classified) Locations					X				X							
NFPA 651 Standard for the Manufacture of Aluminum Powder					X				X							

(*Continued*)

TABLE 71.1 Continued

Reference	MSDS Sections															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
NIOSH www.cdc.gov/niosh/srchpage.html http://www.cdc.gov/niosh/ncpc/ncpc2.html http://www.cdc.gov/niosh/unp-intrecppe.htm		X						X								
North American Emergency Response Guidebook http://phmsa.dot.govt/staticfiles/PHMSA?DownloadableFiles/Files/erg2008_eng.pdf		X			X	X							X	X		
OHS SDS fee/subscription Chem ADVISOR, Inc., 811 Camp Horne Road, Suite ZZO, Stone Quarry Crossing, Pittsburgh, PA 15237, 412-847-2000	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
OSHA Hazard Communication Standard www.osha.gov/SLTC/hazardcommunications/solutions.html				X												
OSHA Medical and First Aid www.osha.gov/SLTC/medicalfirstaid/				X												
OSHA Personal Protective Equipment www.osha.gov/SLTC/personalprotectiveequipment/index.html					X			X								
OSHA Personal Protective Equipment Respirator Web Page http://www.osha.gov/SLTC/respiratoryprotection/index.htm					X			X								
Pennsylvania Right-to-Know www.dli.state.pa.us/landi/CWP/view.asp?a=185&Q=167513															X	
Pesticide Fact Handbook, Volume 1, 2, EPA Noyes Data Corp., Park Ridge, NJ						X						X	X			
The Pesticide Manual Tomlin, C., 10, 2003, British Crop Protection Council, The Royal Society of Chemistry, Crop Protection Publications, ISBN 1901396134						X						X	X			
The Pharmacological Basis of Therapeutics Goodman, L.S. and Gilman, A.G., 10th ed, 2001, Macmillian Publishing Company, NY, NY		X									X					
Pocket Guide to Chemical Hazards www.cdc.gov/niosh/npg/npg.html		X	X	X	X	X	X	X	X	X	X		X			
A Practical Guide to Chemical Spill Response																
Hosty, J.W. and P. Foster, ISBN 0-442-00569-5, John Wiley and Sons, New York					X	X							X			
Practical Guide to Respirator Usage in Industry																
Rajhans, G.S. and Pathak, B., 2nd Edition, 2002, ISBN: 0-7506-7435-0, Butterworth Heinemann via Elsevier					X			X								
Proctor and Hughes' Chemical Hazards of the Workplace																
Hathaway, G.J., Proctor, N.H., 5th Edition, Wiley Publications, 2004, ISBN: 0-471-26883-6					X			X								
Pub Med																
www.ncbi.nlm.nih.gov/entrez/query.fcgi											X					
Quick Selection Guide To chemical Protective Clothing,																
4th Edition, Krister Forsbert, S.Z. Mandorf, 2003, J. Wiley & Sons, New York, NY, Available: Book, ISBN: 0-471-27105-5, E-Book, ISBN 0-471-46239-X ; ACGIH, Publication #9090								X								
Rapid Guide to Hazardous Chemicals in the Workplace																
Lewis, R.J., 2000, Available: Book, ISBN: 0-471-35542-9, Wiley-Interscience		X			X	X	X			X			X			
REACH – EU Registration, Evaluation, Authorisation and Restriction of Chemicals Regulation, EC/1907/2006 European Chemical Agency (ECHA) http://echa.europa.eu/home_en.sap	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

TABLE 71.1 Continued

Reference	MSDS Sections															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Registry of Toxic Effects of Chemical Substances (RTECS)																
US Government Printing Office, Superintendent of Documents, Washington, DC, 20402, 212-264-3825		X	X					X			X					
Respiratory Protection: A Manual and Guideline, AIHA						X			X							
Superfund Hotline – EPA																
800-424-9346					X	X							X			
Threshold Limit Values and Biological Exposure Indices, ACGIH								X								
TOMES® Plus																
Micromedex, Inc., 600 Grant Street, Denver, CO, 80203-3552		X	X		X	X	X	X	X	X	X	X	X	X		X
Toxic Substances Control Act (TSCA) Chemical Substance Inventory: 1985 Edition, 1990 supplement National Technical Information Service, Department of Commerce, Springfield, VA, 22161, 703-487-4650 TSCA Inventory may be searched at : http://www.epa.gov/opptints/newchems/pubs/inventory.htm															X	
TSCA 12(b) www.epa.gov/oppt/chemtest/pubs/main12b.htm															X	
TOXLINE/ TOXNET http://www.epa.gov/oppt/import-export/pubs/sec12.htm		X									X					
Transportation Regulations: ADR Regulations Concerning the International Transport of Dangerous Goods by Road (ADR) United Nations Publications, 2 UN Plaza, Room 853, NY, NY 10017 http://www.unece.org/trans/danger/publi/adr/pubdet.htm														X		
Transportation Regulations: IATA International Air Transport Association, 2000 Peel Street, Montreal, QUE, Canada, H3A 2R4 http://www.iata.org/whatwedo														X		
Transportation Regulations: IMDG International Maritime Dangerous Goods Code (IMDG), 4 Albert Embankment, London, ENG, UK, SE1 7SR www.imo.org/home.asp														X		
Transportation Regulations: TDG Canada www.tc.gc.ca/tdg/menu.htm www.tc.gc.ca/tdg/awareness/menu.htm														X		
Transportation Regulations: USDOT http://www.tc.gc.ca/tdg/menu.htm														X		
United Kingdom Exposure Limits www.hse.gov.uk/coshh/index.htm								X								
U.S. Army Environmental Database (ERED) http://el.erdc.usace.army.mil/ered/Index.cfm												X				
U. S. Code www.gpoaccess.gov/uscode/index.html	X	X	X	X	X	X	X	X	X	X	X				X	
U.S. Code of Federal Regulations – CFR www.gpoaccess.gov/cfr/index.html		X	X			X		X			X		X	X	X	
U.S. Federal Register http://www.gpoaccess.gov/fr/index.html		X	X	X		X		X				X	X	X	X	
Ventilation for Control of the Work Environment William A. Burgess, Michael J. Ellenbecker, Robert D. Treitman, ISBN: 0-471-09532-X, 2004, Wiley Publishing					X			X								

(*Continued*)

Table 71.1

TABLE 71.1 Continued

Reference	MSDS Sections															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
WHMIS Core Manual Workers' Compensation Board of British Columbia, Box 5350, Vancouver, BC, Canada, V6B 5L5 On-line at: http://www.worksafebc.com/publications/health_and_safety/whmis/pub_40_20_20_20.asp															X	
Workplace Environment Exposure Limits (WEELs) American Industrial Hygiene Association, 2700 Prosperity Avenue, Suite 250, Fairfax, VA, 22031								X								

CHAPTER

72

Professional Education

STEVEN G. GILBERT AND KATIE FREVERT

INTRODUCTION

The illiterate of the 21st century will not be those who cannot read and write, but those who cannot learn, unlearn, and relearn. Alvin Toffler

In times of change, learners inherit the Earth, while the learned find themselves beautifully equipped to deal with a world that no longer exists. Eric Hoffer

Toxicologists are confronted with two educational challenges: first, acquiring the fundamental and specialty knowledge and second, to keep pace with the rapid advances across the vast landscape of the toxicological sciences.

A career in toxicology offers a wide range of opportunities that crosses many disciplines and will provide a lifetime of challenges. Toxicology may be defined as the study of the adverse effects of chemical and physical agents on biological organisms. A challenge and attraction of toxicology is the need to integrate knowledge from basic biology, chemical and physical sciences, molecular and genomic sciences, biochemistry, neurosciences as well many other fields, depending on your specialty. Another important aspect of toxicology is evaluating the probability of harm which involves risk assessment, risk management, and risk communication. Employment opportunities in toxicology include basic research, regulatory, and safety evaluation positions. Toxicologists work in many areas such as public health, law, academic, industrial, pharmaceutical, government, or non-profit institutes. The work of a toxicologist affects almost every aspect of our lives by ensuring that what we eat, breathe, and drink is not harmful. Careful planning and attention to one's undergraduate courses, and awareness of graduate educational opportunities will enhance career opportunities. A number of national and international professional organizations have excellent detailed information on developing a career in toxicology.

We are continuously in a state of learning more about what affects environmental and human health. Professional toxicologists must constantly strive to remain current with state-of-the-art science in their education and work experience. Several of the professional societies offer continuing education programs at their national meetings. In addition there are professional certification programs.

Following is a list of career and continuing education opportunities, followed by a list of on-site and distance-learning university-affiliated programs in toxicology. The reader is encouraged to check an institution's website for updated information on its programs. Several of the professional societies also maintain extensive list of academic programs in toxicology. Information on K-12 and general public education resources in toxicology is detailed in Chapter 73, *K-12 and Public Education*. An excellent national resource that contains a broad range of information on Education, Careers, and Outreach is at the National Library of Medicine, National Institutes of Health (http://sis.nlm.nih.gov/enviro/edcotox.html#a5). Detailed information on career opportunities in toxicology was provided with permission by the Society of Toxicology.

CAREERS AND EDUCATION IN TOXICOLOGY

Society of Toxicology* – Careers in Toxicology

Overview

The Society of Toxicology (SOT) is a professional and scholarly organization that represents the great variety of scientists from academic institutions, government and industry who are practicing toxicology in the U.S. and around the world. The organization is dedicated to supporting the creation and communication of sound scientific information that reduces uncertainties in assessing risks and improves decisions regarding the health of humans, other animals, and the environment. Further information is provided on the Society's website (http://www.toxicology.org).

The SOT communicates research to diverse audiences throughout the world. SOT members publish their findings in the leading research journals, present their research at meetings and conferences, testify before government panels, serve in advisory capacities on an international basis, and conduct lectures and training programs for professionals, students, and the general public. The SOT Annual Meeting, held each year in March, is the largest of its kind in the world, with about 5000 participants, and features ground-breaking toxicology research and the exhibition of the latest in instrumentation and services.

The SOT has a strong commitment to public and professional education, offering a variety of programs including a Congressional fellowship, continuing education courses, workshops, symposia, student travel awards and student summer internships. Significant efforts are also aimed at recruiting students from under represented populations to careers in toxicology and to helping the public achieve a better understanding of toxicology. The SOT coordinates several community outreach programs, including a public forum on local issues, special training programs for K-12 teachers, and media training for toxicologists.

The SOT was founded in 1961 as a not-for-profit scientific society. It is governed by an 11-person, elected Council and managed by an administrative office in the Washington, D.C. area. There are approximately 5000 individual members from 42 countries and nearly 60 SOT Associates. The SOT's activities are highly diverse and conducted through the efforts of over 20 elected and appointed committees and task forces. The Society has established 18 specialty sections and 18 regional chapters that foster scientific exchange throughout the year.

Facts about Toxicology

'The dose makes the poison.'
'Toxicology is part of the solution.'
Toxicology … is the science that studies the harmful effects of drugs, environmental contaminants, and naturally occurring substances found in food, water, air and soil.
Toxicology … research is important for improving the health of humans, animals and their environments.
Toxicology … studies are required to ensure the safety of medicines, household and gardening chemicals, and industrial and natural chemicals to which humans and animals are frequently exposed.
Toxicology … research is intended to identify harmful effects of potential new products and to determine safe levels for approved products.
Toxicology … research also provides understanding of the mechanisms by which chemical substances cause injury, and this information can be used in the treatment of poisonings.

Career Opportunities in Toxicology

What is Toxicology?

Hardly a week goes by without hearing that a chemical may potentially threaten our health – pesticides in the food we eat, pollutants in the air we breathe, chemicals in the water we drink, toxic dump sites near our homes. Chemicals make up everything around us. Which chemicals are really dangerous? How much does it take to cause harm? What are the effects of a particular chemical? Cancer? Nervous system damage? Birth defects?

Finding scientifically sound answers to these very important questions is what toxicologists do, using the most modern molecular, genetic, and analytical techniques available. Toxicology combines the elements of many scientific disciplines to help us understand the harmful effects of chemicals on living organisms.

An additional, important aspect of toxicology is determining the likelihood that harmful effects will occur under certain exposure circumstances, sometimes called 'risk assessment.' If the risks are real, then we must be able to deal with them effectively. If the risks are trivial, then we must ensure that valuable public resources are not spent ineffectively. Such important decisions must be made with the best scientific evidence possible.

*Reproduced with permission from The Society of Toxicology; originally published by: Society of Toxicology, 1821 Michael Faraday Drive, Suite 300, Reston, Virginia 20190-5332; Tel: (703) 438-3115; Fax: (703) 438-3113; E-mail: sothq@toxicology.org; http://www.toxicology.org; SOT careers web site: http://www.toxicology.org/AI/APT/careerguide.asp.

The responsibility of the toxicologist is to:

1. Develop new and better ways to determine the potential harmful effects of chemical and physical agents and the amount (dosage) that will cause these effects. An essential part of this is to learn more about the basic molecular, biochemical and cellular processes responsible for diseases caused by exposure to chemical or physical substances;
2. Design and carry out carefully controlled studies of specific chemicals of social and economic importance to determine the conditions under which they can be used safely (that is, conditions that have little or no negative impact on human health, other organisms, or the environment);
3. Assess the probability, or likelihood, that particular chemicals, processes or situations present a significant risk to human health and/or the environment, and assist in the establishment of rules and regulations aimed at protecting and preserving human health and the environment.

Why Consider a Career in Toxicology?

Challenges

Wise use of chemicals is an essential component of the high standard of living we enjoy. The challenge to toxicologists is to ensure that we are not endangering our health or the environment with the products and by-products of modern and comfortable living. As a career, toxicology provides the excitement of science and research while also contributing to the well-being of current and future generations. Few other careers offer such exciting and socially important challenges as protecting public health and the environment.

Opportunities

With the increase in our health consciousness, as well as concern for our environment, a wide and growing variety of career opportunities exist in toxicology.

Toxicologists

participate in basic research using the most advanced techniques in molecular biology, analytical chemistry and biomedical sciences;

work with chemical, pharmaceutical and many other industries to test and ensure that their products and workplaces are safe, and to evaluate the implications of new research data; work for local and federal governments to develop and enforce laws to ensure that chemicals are produced, used and disposed of safely; work in academic institutions to teach others about the safe use of chemicals and to train future toxicologists.

Attractive Salaries and Professional Advancement

The demand for well-trained toxicologists continues to increase. Highly competitive salaries are available in a variety of employment sectors. Increasing specialization in the science of toxicology now provides the toxicologist with a competitive advantage over chemists, engineers, biologists or other scientists without specialized training in toxicology. Opportunities are available for career advancement to executive levels for those with organizational and administrative skills and a superb record of scientific achievement.

What Do Toxicologists Do?

Research

Many toxicologists, especially in academic and nonprofit institutions, are principally involved in the discovery of new knowledge concerning how toxic substances produce their effects. There are many subspecialty areas in toxicology research: chemical carcinogenesis, reproductive and developmental toxicology, neurotoxicology, immunotoxicology, inhalation toxicology, risk assessment and many others. Researchers use laboratory animals, human and animal cells in culture, and other test systems to examine the cellular, biochemical and molecular processes underlying toxic responses. Research opportunities are available for individuals employed in industry, academia and government. There are many commercial and nonprofit laboratories that also provide interesting and challenging research opportunities.

Research is considered to be 'basic' where no immediate commercial or public health application is expected, but the knowledge will add to our understanding of basic life processes. Such research is of great value in solving important and long-term problems. Examples of this would be studies of how a particular enzyme involved in the detoxification of a chemical is regulated at the gene level or how a chemical affects the rate of cell division.

Other research is considered 'applied' when the results are expected to yield direct social or commercial benefit. Examples would be studies to identify new chemicals that selectively kill certain pests or studies to determine if a particular industrial process is responsible for a specific disease identified in a population of workers. Development of antidotes for radiation injury or chemical poisoning are examples of applied research of public health importance.

Product Safety Evaluation

Many industries employ toxicologists to assist in the evaluation of the safety of their products. For therapeutic drugs, food additives, cosmetics, agricultural chemicals

and other classes of chemicals, federal laws often require that the manufacturer provide adequate testing of the product before it is released into commerce. Tests to determine if a chemical has the potential to cause cancer, birth defects, reproductive effects, neurological toxicity or other adverse effects are commonly conducted by the manufacturer.

Toxicologists involved in product safety evaluation have the responsibility to ensure that such tests are designed, conducted and interpreted in a scientifically sound manner. Information from such studies is, in turn, reviewed by toxicologists in various regulatory agencies, such as the Food and Drug Administration (FDA) and the Environmental Protection Agency (EPA), or by international organizations to ensure that the products will not present an unreasonable risk to human health or the environment.

When the information is available, toxicologists also utilize studies of human populations (the science of epidemiology) to assist in the evaluation of the safety and potential risks of the chemical products and by-products of modern society.

Teaching

Toxicologists employed in colleges and universities are involved in teaching toxicology to students and others. Because of increasing interest in the impacts of chemicals on our society, many colleges and universities offer toxicology courses at both the undergraduate and graduate level. Academic institutions that do not have graduate programs in toxicology employ toxicologists to participate in curriculum development and teach basic programs such as chemistry and biology. Thus, opportunities exist to teach toxicology in small colleges as well as major universities. One of the most important efforts of toxicologists in academic institutions is the training of future generations of toxicologists in basic and applied research, data interpretation and evaluation, and risk assessment and regulatory affairs.

Public Service, Regulatory Affairs and Consulting

An important part of any science is communicating results and discussing implications. The tremendous growth in public awareness of chemical hazards over the last two decades has resulted in the passage of many laws governing the production, use and disposal of chemicals. Many local, state and federal regulatory agencies employ toxicologists to assist in the development and enforcement of these laws. An increasingly important area of toxicology is in public communication of chemical risks. Toxicologists employed by regulatory agencies may often be called upon to explain the scientific basis for regulatory actions, or to assist in communicating to the public why regulatory actions are or are not taken in particular situations. There are many private consulting firms with expertise in toxicology that can now provide such services to local and state health departments, public utilities, private industries, etc. Thus, many employment opportunities in the private sector are available to the toxicologist interested in assisting public agencies and private industries in resolving many important public health and environmental problems. Some scientists like this aspect so much that they pursue consulting full-time.

Where Do Toxicologists Work?

The 'Job Market Survey' estimates that 9000 toxicologists are employed in North America. Of recent Ph.D.'s, 53% entered industry, 34% found positions in academia and 12% in government. These numbers are similar to overall employment statistics in the discipline as projected in the 'Job Market Survey.'

Comparison with other careers is possible by investigating the Occupational Outlook Handbook (http://www.bls.gov) produced by the U.S. Bureau of Labor Statistics.

Chemical, Consumer Products, Pharmaceutical and Other Industries

Industries are the number one employer of toxicologists (47%). Product development, product safety evaluation, and regulatory compliance generate a large job market for toxicologists. Pharmaceutical industries employ 17% of toxicologists, and chemical industries employ 7%. These industries often employ toxicologists trained at all levels of education. The 'Toxicologist Supply and Expertise Survey' found that, of recent graduates, 53% of those with Ph.D.s, 73% of those with master's degrees and 58% of those with bachelor's degrees entered industry. Many industries have their own research and product safety evaluation programs, while others may contract their work to specific research organizations that are managed independently from the industry.

Academic Institutions

Academic institutions are the number two employer of toxicologists (21%). The rapid growth in toxicology programs has generated a large and growing market for toxicologists with doctoral level training. Although most of these opportunities are in schools of medicine and/or public health in major universities, smaller colleges are beginning to employ

toxicologists to teach toxicology in basic biology, chemistry and engineering programs.

Government

Government is the third largest employer of toxicologists (14%). Although most government jobs are with federal regulatory agencies, many states are now beginning to employ toxicologists with masters or doctoral degrees.

Consulting

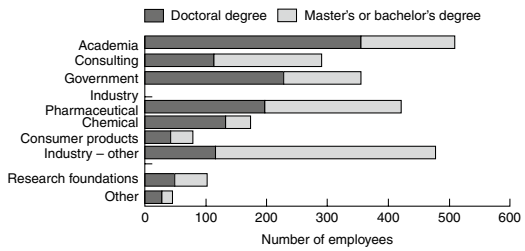
An increasing number of toxicologists are employed in the professional services industry (12%). Providing professional guidance and advice to local public agencies, industries and attorneys involved in problems with toxic chemicals is a rapidly growing activity for the experienced toxicologist. Many graduates of baccalaureate and master's programs in toxicology are finding employment with consulting firms. Individuals with doctoral training and several years of experience in applied toxicology may also find opportunities directing projects and serving as team leaders or administrators in the consulting field.

Research Foundations

A small proportion of toxicologists pursue research within nonprofit organizations (4%). Numerous public and private research foundations employ toxicologists to conduct research on specific problems of industrial or public concern. Toxicologists at all levels of education may work for these research foundations.

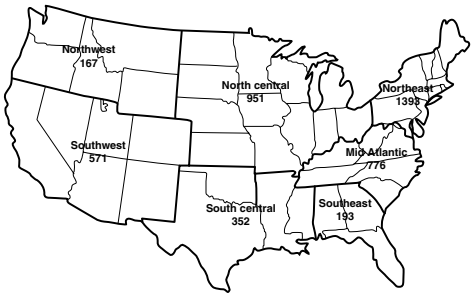
Regional Distribution of Toxicology Jobs

Although the majority of government and industry jobs are located in the eastern portion of the United States, employment opportunities at all levels are available throughout the country. The geographic distribution of SOT members in the continental United States reflects job distribution.



How Much Do Toxicologists Earn?

As with any profession, the level of education and length of experience are key determinants of salary. Entry level positions for those with doctoral degrees are often in the range of $35 000 to $60 000, with rapid advancement possible. In general, positions in industry pay slightly better than government or academia. Mid-range professionals with a Ph.D. degree and 10 years of experience can expect to earn $70 000 to $100 000 annually. Most executive positions in toxicology exceed $100 000 per year, and some corporate executive toxicologists earn $200 000 or more. Of course, salaries for those with master's and/or bachelor's degrees in toxicology will generally be less than those for individuals with doctoral degrees, but are still highly competitive with other science-based professions.



How Do I Prepare for a Career in Toxicology?

Jobs are available for recipients of associate through doctoral degrees. Candidates with two- or four-year degrees can work in toxicology as laboratory assistants, research technicians or animal care specialists.

Depending upon your career aspirations, a bachelor's degree may not be enough for you to achieve your goals. The higher the degree, the more likely your position will provide more opportunities, more responsibility and higher salaries. Of recent graduates from toxicology programs, 55% received Ph.D.s, 22% master's degrees, and 23% bachelor's degrees. According to the 'Job Market Survey,' about half of employed toxicologists have a Ph.D. Post-doctoral experience was considered an 'absolute' requirement by 29% of the employers who planned to hire toxicologists in the next few years; an additional 38% listed such experience as 'desired.' Post-doctoral training is a route to employment in toxicology for those with advanced degrees in other areas, such as the Ph.D. in other biomedical sciences, the M.D., or D.V.M.

In the 'Job Market Survey,' employers requested strong written and oral communication skills and knowledge of computers. Good laboratory practice, project management skills and statistics experience were also viewed as important. The fast pace of change

and future job market will favor workers who can demonstrate flexibility and adaptability.

High School

A strong foundation for any future scientist is based on skills in reading, writing, mathematics, computer science and communication, along with courses in biology, chemistry, and physics. Knowledge of a foreign language is important for exchanging information in our global society. Extra curricular activities such as science fairs and clubs build leadership experience. Part-time or summer work in a research laboratory is also valuable.

Undergraduate Education

If your institution does not have a baccalaureate program in toxicology, a major in biology or chemistry provides a basis for a career in this discipline. Take as many biology and chemistry courses as you can, as well as physics, computer science, statistics and mathematics (including calculus). Improve your writing and speaking skills, and develop a multidisciplinary foundation to increase your options and qualifications. While breadth in your undergraduate training is important, depth and experience provided by working in a laboratory or completing a student research project can be very important in increasing your skills and helping you determine the kind of science career that suits your interest and skills. Engage in activities that improve team-building aptitude, as well as those that improve hand–eye coordination. Join local and national scientific professional societies and participate in student-oriented events, regional and national meetings. All of these efforts will be repaid whether you enter the job market immediately after receiving your degree or pursue graduate study.

Financial Support

Information about financial aid is available on the world wide web at sites such as Financial Aid (http://www.finaid.org) and FastWeb (http://www.fastweb.com). Of special interest to members of groups underrepresented in the sciences is the Minority On-Line Information Service (MOLIS) (http://web.sciencewise.com/molis). MOLIS is a database including information on faculty and programs at about 300 minority institutions, as well as hyperlinks to other information that is of benefit to the minority education and research communities.

Preparation for Graduate Study

Careful planning and attention to your undergraduate courses will enhance your graduate education opportunities.

Most graduate toxicology programs have specific prerequisites for admission. In addition to a baccalaureate degree in a relevant field of study such as biology or chemistry, these requirements often include advanced coursework in chemistry, especially organic chemistry, at least one year of general biology, a year of college math including calculus, and general physics. Additional upper division courses in biochemistry, molecular biology and physiology will often increase your competitive advantage for admission. Effective communication is an important skill for toxicologists; therefore, coursework in scientific writing and public speaking is also useful. Involvement in extracurricular activities is a valuable way to develop and demonstrate your leadership and communication skills.

Consult the programs that are of interest to you to determine their specific admission requirements. In addition to a strong academic record, demonstration of basic laboratory and research skills and leadership abilities will increase your chances of admission to the more competitive programs. Undergraduate research experience or working during the summer in a research laboratory is a plus. From January to April each year, the SOT provides a listing of summer internships available in academic, industrial and government research laboratories across the country. Contact the SOT Headquarters office for more information about the Summer Internship Program.

Performance on the Graduate Record Examination is also important. You should take the exam at least nine months prior to the time you plan to begin your graduate study and you should prepare in advance for the exam.

If possible, plan to visit the programs you wish to consider in advance of your application process. Notify the director of the program of your interests and arrange to speak with the director and other faculty in the program.

An excellent source of information is Careers in Science and Engineering: A Student Planning Guide to Graduate School and Beyond (National Academy Press, 1996) (http://www.nap.edu/readingroom/books/careers). One example in this book traces the career path of a physicist into toxicology.

Graduate Training in Toxicology

Select a Program That's Right for You.

Identifying a graduate training program that is best for you requires some advanced planning. First, you should establish a potential career plan. Consider the various subspecialties in toxicology, such as neurotoxicology, chemical carcinogenesis, teratology, etc., to determine if there is a specific field of research that is of particular interest to you. Attending regional and

national scientific meetings will help you explore areas of interest. Although choosing a specialty early in your graduate education certainly does not commit you to this direction, it will help you in deciding which programs are most likely to meet your needs. It is also useful to talk with toxicologists in local universities, industries and governmental agencies to help you in your selection of a training program and future career direction. Make sure that you are able to satisfy all of the admission requirements prior to the time you intend to begin the program, as these requirements may vary between programs and from the general requirements described above. Geographical considerations are also important to some individuals. Some students balance employment and graduate study. The list of academic programs in toxicology contained in this Guide should help you find the right program for you.

Tips for success in graduate school can be found in Peterson's Graduate School Survival Guide (http://www.petersons.com/graduate/transition1.htm).

Financial Support

Most students in toxicology graduate programs have financial support, which can come from a variety of sources.

Academic Institutions

Many universities have funds to support graduate students during their training. These awards are generally offered as either Teaching Assistantships (TAs) or as Research Assistantships (RAs). As TAs, students generally assist in the preparation and teaching of undergraduate or graduate courses, and obtain valuable experience in teaching that will help them in their future careers as toxicologists. RAs generally assist faculty in research on specific topics or provide general assistance to multiple faculty in the program. Check with the specific academic program directors for more information on the availability of student support for graduate training at your school of choice.

The Government

Research Manpower Development Programs

The National Institute of Environmental Health Sciences (NIEHS) supports research training in four areas related to toxicology: (a) environmental toxicology, emphasizing training in the principles that determine the effects of exposure to environmental agents; (b) environmental pathology, emphasizing training in chemical (as opposed to infectious disease) pathology; (c) environmental mutagenesis, emphasizing training in the application of the principles of genetics and biochemistry to assess the potential genetic hazards to man from environmental chemicals; and (d) environmental epidemiology and biostatistics, emphasizing training in the use of statistical and mathematical tools to assist in the identification of environmental diseases in human populations and in experimental design and interpretation of data.

NIH Individual Investigator Research Awards

Many toxicologists in academic institutions who receive grant support from the National Institutes of Health (NIH) have RAs. These RA positions are often used to support graduate students in their final years of dissertation research. The level of support for a RA may vary from institution to institution, but are generally similar or slightly higher than training grant stipends.

Other Federal Programs

In addition to the specific programs noted above, federal support for graduate training may be available through other training programs or research grants and contracts available from other federal agencies such as the National Science Foundation, the Armed Forces, the EPA, the Department of Defense or the Department of Energy.

The Private Sector

The SOT selects several pre-doctoral students each year for Graduate Fellowship awards. These awards are currently sponsored by the Covance Company, Novartis, and The Procter & Gamble Company. Any student member of the SOT who has (at time of award) completed one year, but not more than three years, of graduate study towards the Ph.D. degree in an area of toxicology, and whose major professor is a member of the SOT is eligible. The Education Committee evaluates candidates on scholastic achievement, letters of recommendation and the dissertation research. Applications and further information are available from the SOT Web site.

Individual academic programs may receive graduate student training support from sponsoring industries or foundations.

Post-doctoral Training in Toxicology

If you've already completed a doctoral degree in a biomedical science, you can enter the field of toxicology by spending two to three years as a post-doctoral fellow in a toxicology laboratory. Post-doctoral education of a toxicologist takes many forms depending on the goal of the scientist. Post-doctoral experience is necessary for most academic and research positions, but is not a requirement for many other positions in government or industry.

Post-doctoral experience can further enhance the marketability of a toxicologist. Recent toxicology graduates may lack experience in project management, people management and grant-writing, and experience in these areas can be gained during post-doctoral training. Although higher numbers of toxicologists are undertaking post-doctoral training in recent years, a smaller proportion of the total number of graduates are engaged in post-doctoral fellowships – 30% in 1990–1995 vs. 43% in 1984–1989.

The SOT Career Resource and Development Services maintains an active list of post-doctoral opportunities available in toxicology. You may obtain more information about the Career Resource and Development Services by visiting the SOT website, or by contacting the SOT.

Government-sponsored Programs

Numerous government agencies provide post-doctoral training programs in toxicology at agency facilities such as the EPA (in its regional laboratories), the FDA at its Beltsville and National Center for Toxicology Research facilities, Occupational Safety and Health Administration, Center for Disease Control's National Institute for Occupational Safety and Health, and the many National Institutes of Health laboratories, especially NIEHS.

A time-honored post-doctoral training route has been through investigator-initiated research grants, which focus the post-doctoral fellow in the area of the mentor. Most researchers at academic institutions who receive federal research grants have funds to support post-doctoral fellows. One means of exploring post-doctoral opportunities is to directly contact individual faculty from graduate programs in toxicology.

In addition to individual research grants, many academic programs receive federal training grants with funds specifically dedicated to post-doctoral training. For example, the NIEHS provides post-doctoral fellowships to academic institutions for post-doctoral training in environmental toxicology and/or environmental pathology. Consult the 'Employment and Training Opportunities' on the NIEHS website (http://www.niehs.nih.gov). You can also write to the Program Administrator (Scientific Programs Branch, MD 3/03, NIEHS, Division of Extramural Research and Training, P.O. Box 12233, Research Triangle Park, NC 27709) to obtain a list of academic programs that receive NIEHS-sponsored post-doctoral training grants in toxicology.

Industry-sponsored Programs

Many companies that employ toxicologists (such as pharmaceutical, chemical, food and automotive companies) provide post-doctoral training opportunities for individuals with doctoral degrees in toxicology or related disciplines.

Another often-overlooked source of post-doctoral training is the contract laboratory. The contract laboratory exposes the early career scientist to the broadest issues in general toxicology, especially testing and preparing documents for submission to regulatory agencies. In many respects, this type of experience represents the practice or art of toxicology, while the university experience represents the science of toxicology.

The Colgate-Palmolive Company offers the Colgate-Palmolive Post-Doctoral Fellowship, which is directed specifically toward innovations in toxicology methodology involving alternatives to whole animal use in testing. This award is administered through the SOT, and further information can be found on the SOT website.

Toxicology Survey References

Information on career outlook and salary is based on the following five reports available on the SOT website.

Gad SC (2005) Sixth Triennial Toxicology Salary Survey. Intern. J. Toxicol.

Gad SC (2002) Fifth Triennial Toxicology Salary Survey. Intern. J. Toxicol. 21.

Gad SC (1999) Fourth Triennial Toxicology Salary Survey and Trends in the Toxicology Job Market. Intern. J. Toxicol. 18: 219–225.

Job Market Survey: Past, Present, and the Future. (1997) SOT Placement Committee Report.

Toxicologist Supply and Expertise Survey: Past, Present, and Future. (1998) SOT Placement Committee Report.

Organizations Supporting Careers in Toxicology

American College of Medical Toxicology (ACMT)

ACMT is a professional, non-profit association of physicians with recognized expertise in medical toxicology, focusing on the diagnosis, management and prevention of poisoning/toxicity and other adverse health effects due to medications, chemicals, occupational and environmental toxins, and biological hazards.

British Society of Toxicology (BTS)

Web: http://www.thebts.org/index.php?content=yt

BTS provides students wanting to learn more about toxicology or seeing careers in toxicology (Young Toxicologists (YTP)) in the UK.

International Union of Toxicology (IUTOX)
Web: http://www.iutox.org/whatisiutox.asp

IUTOX fosters international scientific cooperation among toxicologists and promotes global acquisition, dissemination, and utilization of knowledge in the science of toxicology and ensures continued training and development of toxicologists worldwide.

Society of Toxicology (SOT)
Web: http://www.toxicology.org/ai/apt/career-programs.asp
Web: http://www.toxicology.org/ai/apt/careerguide.asp#How%20Do%20I%20Prepare

SOT, a U.S.-based organization, has an extensive web-based Resource Guide to Careers in Toxicology as well as information on training programs.

Toxicology Teaching Project (Indiana University of Pennsylvania)
Web: http://nsm1.nsm.iup.edu/tsimmons/Tox_Teach_Project_Home.shtm

This project is a joint venture between the Allegheny-Erie Regional Chapter of the Society of Toxicology and the Environmental Health Science Program of Indiana University of Pennsylvania.

Academic Programs

University Listings of Undergraduate, Graduate, Post Graduate Distance Leaning Opportunities

In larger part, the below list was adapted from the Society of Toxicology's 'Academic and Post-Doctoral Toxicology Programs and Web Sites' available on web at:

http://www.toxicology.org/ai/apt/careerprograms.asp. The SOT website contains additional references and material on toxicology careers that students will find useful.

Brown University
Providence, RI
Pathobiology: Environmental Pathology Program
Degrees offered: Ph.D., M.D./Ph.D.
Contact information
Department/College: Department of Pathology and Laboratory Medicine

CIIT Centers for Health Research
Research Triangle Park, NC
Post-Doctoral Toxicology Training
Contact information
CIIT Centers for Health Research
Web: http://www.thehamner.org/program/index.html

Clemson University
Pendleton, SC
Institute of Environmental Toxicology Program
Degrees offered: M.S., Ph.D.
Contact information
Department/College: Department of Environmental Toxicology
Web: http://www.clemson.edu/entox

Colorado State University
Fort Collins, CO
Environmental Toxicology Program
Degrees offered: M.S., Ph.D.
Contact information
Department/College: Department of Environmental Health
Web: http://www.cvmbs.colostate.edu/erhs/toxicology.htm

Dartmouth College
Hanover, NH
Department of Pharmacology and Toxicology
Degrees offered: Ph.D.
Contact information
Department/College: Pharmacology and Toxicology/Dartmouth
Environmental Toxicology Program
Web: http://dms.dartmouth.edu/pharmtox/graduate/

Duke University
Durham, NC
Integrated Toxicology Program
Degree offered: Ph.D.
Contact information
Department/College: Medical Center and School of the Environment
Web: http://toxicology.geneimprint.com/

Florida A&M University
Tallahassee, FL
Environmental Toxicology Graduate Program
Degree offered: Ph.D.
Contact information
Department/College: College of Pharmacy
Web: http://www.famu.edu/index.cfm

Indiana University
Indianapolis, IN
Toxicology Program
Degrees offered: M.S., Ph.D., Post-Doctoral
Contact information
Department/College: Pharmacology and Toxicology
Web: http://medicine.iu.edu/body.cfm?id=4418&oTopID=4418

Iowa State University
Ames, IA

Interdepartmental Toxicology Program
Degrees offered: M.S., Ph.D.
Contact information
Department/College: Interdepartmental Toxicology
Web: http://www.toxicology.iastate.edu/

Johns Hopkins University
Baltimore, MD
School of Hygiene and Public Health, Toxicological Sciences Program
Degrees offered: M.H.S., Sc.M., Ph.D.
Contact information
Department/College: Environmental Health Sciences, Division of Toxicological Sciences
Web: http://www.jhsph.edu/Dept/EHS/

Louisiana State University Medical Center
Shreveport, LA
Graduate Studies in Toxicology
Degrees offered: M.S., Ph.D., M.D./Ph.D.
Contact information
Department/College: Department of Pharmacology
Web: http://www.shrevebiochem.com/GraduateStudies/

Massachusetts Institute of Technology
Cambridge, MA
Graduate Program in Toxicology
Degrees offered: S.M., Ph.D.
Contact information
Department/College: Division of Bioengineering and Environmental Health
Web: http://www.gradschools.com/programs/toxicology.html

Michigan State University
East Lansing, MI
Environmental and Integrative Toxicology Science Training Programs
Degree offered: Ph.D., MS
Contact information
Department/College: Institute for Environmental Toxicology
Web: http://www.iet.msu.edu/Graduate%20Program/grad_program.html

Mississippi State University
Mississippi State, MS
Environmental Toxicology Graduate Program
Degrees offered: M.S., Ph.D.
Contact information
Department/College: Center for Environmental Health Sciences
Web: http://www.cvm.msstate.edu/cehs/graduate_education.htm

New York University
Tuxedo, NY
Environmental Toxicology Program
Degrees offered: M.S., Ph.D.
Contact information
Department/College: New York University School of Medicine
Web: http://www.med.nyu.edu/environmental/graduate/

North Carolina State University
Raleigh, NC
Toxicology Program
Degrees offered: M.Tox, M.S., Ph.D.
Contact information
Department/College: College of Agriculture and Life Sciences
Web: http://www.tox.ncsu.edu/graduate/phd_env.htm

Northeastern University
Boston, MA
Pharmaceutical Sciences/Toxicology Program
Degrees offered: B.S., M.S., Ph.D.
Contact information
Department/College: Pharmaceutical Sciences/Bouve College of Health Sciences
Web: http://www.pharmsci.neu.edu/

Oregon State University
Corvallis, OR
Toxicology Program
Degrees offered: M.S., Ph.D.
Contact information
Department/College: Environmental and Molecular Toxicology
Web: http://emt.oregonstate.edu/grad/index.htm

Purdue University
West Lafayette, IN
Toxicology Program
Degrees offered: M.S., Ph.D.
Contact information
Department/College: School of Health Sciences
Web: http://www.healthsciences.purdue.edu/academics/graduate/toxicology/

Rutgers, State University of New Jersey
Piscataway, NJ
Joint Graduate Program in Toxicology
Degrees offered: M.S., Ph.D.
Contact information
Department/College: Department of Pharmacology and Toxicology
Web: http://eohsi.rutgers.edu/jgpt/newjgpt05/index.html

San Diego State University
San Diego, CA

Toxicology Concentration
Degrees offered: M.S.
Contact information
Department/College: Graduate School of Public Health, Division of Occupational and Environmental Health, College of Health and Human Services
Web: http://publichealth.sdsu.edu/ms-tox-main.php

St. John's University
Jamaica, NY
Toxicology Program
Degrees offered: B.S., M.S., Ph.D.
Contact information
Department/College: Department of Pharmaceutical Sciences
Web: http://www.stjohns.edu/academics/graduate/pharmacy/gradprograms/masters.sju

State University of New York at Buffalo
Buffalo, NY
Environmental Health Sciences and Toxicology Programs
Degrees offered: M.A., M.S., Ph.D.
Contact information
Department/College: Pharmacology and Toxicology
School of Medicine and Biomedical Sciences
Web: http://www.smbs.buffalo.edu/pmy/education.htm

Texas A&M University
College Station, TX
Intercollegiate Faculty of Toxicology
Degrees offered: M.S., Ph.D.
Contact information
Department/College: Veterinary Physiology and Pharmacology/Veterinary Medicine
Web: http://toxicology.tamu.edu/program/index.shtml

Texas Tech University
Lubbock, TX
Environmental Toxicology Graduate Program
Degree offered: M.S., Ph.D.
Contact information
Department/College: The Institute of Environmental and Human Health
Web: http://www.tiehh.ttu.edu/edu.htm

University at Albany
Albany, NY
Toxicology Program
Degrees offered: M.S., Ph.D.
Contact information
Department/College: Environmental Health and Toxicology
Web: http://www.albany.edu/sph/eht/index.html

University of Alabama at Birmingham
Birmingham, AL
Environmental Health/Toxicology Program
Degrees offered: M.S.P.H., Ph.D.
Contact information
Department/College: Environmental Health Sciences
Web: http://www.soph.uab.edu/default.aspx?id=243

University of Alabama at Birmingham
Birmingham, AL
Graduate Training Program in Toxicology
Degree offered: Ph.D.
Contact information
Department/College: Pharmacology and Toxicology
Web: http://main.uab.edu/show.asp?durki=10279

University of Arizona
Tucson, AZ
Graduate Program in Pharmacology and Toxicology (Interdisciplinary)
Degrees offered: M.S., Ph.D.
Contact information
Department/College: College of Pharmacy
Web: http://catalog.arizona.edu/2002-03/dept/PTOX.shtml

University of Arkansas for Medical Sciences
Little Rock, AR
Interdisciplinary Toxicology Program
Degrees offered: M.S., Ph.D.
Contact information
Department/College: Department of Pharmacology and Toxicology/College of Medicine
Web: http://www.uams.edu/pharmtox/pharmacology/

University of California, Berkeley
Berkeley, CA
Molecular Toxicology
Degrees offered: Ph.D.
Contact information
Department/College: Nutritional Sciences and Toxicology/College of Natural Resources
Web: http://nst.berkeley.edu/

University of California, Davis
Davis, CA
Graduate Training in Pharmacology and Toxicology
Degrees offered: M.S., Ph.D.
Contact information
Department/College: Pharmacology and Toxicology Graduate Group
Web: http://www.envtox.ucdavis.edu/grad/default.html

University of California, Irvine
Irvine, CA
Environmental Toxicology Program
Degrees offered: M.S., Ph.D.
Contact information

Department/College: Department of Community and Environmental Medicine/ College of Medicine
Web: http://www.ucihs.uci.edu/som/envtox/

University of California, Los Angeles
Los Angeles, CA
Interdepartmental Doctoral Program in Molecular Toxicology
Degrees offered: Ph.D.
Contact information
Department/College: Schools of Medicine and Public Health, and College of Letters and Science
Web: http://www.pathology.ucla.edu/educ/Mol%20Tox/index.htm

University of California, Riverside
Riverside, CA
Environmental Toxicology Graduate Program
Degrees offered: M.S., Ph.D.
Contact information
Department/College: Biological Sciences Graduate Student Affairs Center
Web: http://www.etox.ucr.edu/

University of Cincinnati
Cincinnati, OH
Molecular Toxicology Graduate Program
Degrees offered: M.S., Ph.D.
Contact information
Department/College: Environmental Health/College of Medicine
Web: http://www.eh.uc.edu/graduate/default.asp

University of Colorado Health Sciences Center
Denver, CO
Degree offered: Ph.D.
Contact information
Department/College: Pharmaceutical Sciences, School of Pharmacy
Web: http://www.uchsc.edu/sop/phd/

University of Connecticut
Storrs, CT
Interdepartmental Toxicology Program
Degrees offered: M.S., Ph.D.
Contact information
Department/College: Pharmaceutical Sciences
Web: http://pharmacy.uconn.edu/index.php?option=com_content&task=view&id=298&Itemid=566&myf=566

University of Florida
Gainesville, FL
Forensic Toxicology Distance Education Program
Degrees offered: Certificate, M.S.
Contact information
Department/College: Center for Environmental and Human Toxicology
Web: http://www.forensicscience.ufl.edu/programs.asp?p=28

University of Georgia
Athens, GA
Interdisciplinary Graduate Program in Toxicology
Degrees offered: M.S., Ph.D.
Contact information
Department/College: Interdisciplinary Program in Toxicology
Web: http://toxicology.uga.edu/

University of Illinois at Urbana-Champaign
Urbana, IL
Interdisciplinary Environmental Toxicology Program
Degrees offered: M.S., Ph.D.
Contact information
Department/College: Department of Veterinary Biosciences
Web: http://www.environ.uiuc.edu/graduate/grad_index.html

University of Kansas Medical Center
Kansas City, KS
Degree offered: Ph.D.
Contact information
Department/College: Department of Pharmacology, Toxicology and Therapeutics
Web: http://www.kumc.edu/pharmacology/graduate.html

University of Kentucky
Lexington, KY
Graduate Center for Toxicology
Degrees offered: M.S., Ph.D.
Contact information
Department/College: Graduate School
Web: http://www.mc.uky.edu/toxicology/grad_program.asp

University of Louisiana at Monroe
Monroe, LA
Toxicology Program
Degrees offered: B.S., M.S., Ph.D.
Contact information
Department/College: Department of Toxicology, College of Pharmacy
Web: http://rxweb.ulm.edu/pharmacy/toxicology/

University of Louisville
Louisville, KY
Pharmacology and Toxicology Programs, University of Louisville School of Medicine
Degrees offered: M.S., Ph.D.
Contact information

Department/College: Pharmacology and Toxicology
Web: http://louisville.edu/medschool/pharmacology/

University of Maryland
Baltimore, MD
Toxicology Program
Degrees offered: M.S., Ph.D.
Contact information: Toxicology Program
Web: http://medschool.umaryland.edu/epidemiology/dr_tox.asp

University of Michigan
Ann Arbor, MI
Toxicology Program
Degrees offered: M.P.H., M.S., Ph.D.
Contact information
Department/College: Environmental Heath Sciences/School of Public Health
Web: http://www.sph.umich.edu/ehs/programs.html

University of Mississippi
University, MS
Environmental Toxicology Program
Degrees offered: M.S., Ph.D.
Contact information
Department/College: Pharmacology
Web: http://www.pharmacy.olemiss.edu/etrp/index.html

University of Mississippi Medical Center
Jackson, MS
Graduate Studies in Toxicology
Degrees offered: M.S., Ph.D.
Contact information
Department/College: Pharmacology and Toxicology
Web: http://pharmacology.umc.edu/

University of Nebraska
Omaha, NE
Center for Environmental Toxicology Program
Degrees offered: M.S., Ph.D.
Contact information
Department/College: Nebraska Medical Center
Web: http://www.unmc.edu/toxcenter/program.htm

University of New Mexico
Albuquerque, NM
Toxicology Program
Degrees offered: M.S., Ph.D.
Contact information
Department/College: College of Pharmacy
Web: http://hsc.unm.edu/Pharmacy/prospective/toxicology.shtml

University of North Carolina at Chapel Hill
Chapel Hill, NC
Curriculum in Toxicology-Post-Doctoral
Degree offered: Ph.D.
Contact information: Toxicology Program
Web: http://www.med.unc.edu/toxicology/Postdoc%20Training%20-%20Program.htm

University of Oklahoma Health Sciences Center
Oklahoma City, OK
Interdisciplinary Toxicology Program
Degrees offered: Ph.D., Post-Doctoral
Contact information
Department/College: Center for Toxicology/College of Pharmacy
Web: http://pharmacy.ouhsc.edu/departments/toxicology/students/

University of Pittsburgh Graduate School of Public Health
Pittsburgh, PA
Molecular Toxicology, Computational Toxicology, Risk Assessment, Environmental and Occupational Health Programs
Degrees offered: Certificates, M.S., M.P.H., Ph.D.
Contact information
Department/College: Environmental and Occupational Health
Web: http://www.publichealth.pitt.edu/

University of Rochester School of Medicine and Dentistry
Rochester, NY
Molecular Toxicology and Environmental Medicine Programs
Degree offered: Ph.D.
Contact information
Department/College: Department of Environmental Medicine
Web: http://www2.envmed.rochester.edu/envmed/TOX/welcome.html

University of Texas at Austin
Austin, TX
Graduate Program in Toxicology
Degrees offered: M.S., Ph.D.
Contact information
Department/College: College of Pharmacy
Web: http://www.utexas.edu/pharmacy/admissions/graduate/

University of Texas Houston Health Science Center – Houston
Houston, TX
Toxicology Program
Degrees offered: M.S., Ph.D.
Contact information
Department/College: Graduate School of Biomedical Sciences
Web: http://www.uth.tmc.edu/schools/gsbs/toxicology/

University of Texas Medical Branch
Galveston, TX
Interdisciplinary Curriculum in Toxicology
Degree offered: Ph.D.
Contact information
Department/College: Graduate School of Biomedical Sciences
Web: http://www.uth.tmc.edu/gsbs/pro_tox.htm

University of the Sciences in Philadelphia
Philadelphia, PA
Pharmacology and Toxicology Programs
Degrees offered: M.S., Ph.D.
Contact information
Department/College: Pharmaceutical Sciences
Web: http://www.usip.edu/graduate/pharmtox/index.shtml

University of Utah
Salt Lake City, UT
Pharmacology and Toxicology Programs
Degree offered: Ph.D.
Contact information
Department/College: Department of Pharmacology and Toxicology
Web: http://www.pharmacy.utah.edu/pharmtox/grad_program.html

University of Washington
Seattle, WA
Toxicology Graduate Program
Degrees offered: M.S., Ph.D.
Contact information
Department/College: Environmental and Occupational Health
Web: http://depts.washington.edu/envhlth/prospective/index.html

University of Wisconsin – Madison
Madison, WI
Molecular and Environmental Toxicology Graduate Program
Degrees offered: B.S. M.S., Ph.D.
Contact information
Department/College: Environmental Toxicology Center, School of Pharmacy
Web: http://www.pharmacy.wisc.edu/student_services/new_student/

Utah State University
Logan, UT
Interdepartmental Graduate Program in Toxicology
Degrees offered: M.S., Ph.D.
Contact information
Department/College: Toxicology Program Office
Web: http://toxicology.usu.edu/

Vanderbilt University Nashville
Nashville, TN
Center in Molecular Toxicology
Degree offered: M.S., Ph.D., Post Graduate
Contact information
Department/College: Biochemistry, Cell Biology, Chemistry, Medicine, Pathology and Pharmacology
Web: http://www.toxicology.mc.vanderbilt.edu/

Virginia Commonwealth University
Richmond, VA
Degrees offered: Certificate, M.S., Ph.D.
Contact information: Toxicology Program
Web: http://www.vcu.edu/pharmtox/prospective/index.htm

Virginia-Maryland Regional College of Veterinary Medicine
Blacksburg, VA
Degrees offered: M.S., Ph.D.
Contact information: Toxicology Program
Web: http://www.vetmed.vt.edu/Organization/Graduate/gradprogs.asp

Wayne State University
Detroit, MI
Graduate Program in Molecular and Cellular Toxicology
Degree offered: Ph.D.
Contact information
Department/College: Institute of Chemical Toxicology
Web: http://www.iehs.wayne.edu/gradprog.html

Wright State University
Dayton, OH
Pharmacology and Toxicology Masters Program
Degree offered: M.S.
Contact information
Department/College: Pharmacology & Toxicology/School of Medicine
Web: http://www.med.wright.edu/pharm/

Medical Toxicologist

Medical toxicologists are physicians with recognized expertise in the diagnosis, management, and prevention of poisoning/toxicity and other adverse health effects due to medications, chemicals, occupational and environmental toxins, and biological hazards. Medical toxicology is officially recognized as a medical subspecialty by the American Board of Medical Specialties (ABMS). The American College of Medical Toxicology (ACMT) is a professional, non-profit association that supports physicians with recognized expertise in medical toxicology and is dedicated to advancing the science and practice of medical toxicology. A list of

training programs in medical toxicology is available from ACMT (http://www.actox.org/) and a list of programs accredited by the American Council of Graduate Medical Education (click on 'List of Programs by Specialty' and then select 'Medical Toxicology').

CONTINUING EDUCATION FOR PROFESSIONALS

American Board of Toxicology, Inc. (ABT)
Web: http://www.abtox.org/.

A professional certification program for toxicologists is offered by this group.

American Industrial Hygiene Association (AIHA)
Web: http://www.aiha.org/Content

Has a number of programs of interest to toxicologists and industrial hygiene professionals.

British Society of Toxicology (BTS)
Web: http://www.thebts.org/

Provides information on continuing professional development and educational courses available in the United Kingdom.

Canadian Network of Toxicology Centres (CNTC)
Web: http://www.uoguelph.ca/cntc/

Focused on advanced principles in toxicology.

CIIT Centers for Health Research (CIIT)
Web: http://www.thehamner.org/

Offers training in toxicology to scientists at every career level and offers stipends and benefits.

National Environmental Health Association (NEHA)
Web: http://www.neha.org/

Incorporated in 1937, offers extensive training in toxicological sciences.

National Institute for Environmental Health Sciences (NIEHS)
Web: http://www.niehs.nih.gov/health/scied/prodevelop/index.cfm

A variety of training programs for scientists.

Society of Toxicology (SOT)
Web: http://www.toxicology.org/ai/ce/ce.asp.

Produces yearly continuing education courses at their annual meeting and has information about current and past courses.

US Army Center for Health Promotion and Preventive Medicine
Web: http://chppm-www.apgea.army.mil/tox/home.aspx

The Directorate of Toxicology of the US Army specializes in the toxicology of military supplies and unique chemicals.

CHAPTER

73

Public Education

STEVEN G. GILBERT AND KATIE FREVERT

INTRODUCTION

> It is not the truth that makes you free. It is your possession of the power to discover the truth. Our dilemma is that we do not know how to provide that power.
>
> Richard Lewontin (New York Review of Books, January 7, 1997)

Education lays the foundation for a civil society by empowering people with tools for life-long learning, a common set of information, and sets the course of the future leaders of our society. One of the challenges of education and education-related resources is the need for a range of material depending on age and background. This chapter addresses resources for teachers and students in K-12 classrooms, and continuing education for the interested public. It includes separate sections on environmental justice and relevant Spanish language resources.

Knowledge about the health effects of chemicals influences decisions that affect not only our individual lives but also our community. The principles of toxicology – dose/response and hazard/exposure – influence the environments in which we live and potentially hazardous effects of the products we buy. We are continuously learning more about what affects environmental and human health; this learning and the knowledge derived from it needs to start in K-12 classrooms.

Opportunities are being sought by educators to integrate environmental health topics and toxicology into a variety of subject areas – mathematics, science, language, arts, and social studies. Environmental health issues are compelling, current, and relevant to young people. They provide the context in which to teach critical thinking and problem-solving skills in multiple disciplines. Rather than compete for class time, environmental and toxicology education fits well within the range of subjects students are traditionally expected to master. Curricula available in this chapter are written to meet the learning objectives and benchmarks that are part of education today.

For K-12 teachers there are a number of general resources that provide an excellent overview of toxicology. Several of these have been developed by government agencies or professional organizations. Video resources for teachers were given a separate heading. The videos referenced are at a middle school/high school level. A broad range of curricula are included that address toxicological issues at different grade levels. In addition, listed under a separate heading, are resources and interactive activities targeted directly for a student's use. Most of these resources are web-based and most are downloadable.

The toxicology texts are directed at K-12 teachers or more senior students. The journal cited is specifically for secondary students. The journal articles listed are drawn from science journals and address educational challenges and successes related to working with K-12 students in toxicology and environmental health sciences.

Equally relevant to non-professional education is material directed toward the general public, media, and government representatives. One's work environment or family life may promote different concerns about chemical exposures. Resources directed to the lay person or non-professional is listed in a separate category but many of the K-12 materials may also be useful. Issues related to environmental justice were listed separately to emphasize the importance of this growing

area. The organizations included offer excellent educational material and guidance in addressing issues at a local level. A growing list of resources in Spanish is available to the public. Communication of health risks to all people remains a societal imperative. This requires that information be provided to meet individual and collective needs in schools, at home, and in the workplace.

The resources presented in this chapter focus primarily on K-12 educational resources and resources useful for the general public. Information for those seeking careers in toxicology is in Chapter 72. An excellent national resource that contains a broad range of information on Education, Careers, and Outreach is at the National Library of Medicine, National Institutes of Health (http://sis.nlm.nih.gov/enviro/edcotox.html).

K-12 EDUCATIONAL RESOURCES

Books

Friis RH (2007)
Essentials of Environmental Health
Jones & Bartlett Publishers
Jones and Bartlett Publishers, Sudbury, Massachusetts, Boston, Toronto, London

A comprehensive study of the major topics in environmental health: toxicology, environmental epidemiology and environmental policy and regulation.

Gilbert SG (2004)
A Small Dose of Toxicology – The Health Effects of Common Chemicals
CRC Press, Boca Raton, FL
Web: http://www.asmalldoseof.org

An introductory text on toxicology that introduces the principles of toxicology and covers a number of common agents, targets of toxic agents, and applied toxicology. The website contains references and PowerPoint presentations for each chapter.

Journals

EHP Student Edition (2005–)
The EHP Science Education Program
Web: http://www.ehponline.org/science-ed-new/resources.html

A library of over 90 science and interdisciplinary lessons based on selected articles and scientific research published in Environmental Health Perspectives. Lessons advance critical basic skills through the context of engaging, current environmental health topics. Grades 9–12 in biology, chemistry, environmental science, geology, and physical science. Many lessons are also appropriate for undergraduates. Lessons and corresponding news articles are downloadable and free.

Journal Articles (Education Related)

Burns ER, Lindsey MS (2004) Cancer education and cancer prevention education for K-12 students and teachers. J. Can. Ed. 19: 105–110. (doi:10.1207/s15430154jce1902_11).

de Peyster A, Eidemiller BJ (2002) 'Paracelsus goes to school' Teacher education workshops: A six-year retrospective. Comments Tox. 8: 165–183. (doi: 10.1080/08865140210511) Web: http://www.tandf.co.uk/journals/titles/10937404.asp Comments on Toxicology now published as Journal of Toxicology and Environmental Health, Part B.

Dereski MO, et al (2002) Environmental health science in the classroom. Comments Tox. 8: 195–207. (doi: 10.1080/08865140210510). Web: http://www.tandf.co.uk/journals/titles/10937404.asp/ Comments on Toxicology now published as Journal of Toxicology and Environmental Health, Part B.

Eaton DL, et al (2002) From visiting professionals to videoconferences: Using creative catalysts to infuse environmental health sciences content into the K-12 curriculum. Comments Tox. 8: 219–233. (doi: 10.1080/08865140210512). Web: http://www.tandf.co.uk/journals/titles/10937404.asp. Journal of Toxicology and Environmental Health, Part B.

Floyd M (2004) Beyond the bench: 'Welcome to Hydroville. ' Environ. Health Perspect. 112(3). Web: http://www.ehponline.org/topic/bench.html/

Freeman K (2005) Beyond the bench: 'Tox-in-a-Box.' Environ. Health Perspect. 113(3). Web: http://www.ehponline.org/topic/bench.html.

Kerkvliet NI, et al (2002) Hydroville curriculum project: A successful toxicology outreach program for high school teachers and students in Oregon. Comments Tox. 8: 209–217. (doi: 10.1080/08865140210508). Web: tandf.co.uk/journals/titles/10937404.asp. Comments on Toxicology now published as Journal of Toxicology and Environmental Health, Part B.

Rudensey L, Whidden J (2005) Spill slueths – An interdisciplinary environmental health investigation. Science Scope February.

Thigpen K (2004) Beyond the bench: 'Cyber Schoolhouse Rocks!' Environ. Health Perspect. 112(1). Web: http://www.ehponline.org/topic/bench.html

Tillet T (2005) Beyond the bench: 'ToxRAP makes the connection.' Environ. Health Perspect. 113(4). Web: http://www.ehponline.org/topic/bench.html

Tillet T (2006) Beyond the bench: 'Tracking clues with environmental health sleuths.' Environ. Health Perspect. 114(3). Web: http://www.ehponline.org/topic/bench.html

Tillet T (2006) Beyond the bench: 'Bringing EXCITEment to the classroom.' Environ. Health Perspect. 114(6). Web: http://www.ehponline.org/topic/bench.html

Tyson FL, et al (2002) A strategy for improving K-12 environmental health science education in the United States. Comments Tox. 8: 185–194. (doi: 10.1080/08865140210509). Web: http://tandf.co.uk/journals/titles/10937404.asp Comments on Toxicology now published as Journal of Toxicology and Environmental Health, Part B.

General Educational Resources

A to Z Index
The National Centers for Disease Control
Web: http://www.cdc.gov/az/a.html

This site acts as a current resource for information on any health topic.

Center for Toxicology Educational Activities and Curricula
University of Arizona College of Pharmacy, NIEHS Center, Toxicology and Environmental Health Program
Web: http://coep.pharmacy.arizona.edu/curriculum/

K-12 educational activities, includes online lesson plans with labs, curricula, Power Point presentations.

Education, Careers, and Outreach
National Library of Medicine
National Institutes of Health
Web: http://sis.nlm.nih.gov/enviro/edcotox.html

This provides information and links to a broad range of toxicology educational materials from K-12 to advanced degrees.

Education Materials
Northwest Association for Biomedical Research
Web: http://www.nwabr.org/education/index.html

Secondary-level curriculum on ethics, HIV, stem cells, animal testing and consumer awareness.

The EHP Science Education Program
Web: http://www.ehponline.org/science-ed-new/

A library of over 90 science and interdisciplinary lessons based on selected articles and scientific research published in *Environmental Health Perspectives*. Lessons advance critical basic skills through the context of engaging, current environmental health topics. Grades 9–12 in biology, chemistry, environmental science, geology, and physical science. Many lessons are also appropriate for undergraduates. Lessons and corresponding news articles are downloadable and free.

Environmental Health Science Education
The National Institute for Environmental Health Sciences (NIEHS)
Web: http://www.niehs.nih.gov/health/scied/teachers/

Resources for K-12 teachers. Curricular materials, lesson resources, fact sheets, booklets. The home page address directs users to downloadable lessons and activities online and web-based for teachers related to toxicology or environmental health sciences. Site includes many links to activities, tools and resources, with an associated student page.

EPA Teaching Center
United States Environmental Protection Agency
Web: http://www.epa.gov/teachers/

Curriculum resources page with links for environmental health topics, including but not limited to: air, human health, waste and recycling, and water.

The North American Association for Environmental Education (NAAEE)
Web: http://www.naaee.org/

The North American Association for Environmental Education (NAAEE) is a network of professionals, students, and volunteers working in the field of environmental education throughout North America and in over 55 countries around the world.

Toxicology for K-12 Educators
Society of Toxicology
Web: http://www.toxicology.org/ai/k12o/k-12educators.asp

This site offers: toxicology curriculum resources, professional development opportunities for K-12 educators, direct web links to other teacher resources.

Curriculum Materials

AMBIENT – Atmospheric and Marine-based Interdisciplinary Environmental Health Training Modules
University of Miami, Rosenstiel School of Marine and Atmospheric Science

Web: http://www.rsmas.miami.edu/groups/niehs/ambient/modules.html

Four curriculum modules in booklets and on web, for Grades 5–8. Contaminants affecting human health: in water, soil, air, and food.

Assessing Toxic Risk
Cornell University, National Science Foundation
Web: http://ei.cornell.edu/pubs/atr.asp

High-school-level curriculum about toxicology concepts. Focus on bioassays; e.g. testing the effects of chemicals on duckweed, daphnia, or seed germination. Includes laboratory activities, and a section to help students plan bioassay experiments to test the effects of suspected toxics. Student and teacher editions are available (for purchase).

Chemicals, the Environment and You: Explorations in Science and Human Health.
Curriculum and CD-ROM
National Institutes of Health, Office of Science Education and National Institute of Environmental Health Sciences
Web: http://science.education.nih.gov/Customers.nsf/MSEnvironment.htm

Students in Grade 6–7 explore the relationship between chemicals in the environment and human health, utilizing basic concepts in the science of toxicology. This curriculum includes six hands-on activities that will encourage students to think about chemical exposures, dose–response, and individual susceptibility.

Crabby Kathy
University of Medicine and Dentistry of New Jersey-School of Public Health with the Public Education and Risk Communication Division, Environmental and Occupational Health Sciences
Web: http://kids.niehs.nih.gov/kathy/home.htm

Grade K-6. Storybook chronicles the experience of a third-grade class as they investigate an environmental health issue of their teacher Kathy.

Enviro-Health Links – Education, Careers, and Outreach
Web: http://sis.nlm.nih.gov/enviro/edcotox.html

Resource links provided by the U.S. National Library of Medicine, Environmental Health & Toxicology.

Enviro-Health Connections
Maryland Public Television and Johns Hopkins University Bloomberg School of Public Health
Web: http://www.thinkport.org/classroom/connections/default.tp

Web-based format for teachers and their students to explore the relationships between the environment and human health. Grades 5–12. The complex questions raised by environmental health issues can be addressed in the context of classes in language arts, social studies, mathematics, as well as science and health.

Environmental Health Fact Files: LEAD and ASTHMA
University of Washington, NIEHS Center for Ecogenetics and Environmental Health Sciences
Web: http://www.iehmsp.com/online/teachers/EH_fact_files.php

Interdisciplinary curricular materials designed to integrate environmental health across the middle school curriculum. Each Environmental Health Fact File focuses on an environmental health topic (lead and asthma) of importance to middle school students and their teachers. Lessons in mathematics, science, language arts and social studies (free and downloadable).

Exploring Environmental Issues: Focus on Risk
American Forest Foundation, Project Learning Tree
Web: http://www.plt.org/curriculum/risk.cfm

High-school-level module helps students explore the different aspects of environmental and human health risks that affect their everyday lives. It incorporates science, social studies, math, geography, and language arts. Through eight hands-on activities, students analyze, explore, discover, and learn about risk assessment, risk communication, risk perception, and risk management (free to teachers who participate in training).

Hydroville Curriculum Project
Oregon State University, Environmental Health Sciences Center and Marine Freshwater Biomedical Sciences Center
Web: http://www.hydroville.org

Grades 9–12. Environmental health scenarios that are real-world scenarios based on actual occurrences and real data.

My Health My World
Baylor College of Medicine
Web: http://kids.niehs.nih.gov/baylor/home.htm

Grades K-4. Storybooks, teacher guides, magazines for students. Inquiry-based, educational materials on environmental health issues. Students learn fundamental physical and life science concepts and acquire problem-solving and decision-making skills.

PEER – Partnership for Environmental Education and Rural Health

Texas A&M University, Department of Veterinary Anatomy and Public Heath
Web: http://peer.tamu.edu/index.html

Environmental health science curriculum modules for middle school science and non-science classes. Web-links to related resources for teachers

Peril
Canadian Network of Toxicology Centres, University of Guelph
Web: http://www.uoguelph.ca/cntc/educat/peril/index.html

Middle school grade level. A game of risk perception (available for purchase).

The Trouble in Fruitvale and Thresholds & Toxicology, SEPUP Modules
Lawrence Hall of Science, UC Berkeley
Web: http://www.lawrencehallofscience.org/sepup/

Grades 6–12. One of a series of SEPUP (Science Education for Public Understanding) modules. Activities use inquiry-based problem-solving approaches to learning. Science kits cover topics such as risk, threshold limits, water quality, toxic waste, food additives, household chemicals, product safety and government approvals for new products. Each module includes a kit containing materials needed to complete the activities, student pages, and background and instructional materials for the teacher (available for purchase).

The Living Environment – Toxicology Lessons
Science NetLinks, American Association for the Advancement of Science
Toxicology 1: Toxicology and Living Systems
Web: http://www.sciencenetlinks.com/lessons.cfm?DocID=429
Toxicology 2: Finding the Toxic Dose
Web: http://www.sciencenetlinks.com/lessons.cfm?DocID=430
Toxicology 3: Toxicology and Human Health
Web: http://www.sciencenetlinks.com/lessons.cfm?DocID=431
Toxicology activities for secondary teachers (free).

The Quicksilver Question
University of Washington, NIEHS Center for Ecogenetics and Environmental Health Sciences
Web: http://www.iehmsp.com/online/webModules/qsIntro.php

This middle-school-level web module is an innovative, interactive computer-based curriculum that introduces basics of environmental health and toxicology. Students solve the mercury mystery by using community resources to find a solution. Extension lessons for mathematics, science, language arts and social studies (free and downloadable).

The Toxicology Study Guide
The Canadian Network of Toxicology Centres (CNTC)
Web: http://www.uoguelph.ca/cntc/educat/guide/study.shtml

The Toxicology Study Guide – An Environmental Education Unit for Secondary Schools and Communities (English, French).

The Unsolved Mysteries of Human Health: How Scientists Study Toxic Chemicals (Hydroville Supplement)
Oregon State University, Environmental Health Sciences Center and Marine Freshwater Biomedical Sciences Center
Web: http://www.unsolvedmysteries.oregonstate.edu/

This secondary-level teaching tool addresses complex concepts with scientific accuracy and through non-technical language.

Toxic Leak!
Event-Based Science
Web: http://www.ebsinstitute.com/ebs.ToxicLeak.html

Grades 7–12. Book and accompanying video. An interdisciplinary curriculum centered around a real gasoline leak, that contains activities to study groundwater, pollution, permeability and porosity of soils, and geology. The unit is inquiry-oriented and emphasizes cooperative learning, teamwork, independent research, and hands-on investigations.

ToxRAP (Toxicology, Risk Assessment and Pollution)
Rutgers, University of Medicine and Dentistry of New Jersey-School of Public Health
Web: http://eohsi.rutgers.edu/rc/

Grades K-9. Lesson plans, oversized children's storybook and a game for students. Activities and lessons use a risk assessment framework that draws upon processes and tools from toxicology, environmental health risk assessment and risk management. The Case of the Green Feathers (K-3), What is Wrong with the Johnson Family (3–6), Mystery Illness Strikes the Sanchez household (6–9) (available for purchase).

Video Resources for Educators

EnviroMysteries: 'Water+?=Trouble'
Maryland Public Television and Johns Hopkins University Bloomberg School of Public Health

Web: http://enviromysteries.thinkport.org/watertrouble.html

Grades 5–9, video and hardcopy teacher's guide. The first episode of *EnviroMysteries*, students are introduced to environmental health concepts through the eyes of a young group of television journalists, who are chronicling the local health department's investigation of a waterborne illness.

EnviroMysteries: 'Breaking the Mold'
Maryland Public Television and Johns Hopkins University Bloomberg School of Public Health
Web: http://enviromysteries.thinkport.org/breakingthemold/

Grades 5–9, video and hardcopy teacher's guide. This video and accompanying extensive online educational resources look at health and airborne illness and empower students to take an active role in environmental issues that can affect their health today and in the future.

Is It Safe – Video
Toxicology Education Foundation
Web: http://www.toxedfoundation.org/video_pg.html

A 17-minute video on the basic concepts of toxicity, exposure, and risk with a goal of empowering the public to make good decisions about risk associated with everyday products (downloadable or available free on DVD).

Kids and Chemicals – Facts and Laws
Public Broadcasting System
Web: http://www.pbs.org/now/classroom/classroom_kids1.html

Online lessons for grades 9–12. Includes identification of synthetic chemicals and how they affect people. Used with PBS NOW program video (available for purchase).

TRADE SECRETS: A MOYERS REPORT
Public Broadcasting System – PBS Bill Moyers and Sherry Jones
Web: http://www.pbs.org/tradesecrets/program/program.html

Bill Moyers investigation of the history of the chemical revolution and the companies that drove it. Today, every man, woman, and child has synthetic chemicals in their bodies. No child is born free of them. Crucial questions raised by the documentary and addressed in a panel discussion moderated by Bill Moyers in the program's final half hour (available for purchase).

Students' Resources

NIEHS Resource Page for Students
The National Institute for Environmental Health Sciences (NIEHS)

Materials and activities help students understand links between human health and the environment. Lists research and job opportunities in the field for students.

Environmental Diseases from A to Z
The National Institute for Environmental Health Sciences (NIEHS)
Web: http://www.niehs.nih.gov/health/topics/atoz/

Environmental Health and Science Hot Topics
The National Institute for Environmental Health Sciences (NIEHS)
Web: http://www.niehs.nih.gov/kids/hottopics.htm

Peril
Canadian Network of Toxicology Centres, University of Guelph
Web: http://www.uoguelph.ca/cntc/educat/peril/peril_orders.htm

A game of risk perception for secondary age students, must be ordered (available for purchase).

The Quicksilver Question Interactive Web Module
University of Washington, NIEHS Center for Ecogenetics and Environmental Health Sciences
Web: http://www.iehms.com/online/webModules/qsStudents.php

An innovative, interactive computer-based learning activity based on a community environmental health topic (click on 'For Non- Student's' at bottom of the page) (free).

ToxMystery
US National Library of Medicine
Web : http://toxmystery.nlm.nih.gov

An interactive learning site, designed to help kids age 7 to 10 find clues about toxic substances that can lurk in the home. With lively animations, surprising sound effects and lots of positive reinforcement, ToxMystery provides a fun, game-like experience, while teaching important lessons about potential environmental health hazards (free).

Tox Town
US National Library of Medicine
Web: http://toxtown.nlm.nih.gov/

Interactive activity for elementary and secondary students exploring commonly encountered toxic chemicals, environmental health risks, and the public's health (free).

Toxicology for K-12 Students
Society of Toxicology
Web: http://www.toxicology.org/ai/k12o/k-12students.asp

Web pages to investigate science and explore careers.

PUBLIC EDUCATION RESOURCES

Agency for Toxic Substances and Disease Registry/U.S. (ATSDR)
US Department of Health and Human Services
Web: http://www.atsdr.cdc.gov/

ATSDR serves the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances.

The Canadian Network of Toxicology Centres (CNTC)
2nd Floor, Bovey Bldg
Gordon Street
University of Guelph
Guelph, Ontario. N1G 2W1
Phone: 519-824-4120 ext. 52950
Fax: 519-837-3861
Email: dwarner@uoguelph.ca
Web: http://www.uoguelph.ca/cntc/

CNTC, formed in 1988, has as one of its missions to 'transfer information and achieve toxicological literacy among all Canadians.'

Toxicology Education Foundation
P.O. Box 31021
Raleigh, North Carolina 27622-1021
Phone: 919-676-4666
Fax: 919-841-5042
Email: tefhq@toxedfoundation.org
Web: http://www.toxedfoundation.org/

The Toxicology Education Foundation's purpose is to encourage, support, and promote charitable and educational activities that increase the public understanding of toxicology.

Toxicology Problem Set
The Southwest Environmental Health Sciences Center
The Biology Project
The University of Arizona
Tucson AZ 85721
Phone: 520-621-2211
Web: http://www.biology.arizona.edu/chh/problem_sets/toxicology/toxicology.html

Eleven problem sets designed to elucidate the basic principles of toxicology.

Toxicology Tutorials
U.S. National Library of Medicine, Environmental Health & Toxicology
2 Democracy Plaza, Suite 510
6707 Democracy Blvd., MSC 5467
Bethesda, MD 20892-5467
Phone: 301-496-1131 (local and international)
Fax: 301-480-3537
Toll free: 1.888.FINDNLM
Email: tehip@teh.nlm.nih.gov
Web: http://www.sis.nlm.nih.gov/enviro/toxtutor.html

Three toxicological tutorials that cover basic principles, toxicokinetics, and, cellular toxicology. Currently undergoing revision in a joint project with the U.S. Society of Toxicology. To be renamed ToxLearn.

World Wildlife Fund
Toxic Chemicals
1250 Twenty-Fourth Street, N.W.
P.O. Box 97180
Washington, DC 20090-7180
Phone: 202-293-4800
Email: membership@wwfus.org
Web: http://www.worldwildlife.org/toxics/

ENVIRONMENTAL JUSTICE RESOURCES

Center for Community Action and Environmental Justice (CCAEJ)
PO Box 3 3124
Riverside, CA 92519
Phone: 951-360-8451
Fax: 951-360-5950
Email: admin@ccaej.org
Web: http://www.ccaej.org

The Center's goal is to bring groups of people together to find opportunities for cooperation, agreement and problem solving, with resource for community groups in English and Spanish.

Center for Health, Environment and Justice (CHEJ)
P.O. Box 6806
Falls Church, VA 22040-6806
Phone: (703) 237-2249
Email: chej@chej.org
Web: http://www.chej.org/

Through training, coalition-building and one-on-one technical and organizing assistance, CHEJ works to build healthy communities, with social justice, economic well-being, and democratic governance.

Community Coalition For Environmental Justice
1620 18th Ave
Suite 10
Seattle, WA 98122
Phone: 206-720-0285
Fax: 206-720-5241
Email: justice@ccej.org
Web: http://www.ccej.org/

A Seattle Washington organization provides community education, speakers, activism opportunities, and an EJ library.

Environmental Coalition of South Seattle
8201 10th Avenue South, #3
Seattle, WA 98108
Phone: 206-767-0432
Fax: 206-767-0203
Email: ecoss@ecoss.org
Web: http://www.ecoss.org

A Seattle, Washington-based group that provides education and other resources on environmental health issues in south Seattle.

Environmental Justice & Health Union
528 61st Street, Suite A
Oakland, CA 94609
Phone: not available
Email: ejhu@ejhu.org
Web: http://www.ejhu.org/

The mission of the Environmental Justice and Health Union is to identify tools to help environmental justice activists and environmental health professionals work together to stop environmental disease in low-income communities of color in the United States.

Environmental Justice Resource Center (EJRC) of Clark Atlanta University
223 James P. Brawley Drive
Atlanta, GA 30314
Phone: 404-880-6911
Fax: 404-880-6909
Email: ejrc@cau.edu
Web: http://www.ejrc.cau.edu/

EJRC is an excellent resource for reports, news, books, and other materials on EJ. EJRC was formed in 1994 to serve as a research, policy, and information clearinghouse on issues related to environmental justice, race and the environment, civil rights, facility siting, land use planning, brownfields, transportation equity, suburban sprawl, and Smart Growth.

Greenaction for Health and Environmental Justice
One Hallidie Plaza
Suite 760
San Francisco, CA 94102
Phone: 415-248-5010
Fax: 415-248-5011
Email: greenaction@greenaction.org
Web: http://www.greenaction.org/

Focused primarily in Southwest U.S., Greenaction mobilizes community power to win victories that change government and corporate policies and practices to protect health and to promote environmental justice.

U.S. Environmental Protection Agency Environmental Justice
Mail Code: 2201A
1200 Pennsylvania Ave., NW
Washington, D.C. 20460-0001
Phone: 800-962-6215
Email: visit web site to contact
Web: http://www.epa.gov/compliance/environmentaljustice/

U.S. EPA has a wide range of resources and good source for laws, regulations, programs, and grant information.

Environmental Community Action (ECO-Action)
The Grant Building
44 Broad St. NW, Suite 711
Atlanta, GA 30303
Phone: 404-584-6499
Fax: 404-584-6497
Email: contactus@eco-act.org
Web: http://www.eco-act.org/

An Atlanta, Georgia-based organization with a resources and examples of local EJ actions. The site includes training programs on the precautionary principle.

West Harlem Environmental ACTion (WEACT)
WE ACT, Inc.
271 West 125th Street, Suite 308
New York, New York 10027-4424
Email: Peggy@weact.org
Web: http://www.weact.org/

WEACT is a non-profit organization working to improve environmental policy, public health, and quality of life in communities of color. WEACT advances its mission through research, public education, advocacy, organizing, government accountability, litigation, legislative affairs and sustainable economic development.

SPANISH RESOURCES

Dictionary of Environmental Science and Engineering: English–Spanish/Spanish–English
Howard Headworth, Sarah Steines
ISBN: 0-471-96273-2
Wiley
Paperback, 324 pages
February 1998
Web: http://www.wiley.com/WileyCDA/WileyTitle/productCd-0471962732.html

Is It Safe – Video – Spanish language version
Toxicology Education Foundation

A 17-minute video on the basic concepts of toxicity, exposure, and risk with a goal of empowering the public to make good decisions about risk associated with every day products (downloadable or available free on DVD).

Toxicologia Ambiental: Evaluation de Riesgos y Restauracion Ambiental – (Spanish Language Program from the University of Arizona)
Web: http://superfund.pharmacy.arizona.edu/toxamb/

Riesgos Ambientales y Efectos en la Salud (Environmental hazards and health effects)
CDCi
National Center for Disease Control Environmental Health in Spanish
Web: http://www.cdc.gov/spanish/temas/ambiental.html

The Biology Project
The University of Arizona.
Web: http://www.biology.arizona.edu/

A goal of the Biology Project is to serve the general public and learners at all levels – from kindergarten to the upper division university level. This effort includes translating learning materials into Spanish and other languages to increase accessibility of learning materials worldwide.

Enfermedades provocadas por el ambiente de A a Z
National Institute of Environmental Health Sciences
Web: Web:http://www.niehs.nih.gov/about/community/espanol/hechos/enfermedades/index.cfm
Website of del la Educacion del la Ciencia de la Salud de Environmental
Web: http://www.niehs.nih.gov/about/community/espanol/educacion.cfm

CHAPTER

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Grants and Funding

FREDERICK W. STOSS

INTRODUCTION

'Competition for research funds has always been a problem for researchers investigating various aspects of toxicology and environmental health.' This is the first sentence of this chapter in the previous installment of *Information Resources in Toxicology*. This chapter was introduced in the 3rd edition, and its introduction rings more loudly a decade later. The same needs to support and fund basic and applied research, educational opportunities, and activism at the grassroots and community level is, perhaps, more acute now than then. Our understanding of the complexities of living organisms to toxic exposures expands rapidly and is now being studied at molecular levels only speculated a decade ago. As during other eras of great exploration there remains a constant – the need for funding and support for the research spawned from the initial ideas and stimulations of that exploration.

In 1997, the National Academy of Sciences (NAS), the National Academy of Engineering (NAE), the Institute of Medicine (IOM) and the National Research Council (NRC) joined together to launch Shaping the Future, the first Academies-wide fundraising initiative in our history. More than $300 million were raised. The National Academies address critical national issues and provide cogent, unbiased advice to the United States government and its citizens in matters of science, engineering, and medicine. They still need sources outside the funding from the Federal government to support their missions. The Foundation Gateway is a resource for foundations and other private funders and organizations that are interested in supporting the work of the National Academies (see: http://www.nas.edu/gateway/foundations/engineering.html).

There is a bitter irony that this chapter on financial support for research and education in the areas related to toxicology are written as forecasters place the U.S. and the world's economies in a global recession. These general negative tones for the overall economy give rise to the pessimism for the funding of basic research and development activites and educational support. Newsletters, blogs and trade journals will provide needed current-awareness services.

John Billings (2007), professor of health policy and public service (New York University) and former foundation executive, stated, 'At last estimate, private foundations had assets of more than $550 billion and gave out almost $41 billion annually, and these numbers will continue to grow as high-tech and financial investment entrepreneurs begin to cash out.' While these numbers are impressive by themselves, they do not necessarily reflect the current state of affairs for government funding in the areas related to environmental and public health.

The period of time from 2007 to early 2008 was marked by various editorial commentaries, news articles, and features noting the inadequacy of funding science and health-related research in the first years of the new millennium. Joycelyn Kaiser (2007) comments on the continuing trend in the success rate of proposed biomedical science funding from the U.S. National Institutes of Health (NIH) in 2008. 'According to data from the presidential budget request, the success rate for researchers seeking for NIH grants is expected to drop from 21% in 2007 to

19% in 2008. The falling numbers have been due to the decreasing budget from the government to finance NIH grants.' An article by Jeffrey Levi, Chrissie Juliano, and Maxwell Richardson in the trade magazine, *Nation's Health* ('Federal Funding for Preparedness at Health Departments Suffers Cuts,' November 2007, Vol. 37 Issue 9, p. 12) comments on a National Association of County and City Health Officials about the loss of local departments of health throughout the United States.

While most departments are noted to have increased their capacities to respond to medical emergencies since 9/11, continued loss of funds from the Centers for Disease Control and Prevention 'have led local health departments to delay or cancel acquisition of equipment and supplies, reduce staff time on preparedness, delaying completion of preparedness plans and cancel work force training.'

Changing paradigms in funding are noted in recent years. Ian Wilhelm (2007) reports that a growing number of U.S. foundations are making loans or investments to achieve their charitable goals. The report, which examined 92 philanthropies, says the number of funds involved in so-called mission-related investing doubled in the last 10 years, with 42 active in such investments in 1995 and 90 in 2005. The foundations have primarily used mission investments to focus on economic development, creating affordable housing, improving education, and helping the environment. How much of such funding is applied to environmental health and toxicology-related activities was not reported. The FSG Social Impact Advisors, a non-profit research and consulting group in Boston, formerly known as the Foundation Strategy Group prepared this report, paid for by the David and Lucile Packard Foundation, in Los Altos, CA. The 54-page report, 'Compounding Impact: Mission Investing by U.S. Foundations,' is available free on the FSG website: http://www.fsg-impact.org/app/content/ideas/item/485. Specific regional changes in grant funding are noted for California by Delfin Jr. and Tang (2007).

There are also recent lamentations about the ugliness with which politics has hindered basic research and development in decreasing budget allocations in the sciences, including those broadly related to the environment and aspects of medical research or the potential of conflicts of interest entering Federal funding allocations (Anonymous 2008a, 2008b, Golston 2008, Kaiser 2007, 2008, Mervis 2008a, 2008b, Pope 2008, Renner 2007). Additional articles include: 'Business And Academia Try To End Science Funding Stalemate' (Anonymous, CongressDaily, 11/13/2007, p. 8); 'Spending Stalemate' (David Goldston, Nature; 10/25/2007, Vol. 449 Issue 7165, p. 962).

GRANTSMANSHIP: THE ART OF GETTING FUNDED

Since the writing of the third edition of this work, there has been an increase in the number of books published on the topic of how to write effective grant proposals and how to build an expertise in what many regard as the *art* of the grant-writing process, often called, 'Grantsmansip.'

A search of the OCLC database, *First Search*, reveals more than 3400 items retrieved on the general topic of grants, grantsmanship, and grant or proposal writing, with nearly 900 of those works written since 2000 and nearly all of them describing the process of how to write grant proposals and other requests for funding. The specific resources for identifying the sources of funding are described below. This section of the chapter provides an introductory perspective on the art of grantsmanship and the resources that are blossoming with regard to writing cogent and, hopefully, successful grant proposals.

Many libraries and information centers maintain in their collection a cadre of resources to assist individuals and organizations seeking grants and funding and the process of preparing proposals and other solicitations for grants and other opportunities for funding. Library of Congress Subject Headings for locating books about grants and grant writing are:

- Fund raising
- Grants-in-aid
- Medical care – research grants
- Proposal writing for grants
- Proposal writing in education
- Proposal writing in human services
- Proposal writing in medicine
- Public health – research grants.

In addition to these terms being used as primary indexing terms, they are more effectively used as secondary indexing terms, such as Toxicology-Research Grants or Toxicology-Scholarships, Fellowships.

There remains, however, a paucity of monographs specifically addressing the writing of grants specifically for toxicology, environmental health, or general environmental science. The lack of such resources is partially offset by a number of good monographs addressing grantsmanship from a more generic perspective such as, *The Only Grant-writing Book You'll Ever Need*, by Ellen Karsh and Arlen Sue Fox (New York: Carroll and Graf Publishers, distributed by Publishers Group West [Berkeley, CA], 2006); *Finding Funding: Grantwriting from Start to Finish, Including Project Management and Internet Use, 5th Edition* (Thousand Oaks, CA: Corwin Press, 2008); *Grant*

Writing for Dummies, by Beverly A Browning (Hoboken, NJ: Wiley Publishing, 2005); *The Everything Grantwriting Book*, by Judy Tremore and Nancy Burke Smith (Avon, MA: Adams Media Corp., 2003); *The Complete Idiot's Guide to Grant Writing*, by Waddy Thompson (Indianapolis, MN: Alpha Book, 2007); *Webster's New World, Grant Writing Handbook*, by Sara D. Wason (Hoboken, NJ: Wiley Publishing, 2004); and *Proposal Writing: Effective Grantsmanship*, by Soraya M. Coley and Cynthia A. Scheinberg (Los Angeles, CA: SAGE Publications, 2008). The Foundation Center's *Guide to Proposal Writing* (the Foundation Center, New York, NY) provides an overview of grantwriting, including the six steps for successfully writing grants. Appendices include practical aids, including a bibliography, a sample proposal, and other useful resources.

Laura N. Gitlin and Kevin J. Lyons have updated their classic book (nearly 900 academic, public, hospital and other special libraries claim one or more of the work's three editions), *Successful Grant Writing: Strategies for Health and Human Service Professionals, 3rd Edition* (New York: Springer Publishing Company, 2008). John J. Garland contributes another monograph for the health sciences, with *Better Physician Writing and Speaking Skills: Improving Communication, Grant Writing, and Chances for Publication* (Oxford, Seattle, WA: Radcliffe Publishing, 2007). Otto O. Yang published a 2007 update to the *Guide to Effective Grant Writing: How to Write an Effective NIH Grant Application* (New York: Springer Publishers, 2007), which is frequently used as a textbook or supplemental reading for writing or communication classes in medical schools and science writing classes.

Non-profit organizations, institutes, agencies, especially at state, regional, or local levels, may not have the same caliber of resources for grantwriting as found in colleges, universities, and for-profit entities. The American Association of Museums (AAM) represents museums and professionals and non-paid staff who work for and with museums, a vast major of which are in the non-profit sector. AAM represents more than 15 000 individual museum professionals and volunteers, 3000 institutions, and 300 corporate members, including museum directors, curators, registrars, educators, exhibit designers, public relations officers, development officers, security managers, trustees, and volunteers. AAM also represents such personnel from science and technology, military and maritime, and youth museums, as well as aquariums, zoos, botanical gardens, arboretums, historic sites, and science and technology centers – all of which have the potential for addressing the issues related to toxicology and environmental or occupational health. AAM distributes through its bookstore (http://iweb.aam-us.org/Purchase/SearchCatalog.aspx), in the 'Development' section, 24 books on various aspects of grantwriting and grantsmanship, including: *Thank You for Submitting Your Proposal: A Foundation Director Reveals What Happens Next* (Martin Teitel, Emerson and Church Publishers, 2006), *Proposal Planning, and Writing, 3rd. Ed.* (Lynn E. Miner and Jeremy Miner, Oryx Press/Greenwood Publishing Group, 2003), and *The "How To" Grants Manual: Successful Grantseeking Techniques for Obtaining Public and Private Grants, 6th Ed.* (David G. Bauer, Praeger Publishers, 2007).

The *Grassroots Fundraising Journal* provides information for small to medium-sized non-profits on how to raise money from individuals. Articles include case studies, profiles of major donors, tax laws affecting nonprofits, and the historical background of grassroots fundraising (see: http://www.grassrootsfundraising.org/magazine/index.html).

Fundraising Success Magazine (http://www.fundraisingsuccessmag.com) and *FundRaising Success Advisor* are among the free subscription serials available from the North American Publishing Company (Philadelphia, PA), and produced primarily to assist non-profits in their quest for grant funding. Their *Fundraising Resource Guide* includes hundreds of agencies, consultants and service/product/software providers (see: http://www.fundraisingsuccessmag.com/resourceguide/index.php).

The Fund$Raiser Cyberzine is a digital magazine for small to medium-size non-profit groups looking to raise money. They provide information, news, reviews, feature articles, and more on a monthly schedule (current issue is always free). See: http://www.fundsraiser.com/.

FINDING FUNDS AND GRANTS

Finding appropriate grants and sources of funding can be an arduous task. As in years past, the competition for available funds is intense and the need to have an arsenal of resources at the ready is essential for those applying for grants to support research, learning, and advocacy.

Traditional grant and funding reference resources include the following list of titles and annotations. If you are using an academic, public, or special library to access these resources in their print formats, be sure to check the year(s) for which the directory-style resource(s) is compiled. If there is only an older (>5 years) print copy available, check to see if that library or institution subscribes to an online equivalent (see below).

There have been very few changes in the inventory of general grant and funding reference works. It is,

however, sad to announce the one resource that was most specific to this topic, as it pertains to non-government-supported funding, is the canceling of the print and CD-ROM version of the *Environmental Grant-Making Foundations* directory. A quick search of the OCLC database reveals that it was poorly subscribed to in any of its eight or nine editions. The announcement of their demise was made in a brief statement on their website.

GuideStar, a powerful directory database produced and maintained by Philanthropic Research, Inc., is a 501(c)(3) public charity founded in 1994. *GuideStar* identifies charitable causes and enables supporters and non-profit managers to research and benchmark organizations' missions, programs, and performance. Information for the database is collected from a number of resources. Financial information comes from the IRS Business Master File of exempt organizations and IRS Forms 990, 990-EZ, and 990-PF. Other information, such as an organization's programs, accomplishments, and goals, are obtained directly from the organization or from the organization's Form 990 or 990-EZ. You can search the database and view basic information about organizations entered, including Form 990 images and other public documents when available. There is a simple, no-cost registration providing access to this information. There is no fee to register, but they do ask you to agree to a site license agreement. *GuideStar's* database includes information on all tax-exempt non-profits registered with the IRS. Currently, there are more than 1.7 million organizations in the database including information on more than 900 000 public charities, approximately 118 000 private foundations, and nearly half a million other exempt organizations. *GuideStar's* search engine allows you to search by keyword or using our advanced search. The number of fields available in the advanced search is determined by whether you are a *GuideStar Basic*, *GuideStar Select*, or *GuideStar Premium* user (the latter two products are subscription based).

A simple search for 'toxic* and foundation*' identifies 382 sources, while 'toxic* and grant*' retrieves 72 entries. Sadly, there is not a means to search the free database to differentiate whether an entry is receiving or providing funding. For the broad search for any entry giving or receiving foundation funding the following entries retrieved are provided as examples.

- Toxicology Education Foundation (Raleigh, NC 27622)
- Reproductive Toxicology Center: A Non-Profit Foundation (Bethesda, MD 20814)
- Promind Foundation Charitable Trust (Sebastopol, CA 95472)
- ILSI Research Foundation (Washington, DC 20005)
- Te Giovanni Lorenzini Medical Foundation (Houston, TX 77030)
- Silent Spring Institute, Inc. (Newton , MA 02458)
- International Life Sciences Institute (Washington, DC 20005)
- Texas Southern University Foundation (Houston, TX 77004)
- Coalition for Justice in the Maquiladoras (San Antonio, TX 78228).

An additional search for "'environmental medicine' and foundation*" reveals 12 entries; for "'environmental health' and foundation" retrieves 72 database entries, and for lead poisoning 11 entries are found.

STANDARD GRANT AND FUNDING REFERENCE RESOURCES

Annual Register of Grant Support, 2008
National Register Publishing Co., Wilmette, IL

Provides grant programs of government agencies, public and private foundations, corporations, community trusts, unions, professional societies and associations, and educational and special interest groups.

Catalog of Federal Domestic Assistance, 2007
U.S. Government Printing Office, Washington, DC

A comprehensive compendium of federal government assistance programs administered by more than 50 agencies, including those providing support for toxicology research.

Corporate 500: The Directory of Corporate Philanthropy
Ceased publication

Corporate Foundation Profiles
The Foundation Center, New York, NY

Most current: 2002. More than 3000 programs on human health and bio-medicine are profiled.

Directory of Grants in the Physical Sciences
Ceased publication.

Directory of Research Grants
Oryx Press, Phoenix, AZ

Most current: 2006. Lists research funding in all areas of study, including the life, physical, and medical sciences.

Foundation 1000, 2007
The Foundation Center, New York, NY

Profiles of the 1000 largest U.S. foundations.

Foundation Grants Index
The Foundation Center, New York, NY

Provides a listing of grants of $5000 and greater. A useful tool to examine the types of funding support available for specific grant funding areas.

Grants Register
Ceased publication.

Grants for Information Technology
The Foundation Center, New York, NY

Most recent: 2000. With increased attention to data and information management, data archives, communication, and new technologies such as the Internet, World Wide Web, and CD-ROMs.

A Guide to NIH Grant Programs
Oxford University Press, New York, NY, 1992

No longer provided and no evidence of it being updated. However, NIH provides a website for its grants: http://grants.nih.gov/grants/grant_basics.htm. This is, sadly, not a substitute for the Guide.

National Directory of Corporate Giving, 2007
The Foundations Center, New York, NY

Provides profiles of more than 1500 corporations and companies contributing to non-profit, non-governmental organizations.

The Community of Science (COS, http://www.cos.com) is an online inventory of research funding in the United States and Canada. The Community of Science World Wide Web server contains information about scientific expertise, funded scientific research, and funding opportunities for research, and is a primary source of comprehensive grant, fellowship, and other funding opportunities in the public and private sector. For many research-oriented universities and colleges, COS, is an essential one-stop shopping mall of information. The COS philosophy is to provide working researchers with valuable information tools through its inventories of institutional support and funding opportunities. It maintains an extensive, multidisciplinary Topic Index, an interactive inventory of funded research projects, which includes many topics related to environmental and drug toxicology, environmental and occupational medicine, environmental health, and related topics.

The two most important resources for the official listings of U.S. Federal government announcements of grants and research funding are the *Commerce Business Daily* (http://cbd.cos.com/), which provides a daily listing of notices of actions and activities of the U.S. federal government and requests for proposals and contract awards and the *Federal Register* (http://gpo.lib.purdue.edu/), the official record of the U.S. government, in a searchable format, updated daily, and free of charge from GPO Access.

Channing Bete Company, long noted for its series of information booklets for general audiences has begun a special funding alerts Website of 'Current Funding Opportunities' (http://www.channing-bete.com/funding/funding-topics/health.php\?\), to provide users of their information resources access to grants applying to those issues. Topic included cover grants for various environmental health (e.g., U.S. Environmental Protection Agency (EPA) – National Community-Based Lead Outreach and Training Grant Program, U.S. Environmental Protection Agency (EPA) – Tribal Educational Outreach on Lead Poisoning and Baseline Assessment of Tribal Children's Existing and Potential Exposure and Risks Associated with Lead), drug and alcohol treatment (e.g., Open Society Institute – Closing the Addiction Treatment Gap, U.S. Department of Education, Office of Safe and Drug-Free Schools – Safe and Drug-Free Schools and Communities (SDFSC) Programs for Native Hawaiians; Mothers Against Drunk Driving (MADD) – UMADD Mini-Grants). If you are looking for a simple introductory resource, or are planning a grant-writing workshop and are looking for tips and strategies for writing a successful grant proposal, you can obtain Channing Bete's free booklet, *Finding And Getting Funding* (EM489833CBC), a brief primer on the grants process. They also produce a free online publication, Funding Opportunities-e-Newsletter (http://img.channing-bete.com/H303L/cbc_H303L.html\). Contact information for Channing Bete: One Community Place, South Deerfield, MA 01373-0200; 800-391-2118, 800-477-4776; www.channing-bete.com.

INTERNSHIPS AND SCHOLARSHIPS

New to this chapter in its fourth edition is a brief commentary and compilation on funding of higher education and post-graduate research. This is by no means to be a comprehensive discourse on how to obtain scholarships, internships, and other opportunities of support for higher education. It is meant to provide an overview of the resources and strategies for locating additional information.

Several of the more popular reference books frequently found in academic and larger public libraries:

The Scholarship Book [2007]: The Complete Guide to Private-sector Scholarships, fellowships, Grants and Loans for the Undergraduate
Cassidy DJ (2007)

New York: Prentice Hall Press

Vault Guide to Top Internships
Rosen R (2007)
New York: Vault

Scholarships, Fellowships and Loans. Vol. 5. The College Blue Book, 35th Edition.
Detroit, MI: Thompson-Gale

The U.S. Environmental Protection Agency's Science to Achieve Results (STAR) Program has four formal solicitation periods during the year: January, April, August, and October. STAR Requests for Applications invite research proposals from academic and non-profit institutions located in the U.S., and state and local governments. Details are found at http://es.epa.gov/ncer/rfa/.

Social Science Research Council (SSRC) fellowship and grant programs provide support innovators within fields, and especially to younger researchers whose work and ideas will have longer-term impact on society and scholarship. These programs often target the spaces between disciplines, where new perspectives emerge and struggle for acceptance, thus ensuring the production of knowledge and expertise on key topics, regions, and social challenges. They are great resources for bridging the scientific, medical and technical gaps favoring a strong sense of social responsibilities, such as environmental conditions in urban, rural, and migrant communities. The book, The Art of Writing Proposals, by Adam Przeworski and Frank Salomon, is among the many resources and services and opportunities provided. See: http://fellowships.ssrc.org/.

GuideStar (see above) also provides an interesting retrieval of non-profit organizations accepting interns or foundations that support internship programs in the areas of toxicology and environmental health and medicine.

Several selected and more prestigious sources of support for scholarly pursuits are provided here.

Alexander Hollaender Distinguished Postdoctoral Fellowship Program
Web: http://www.orau.gov/orise/edu/postgrad/alexh.htm

This site describes the U.S. Department of Energy's prestigious postdoctoral award for research opportunities in energy-related life, biomedical and environmental sciences.

National Academy of Science Fellowships
Web: http://www4.nas.edu/osep/fo.nsf

Information related to NAS predoctoral, dissertation, and postdoctoral fellowship programs.

Oak Ridge Associated Universities/Oak Ridge Institute for Science and Education
Web: http://www.orau.org/ and www.orau.gov/orise/Educ.html

ORAU programs include Junior Faculty Enhancement Awards to help faculty members enhance their research during the early stages of their careers. The Oak Ridge Institute for Science and Education (ORISE) was established by the U.S. Department of Energy to undertake national and international programs in education, training, health, and the environment. The ORISE Resource Guide is available in Adobe PDF format (728K) and provides a comprehensive listing of ORISE's educational opportunities for pre-college and college faculty as well as postdoctoral, doctoral, graduate, undergraduate, and pre-college students.

Scholarship and Fellowship Databases
Web: http://www.finaid.org/finaid/awards.html

This page provides links to a variety of general scholarship and fellowship databases. The term scholarship refers to awards intended primarily for undergraduate students. The term fellowship refers to awards intended primarily for graduate and postgraduate students.

Smithsonian Opportunities for Research
Web: http://www.si.edu/youandsi/studies/ofg/fellapp.htm

Grants site for the Smithsonian Institution, providing guidelines and assistance for grants and fellowships.

Society of Toxicology—Awards
Web: http://www.toxicology.org

Lists SOT awards and fellowships and links to the Sponsored Awards & Student Awards page at www.toxicology.org/spon.html, including the Burroughs Welcome Fund Award in toxicology (www.bwfund.org).

Grant and funding resource opportunities are covered in Technology Grant News, a newsletter published four times a year. This publication presents a variety of approaches to supporting technology use and development in the world of philanthropic support available for technology. Technology Grant News provides accurate, one-stop information on technology grants, free technology resources, technology partnerships, strategic alliances and technology advancement for your organization. It is a unique service for colleges and universities, K-12 schools, non profits, libraries and museums, and towns and cities. Subscriptions (for as low as $35.00 per year) to Technology Grant News provides access to a searchable Grant Index. For details go to: http://www.technologygrantnews.com/

technology-funding.html or 561 Hudson Street, Suite 23, New York, N.Y. 10014; (212) 929-4347.

Many colleges and most research universities have administrative offices or departments devoted to sponsored programs services [e.g., State University of New York (SUNY) at Buffalo Sponsored Programs Administration at http://wings.buffalo.edu/spa]. These offices serve as liaisons between grant-making groups (and other funding sources) and those faculty and staff seeking and preparing grants. These program offices typically provide comprehensive resources for applying for grants, including institution-specific requirements and guidelines and other grants-related resources. They may provide resources and documentation required to complete grant and contract applications, including links to Internet resources.

ADDITIONAL SELECT WEB-BASED GRANT-FINDING RESOURCES

American Fund for Alternatives to Animal Research – Grants
Web: http://www.ortge.ufl.edu/fyi/v23n05/fyi017.html
Information on grants in the biological sciences to replace or reduce the use of animals in biomedical research.

Biomedical Grant Information
Web: http://scilib.ucsd.edu/bml/grants.htm

This site is compiled by the Biomedical Library at the University of California at San Diego for the biomedical research community.

Catalog of Federal Domestic Assistance
Web: http://www.gsa.gov/fdac

The Catalog of Federal Domestic Assistance, produced by the General Services Administration, is a government-wide compendium of federal programs, projects, services, and activities which provide assistance or benefits to the American public. It contains financial and non-financial assistance programs administered by departments and establishments of the federal government. Entries from the Catalog of Federal Domestic Assistance include Agriculture, Environmental Quality, and Science and Technology (which includes the following subcategories: Biotechnology, Biological Sciences, Science and Education, Environmental Research, and Pesticides Control).

Centers for Disease Control and Prevention (CDC)
Web: http://www.cdc.gov/funding.htm

Site providing information on funding opportunities at the CDC.

Computer Retrieval of Information on Scientific Projects (CRISP)
Web: www-commons.cit.nih.gov/crisp

A weekly update of this service provides information on research supported by the U.S. Public Health Service.

(U.S.) Department of Energy Office of Science
Web: http://www.er.doe.gov/production/grants/grants.html

This is the DOE Office of Science's 'Grants and Contracts Web Site,' providing information on applying for an Energy Research Grant.

(U.S.) DHHS Grantsmanship
Web: http://www.hhs.gov/progorg/grantsnet

The U.S. Department of Health and Human Services has assembled a vast repository of resources for its grants programs (e.g., NIH, NIEHS, and CDC). These documents comprise a core collection of useful resources for locating grants information, applying for funding, and preparation of proposals.

EPA Grants
Web: http://www.epa.gov/epahome/grants.htm

The U.S. Environmental Protection Agency's official grants page, providing access to all relevant information concerning the agency's grants and procurements, including the EPA Grant Programs as listed in the Federal Domestic Assistance Catalog, STAR Grants and Cooperative Agreements from the EPA's National Center for Environmental Research and Quality Assurance (NCERQA), and McCrea's Resident Research Associate Program for postdoctoral and senior research awards. EPA Grants and Fellowship Information (http://www.epa.gov/epahome/scifund.htm) provides additional access to research funding opportunities in specific EPA program areas.

Federal Information Exchange (FEDIX)
Web: http://web.fie.com

Provides detailed and comprehensive coverage of federal agency programs and opportunities for funding research. Includes Opportunity Alert, an e-mail service announcing new funding opportunities in specified areas of interest.

FinAid
Web: http://www.finaid.org

To date, the most comprehensive source for all types of information about grants, fellowships, and scholarships.

Fundraising Online-IGC
Web: http://www.igc.org/fundraising

IGC has been providing Internet access to non-profit groups for a long time, and on this site they pull together some good advice about online fund-raising and online resources for fund-raising. Updated periodically.

Grants Net
Web: http://www.os.dhhs.gov/progorg/grantsnet

A resource for finding information about the Department of Health and Humans Service and other federal grants, includes key contacts for federal grant-making agencies.

International Foundation for Ethical Research – Preproposals
Web: http://www.ortge.ufl.edu/fyi/v22n20/fyi022.html

Grants for valid alternatives to the use of live animals in research, testing, and teaching.

MedWeb
Web: http://www.emory.edu/medweb/

An inventory of resources broadly related to biomedical research, including electronic publications, general grants and funding sources, guidelines and guides, institutes and agencies issuing grants, lists of Internet resources, National Library of Medicine Extramural Grants and Contracts Program, and public health.

National Institutes of Health – Office of External Research
Web: http://www.nih.gov/grants/oer.htm

An inventory of grant and contract opportunities, guidelines, and other relevant information. Includes links to the comprehensive listing of funding programs from the NIH.

National Oceanic and Atmospheric Administration Grants
Web: http://www.rdc.noaa.gov/~grants

The NOAA Grants home page provides links to appropriate sites, including the Grants Management Administration with links to specific NOAA research program areas.

National Science Foundation Biological Sciences Directorate
Web: http://www.nsf.gov/home/grants.htm

This page provides access to all NSF programs and projects related to the biological sciences and includes relevant information and resources for grants and funding. Specifies requirements, program areas, and deadlines for NSF-sponsored research grants and other funding opportunities. NSF also maintains a Grant Proposal Guide as an online resource. Alphabetical listing of NSF programs is also available.

NIEHS Grants and Contracts
Web: http://www.niehs.nih.gov/external/grant.htm

NLM Extramural Programs (Grants and Other Assistance Mechanisms)
Web: http://www.nlm.nih.gov/ep

The Extramural Programs (EP) of the National Library of Medicine (NLM) funds projects in areas defined by NLM as important to its mission. Grants are available to investigate the management and utilization of biomedical information, such as representation of medical knowledge in computers; organization and retrieval issues for image databases; enhancement of human intellectual capacities through virtual reality, dynamic modeling, artificial intelligence, and machine learning; medical decision making; linguistic analyses of medical languages and nomenclatures; investigations of topics relevant to health information or library science; and biotechnology informatics issues. These areas are applicable to data, information, and library management related to toxicology and environmental or occupational health issues and concerns.

NonProfit Gateway
Web: http://www.nonprofit.gov

NonProfit Gateway was created for non-profit groups to access federal information, including grants and other financial information. Grants-related information is available on topics such as loans and grants, federal register notices (and other toxicology issues such as community right-to-know, pollution prevention, and partnerships). The website is the result of a year-long partnership between federal agencies and departments and hundreds of non-profit groups. The Nonprofit Resources section provides links to department and agency-specific management and policy resources, such as grants, non-financial, laws, regulations, volunteer opportunities partnering, and budgets. The NonProfit Gateway provides a convenient hypertext link from a tabular matrix to specific grant-providing offices of Cabinet Departments, Federal Agencies, and Search Notices of Funding Availability.

RAMS
Web: http://www.rams-fie.com/

Provides access to assorted grants and funding opportunities.

The Grants and Other Funding chapter of the third edition of this book contained an extensive inventory of grant-providing resources from the 1998 edition of

Environmental Grantmaking Foundations. Since this reference resource no longer exists, it is not possible to provide an accurate inventory of such resources. However, the National Council for Science and the Environment (NCSE) provides an information resources portal where one can link to more than 240 'Foundations Providing Grants for Environmental Purposes.' By accessing this site one is directed to an annotated inventory of environmental grant-making organizations and a direct link to its website. To access this site go to: http://ncseonline.org/nle/. There no search capability to this inventory, and no indexing associated with it. It is, though, the most comprehensive resource for environmental grant funding.

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CHAPTER

75

Poison Control Centers

AXEL HAHN

INTRODUCTION

Poisoning is a significant global public health problem. According to World Health Organization (WHO) data, in 2002 an estimated 350 000 people died worldwide from unintentional poisoning. More than 94% of fatal poisonings occurred in low- and middle-income countries. Sufficient global figures for poisonings and their spectrum are lacking, and common statistics about poisonings are unavailable even in Western countries with a high level of chemical production. The official statistics of deaths are related to poisonings in some countries, but often only to a small sample of the variety of substances and compounds, and are not related to any products or product categories. Often, the country-specific spectrum of poisonings can be assessed only roughly via inquiries made to their centers. Since many countries have several poison centers, the data for regular national poisoning statistics need to be combined and harmonized for analysis and use in prevention and public health matters.

HISTORY

After World War II there was a proliferation of new drugs, chemicals, and household products, so that suicides and childhood poisonings from these agents drastically increased. For prevention and risk management the medical communities developed instruments to both unintentional and intentional poisonings. Special toxicology centers were founded in Europe in the late 1940s. Focal points were initiated in Denmark, Hungary, and the Netherlands, and these countries started very early with poison information services.

The first U.S. poison information center was founded in Chicago in 1953. By 1957 there were 17 poison control centers in the US. The centers collected their special information and gave it to a panel of medical professionals who added their treatment recommendations. The summarized data were typed onto index cards. Whenever medical professionals called, the aggregated data could be read easily from the printed cards. Later the originated poison centers started taking calls from the general public and improved their services and offerings. Based on their business the centers can be divided into poison information centers and poison treatment centers. The majority of poison centers in the world are not part of a patient treatment facility and function strictly as information centers.

A similar movement evolved in Europe but compared to the USA the majority of the EU centers were centralized toxicology treatment centers with integrated poison information centers. The French developed an inpatient unit for the treatment of poisoned patients in the late 1950s. In England the National Poison Information Service was developed at Guy's Hospital in London. In 1963 the first German center was formed in Berlin at the Childrens' Hospital of the Free University, followed in 1965 by a Poisoning Treatment Center at the Munich Technical University and further 15 centers. Australasian centers were also established in the 1960s.

POISON CENTERS

Modern poison centers are specialized units, often called poison control centers (PCCs) which advise on, or assist with, the prevention, diagnosis, and

management of poisoning. The structure and function of poison centers varies around the world. At a minimum a poisons center is an information service, but poison centers may also include other services such as toxicology laboratories and/or clinical treatment units. Poison centers provide emergency poison information, but can also provide clinical service and analytical toxicology support and can be involved in research, education, and training. The centers may also play an important role in monitoring adverse effects of drugs and consumer products, in handling problems of substance abuse, and in the management of chemical disasters. Often this valuable work of the poison centers is called 'toxicovigilance' or 'toxicosurveillance' in analogy to the well-known 'pharmacovigilance' or 'pharmacosurveillance.'

A poison center as part of a medical facility is able to provide immediate, free, and expert treatment advice and assistance over the telephone in case of exposure to poisonous or hazardous substances. They answer questions about personal care products, household products, medicines, pesticides, plants, bites and stings, food poisoning, alcohol, gases, fumes, etc. More than 75% of poison inquiries are managed simply by phone, greatly reducing the need for costly emergency room and doctor visits. In most countries around the world poison control centers can be reached toll free, 24 hours a day, seven days a week, and 365 days a year.

POISON INFORMATION SERVICE

The poison information service deals with the risk assessment, diagnosis, management, and prevention of exposure to any substance, by any route, in patients of any age, and arising from any circumstance, be it accidental, intentional, occupational use, etc. In addition the poison center can provide general information about substances, their properties, and toxicity to the public. The users are physicians, patients, and their relatives, bur also other emergency services, government ministries, regulatory agencies, education services, researchers, etc. The staff of the poison centers are usually physicians, nurses, scientists, or pharmacists, or a combination of these occupations. This depends very much on local circumstances, the budget, and can differ considerably around the world.

CLINICAL TREATMENT/INTENSIVE CARE UNITS

Poison centers in Western countries are often part of (university) hospital departments, often in close connection to their intensive care units. The poison center physicians or nurses would be in tight contact to the clinical treatment of poisoned patients and have special practical experience, especially in high-risk case treatment (suicide attempts, industrial intoxications, plant protection agents, drug abuse, etc.). These centers with their special knowledge could give assistance in special treatment of patients, in particular if precise and skilful treatment of highly intoxicated patients is needed, e.g., an urgent need for antidotal or secondary poison elimination therapy like dialysis, hemoperfusion, etc. Some poison centers include a high-tech laboratory for a wide range of analytical toxicology problems.

THE ASSESSMENT OF POISONINGS

The assessment of poisonings in the sense of a substance or compound related disease follows the approved principles of Clinical Toxicology.

- The evidence of a disease: Is there a disease or a definite health impairment with medical findings and signs?
- The proof of an substance or compound related exposure: Is there a (laboratory)-confirmed exposure to the involved substance or compound?
- The causal connection: Is there a causal connection between the health impairment and the related exposure?

Beside the causal connection between the health impairment and the related exposure, the severity of the poisoning has to be assessed for different analysis. Due to the fact that a great deal of the poisonings come from inquiries by phone, the assessment process has to be focused on the given phone information. The first investigations in assessing telephone inquiries on poisonings were based on developing a PhoneToxScore, which was improved through the now well-established Poison Severity Score.

POISONING SEVERITY SCORE

A standardized and generally applicable scheme for grading the severity of poisoning allows a qualitative evaluation of morbidity. Working from a simple grading scale proposed by the European Association of Poisons Centers and Clinical Toxicologists (EAPCCT), a Poisoning Severity Score (PSS) for the assessment of cases of telephone enquiries has been developed jointly with the International Programme on Chemical Safety (IPCS) and the European Commission.

0 None:	No symptoms or signs
1 Minor:	Mild, transient and spontaneously resolving symptoms or signs
2 Moderate:	Pronounced or prolonged symptoms or signs
3 Severe:	Severe or life-threatening symptoms or signs
4 Fatal:	Death

FIGURE 75.1 Poison severity score (PSS)

The Poisoning Severity Score has been elaborated, tested, and gradually revised during a project running from 1991 to 1994. Fourteen poisons centers from various countries have participated. Each center independently graded 371 cases of acute poisoning by ten different toxic agents. The data were then analyzed and compared. The concordance in grading the severity increased during the study period, and in the last phase there was an acceptable concordance among centers in 80% or more of the cases. Given the condition and quality of the original case records, this result was considered satisfactory and agreement was reached on the scoring scheme presented here. The Poisoning Severity Score grades severity as (0) none, (1) minor, (2) moderate, (3) severe, and (4) fatal poisoning (see Figure 75.1). It is intended to be an overall evaluation of the case, taking into account the most severe clinical features. Use of the Poisoning Severity Score normally requires a follow-up of all cases, but may be used on admission or other times during the course of poisoning if this is clearly stated when data are presented.

The Poisoning Severity Score has been found to be applicable for grading the severity of poisoning. It is foreseen that the Poisoning Severity Score will meet the expectations and be used in practice, but its future use and evaluation may result in some further revision and refinement. One relevant publication is Casey et al (1998).

NOTIFICATIONS OF POISONINGS IN GERMANY

In contrary to other countries Germany has a legal basis for the documentation of poisonings since 1990. With the German Chemicals Act (ChemG), the legislation of Germany has provided a basis 'to protect humans and the environment from harmful effects of dangerous substances and preparations, particularly to make them recognizable, to avert and to prevent the development of such effects.' For a realistic assessment of risks for human health, importance has been increasingly given to the knowledge of data on human toxicology that can be obtained from the evaluation of cases of poisoning in humans.

A physician who is consulted for treatment or evaluation of sequelae of diseases caused by chemical substances or products in Germany is obliged to submit essential data on poisonings to the National Center for Documentation and Assessment of Poisonings at the Federal Institute for Risk Assessment (BfR-DocCenter). The reporting refers to health impairments or even in suspected poisonings that are associated with the following substances:

- Chemical substances and products used in the household, e.g., detergents and cleansing agents, hobby, and do it yourself (DIY) articles;
- Cosmetics;
- Pest control products;
- Plant protection products;
- Wood preservatives;
- Chemicals used at the workplace;
- Harmful chemical substances found in the environment, also after industrial accidents and transportation accidents and
- Plants/animals.

In addition, the German poison information and treatment centers were subjected to compulsory reporting of their findings of general importance gained in the context of their activities.

At the same time there is a notification process for manufacturers or distributors for dangerous preparations, biocides, cosmetics, and detergents for use in emergencies by poison centers, in which the BfR-DocCenter with its 'Poison Information Database' has a key function for the German poisons centers.

The estimation of toxic risks in humans is based on analyses and evaluation of the data from poisoning cases. For these purposes, the data on cases in humans are continuously documented in the form of case data sets and case reports. Information on identified risks is provided to the responsible ministries, manufacturers, and industrial associations in the form of rapid communications or annual summarizing reports by means of the product information system called PRINS. The DocCenter publishes annual reports on the knowledge gained from the cases of poisoning reported by physician as electronic documents on the internet (www.bfr.bund.de) and administers the German Commission 'Assessment of Poisonings'.

REPORTED CASES

Experience has shown that the concept of 'poisoning' can cause considerable misjudgments of the

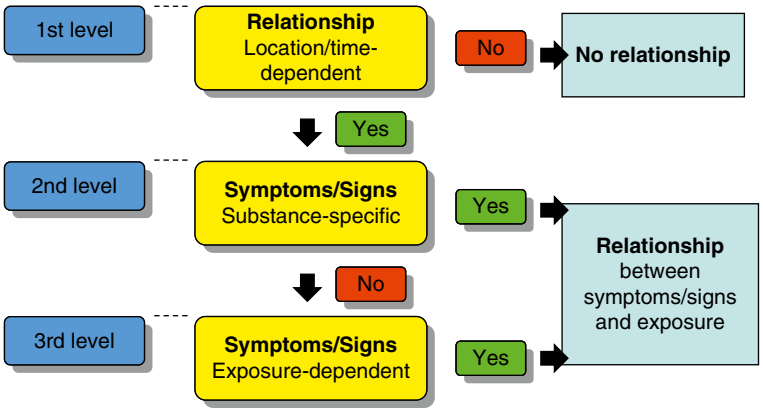

FIGURE 75.2 BfR three level model: Relationship between symptoms/signs and exposure

degree of severity and the sequelae in a 'case of poisoning.' However, the term 'poisoning' as it is commonly understood does not comply with a large number of severe cases reported to the BfR-DoCCenter, as most of the reported cases have no acute severe damage to health or subsequent damage to health in their course. This applies particularly to unintentional ingestion by children and adults. Owing to the small amounts ingested, a major part of the cases on which advise is given by poison control centers or which are treated in hospitals do not result in serious acute nor in permanent damage to health. Fortunately, cases of poisonings resulting in severe or even irreversible damage to health are very rare. In order to avoid unnecessary dramatization, the term 'poisoning' should be used in a differentiated way. This applies especially to cases involving chemical substances from the environment. It would be more appropriate here to refer to them as to health impairments caused by chemical substances.

ASSESSMENT OF POISONINGS

Evaluation of the single cases according to proved and scientifically acknowledged principles is required to derive from the reports substantiated statements about the course of poisonings by chemicals. The fundamentals for documentation and computerized evaluation of data were developed under a research project of the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety. This is the only way to develop a systematic and realistic description of the health risk associated with individual substances. Evaluation of the individual cases should be based on the causal relationship between exposure and manifestation of the health impairment. The most important criterion is to answer the question whether there is a chronological relationship between health impairment and exposure. If the answer is 'yes,' a causal relationship cannot be denied. As a rule, this question can be answered easily in cases of acute poisoning. In many cases, particularly those involving suspected chronic exposure, data are often contradictory and vague. In such cases it is of great importance whether symptoms or signs disappear if exposure is avoided ('dechallenge') and appear again after fresh exposure ('rechallenge'). In many cases, original conditions are not reproducible in a plausible way and such cases cannot be evaluated. The evaluation of causality is supported by assignment of the cases to different categories.

Base Criteria for Evaluation

The first step of evaluation (see Figure 75.2) involves assigning a case to one of three clear-cut categories, depending on the relationship between the location of the poisoning event and time-dependency of symptoms/signs (1st level), the substance-specific symptoms/signs (2nd level), and additional exposure-dependent symptoms/signs (dechallenge/rechallenge 3rd level). This led to the 'relationship between health impairment and exposure' of: 1. No relationship, 2. Relationship exists, and 3. Relationship cannot be evaluated.

A more detailed pre-analysis especially in the clarification of the exposure is shown in Figure 75.3.

In cases, especially in those with chronic low-dose levels, a matrix of exposure vs. probability is recommended.

The evidence of related symptoms/signs, specific clinical analysis and other diagnoses is very important to assess, especially in difficult cases, to have a clear evaluation of the relationship between exposure and health impairment (Figure 75.4).

One question that is posed is whether the symptoms and signs observed are already known, i.e., have they been described in literature or in plausible reports about other cases? If there is a 'typical' pattern

Exposure		Noxious agent	Ambient monitoring		Human biomonitoring	
		Source? distance?	Single measurement	Measurements representative	Single measurement	Above reference levels
NO	None	–	–	–	–	–
YES	Possible	+	+	–	–	–
	Probable	+	+	+	+	–
	Certain	+	+	+	+	+
?	Not assessible	Lack of data				

FIGURE 75.3 BfR assessment tool: Decision matrix "exposure vs. probability"

Causality		Exposure	Health impairment			
		Plausible	Partly specific symptoms/signs	Specific symptoms/signs	Specific clinical analysis	Other diagnoses
NO	None	–	–	–	–	+
YES	Possible	+	+	–	–	+
	Probable	+	+	+	–	–
	Certain	+	+	+	+	–
?	Not assessible	Lack of data				

FIGURE 75.4 BfR assessment tool: Causality matrix "exposure vs. health impairment"

of symptoms and signs, the degree of probability of a relationship between exposure and disease is high. If it is not, the relationship is uncertain but cannot be excluded without a sufficient degree of certainty. Evaluation of the substance-related pattern of symptoms and signs, which is often very unspecific and difficult to assess, requires a high degree of sound practical experience in toxicology. This applies particularly to chronic poisonings. A detailed inquiry concerning case history, findings, differential diagnoses, etc. conducted by telephone and in writing is useful. Results of clinical and environmental measurements also help.

Specific Problems Involved in the Evaluation of Chronic Exposure to Chemicals

In cases of chronic exposure to substances and subsequent impairment of health (e.g., cases of 'environmental poisoning'), such an evaluation is particularly difficult since many cases involve a vague exposure and the level of possible exposure to substances can be assumed to be small. As a rule, the pattern of manifestations of health disturbances is often different and unspecific for most of the chemicals. An essential problem is the differentiation of the symptoms and signs observed in relation to spontaneously occurring

disorders, e.g., headache, lack of concentration, dizziness, etc. The relationship between chronic exposure to substances and subsequent health impairment can only be established on the basis of the toxicological history and extensive examinations using assessment tools like Figs 75.2–75.4. The several kinds of differential diagnosis have to be proved. Experience has shown the importance of having all findings and assessments of a case discussed among a group of specialists.

International Associations

American Association of Poison Control Centers (AAPCC) and American Academy of Clinical Toxicologists (AACT)

The American Association of Poison Control Centers (AAPCC) was founded in 1958 to promote cooperation between poison centers in various cities, and to standardize the operation of these centers. In addition, AAPCC activities included poison prevention and education programs for both physicians and the general public. In 1968 the American Academy of Clinical Toxicologists (AACT) was established by a group of medical doctors. The AACT's main objective was to apply principles of toxicology to patient treatment and improve the standard of care on a national basis. The 1960s and 1970s had a rapid proliferation of poison centers, and by 1978 there were 661 centers in the United States. This trend reversed during the 1980s and 1990s with a number of centers closing or merging. There was 51 certified centers in the US in 2000, and in 2004, a total of 63 poison control centers (PCCs) provided emergency phone consultations to the US public.

The AAPCC provides a forum to promote the reduction of morbidity and mortality from poisonings through public and professional education and scientific research, and ways to set voluntary standards for poison center operations together with criteria for certification of poison centers and their systems. Current criteria and actual lists of US poison centers can be downloaded from the AAPCC website (www.aapcc.org). The AAPCC periodically surveys all US poison centers to characterize operations, services, staffing, and public education activities. The AACT regularly organizes congresses and joint meetings.

The Toxic Exposure Surveillance System (TESS)

The Toxic Exposure Surveillance System (TESS) is a US monitoring system for toxic exposures. The TESS data are compiled regularly by the AAPCC on behalf of the US poison centers. These data can be used to identify hazards early and their trends, give information for prevention measures and strategies, provide data for educational and research matters and can be a base for post marketing surveillance.

National Poison Data System

The AAPCC is creating a New Core System Database (NCSBeta), the only comprehensive poisoning surveillance database in the United States. NCSBeta is a valuable resource for product safety managers, medical directors, regulatory affairs directors, and other important decision-makers within industry. The AAPCC previously developed the National Poisoning and Exposure Database, which contains detailed toxicological information on more than 24 million poison exposures reported to U.S. poison centers. This includes more than 2 million reports to poison centers in the year 2000 alone, and covers an estimated 96% of all poison exposures reported to poison centers in the U.S.

The European Association of Poisons Centers and Clinical Toxicologists (EAPCCT)

The European Association of Poisons Centers and Clinical Toxicologists (EAPCCT, www.eapcct.org/) was founded in 1964 with the specific goal of advancing knowledge and understanding of the diagnosis and treatment of all forms of poisoning. This includes a better understanding of the principles and practice of clinical toxicology in order to prevent poisoning, and to promote better care for the poisoned patient particularly through poisons information centers and poisons treatment centers. The EAPCCT hosts annual international congresses.

Together with the American Academy of Clinical Toxicology, the EAPCCT sponsors the scientific journal *Clinical Toxicology* (until 2004 named *Journal of Toxicology – Clinical Toxicology*). As the official journal of the EAPCCT, *Clinical Toxicology* publishes peer-reviewed scientific research and clinical advances in clinical toxicology. The EAPCCT regularly organizes joint meetings, particularly through the auspices of the International Programme on Chemical Safety (IPCS), which is a joint undertaking of WHO, International Labour Organisation (ILO), and United Nations Environment Programme (UNEP).

WHO and the International Programme on Chemical Safety (IPCS)

The International Programme on Chemical Safety (IPCS), established in 1980, is a joint program of three Cooperating Organizations (WHO, ILO, and UNEP), implementing activities related to chemical safety. WHO is the Executing Agency of the IPCS, whose

main roles are to establish the scientific basis for safe use of chemicals, and to strengthen national capabilities and capacities for chemical safety. The IPCS Programme on Poisoning Prevention and Management seeks to build capacity in countries to deal with these problems. An important area of activity is promoting the establishment and strengthening of poison centers, an effort carried out under the IPCS INTOX Programme. Other WHO activities include the provision of information on chemicals, the provision of information management tools, and the development of internationally peer-reviewed guidelines concerning the prevention and clinical management of poisoning and to provide the world directory of poison centers (WHO Yellow Tox, www.who.int/ipcs/poisons/centre/directory/en/).

The IPCS INTOX Programme

The IPCS INTOX Programme (www.who.int/ipcs/poisons/intox/en/index.html) is a global endeavor to promote chemical safety through the establishment and strengthening of poisons centers. The program's objectives are achieved through international cooperative and collaborative efforts coordinated by IPCS. These efforts have been particularly directed at the following activities: (1) Development and provision of information on chemicals and chemical exposures (INTOX Databank), (2) Development and provision of information management tools (INTOX Data Management System), and training in their use, (3) Development of training materials (INTOX Poisons Centre Training Manual), (4) Maintenance of a network for sharing information and for mutual assistance on poisons center and toxicological issues (INTOX Network), and (5) Workshops on the establishment of poisons centers.

Who Participates in the IPCS INTOX Programme?

More than 100 experts from over 75 countries and those responding to emergencies concerning toxic exposures bring their collective knowledge, expertise, and experience to the development of IPCS Poisons Information Monographs (PIMs) and IPCS Treatment Guides. They contribute to the program in a number of different ways, e.g., by writing and peer-reviewing documents for the INTOX Databank on the prevention, diagnosis, and management of poisoning, by assisting with training, by providing support to newly established poisons centers, by participating in INTOX working groups, and by making available their expertise and knowledge to help with toxicological problems.

The INTOX Databank and Data Management System (the INTOX Package) was developed and is under maintenance of the Canadian Center for Occupational Health and Safety (CCOHS). The INTOX monographs are a unique collection, providing advice on the prevention and treatment of poisoning. The following are the collections of documents contained in the IPCS INTOX Databank.

IPCS Poisons Information Monographs (PIMs)

PIMs provide evaluated information on substances (chemicals, pharmaceuticals, poisonous plants, and poisonous and venomous animals) commonly involved in cases of poisoning. A PIM is a practical document designed to facilitate the work of poisons information specialists, clinicians, and analytical toxicologists. PIMs summarize the physico-chemical and toxicological properties of the substance, clinical features of toxicity resulting from different routes of exposure to the substance, the patient management, and the supporting laboratory investigations.

IPCS Treatment Guides

These guides are concise documents which harmonize indications for the clinical management of poisoning cases. They deal with the management of symptoms, clinical conditions or syndromes commonly observed in toxic exposures. Treatment Guides are prepared by experienced clinical toxicologists and pharmacists, reviewed by working groups and then incorporated into the IPCS INTOX Databank when consensus on clinical recommendations has been reached.

IPCS/EC Evaluation of Antidote Series

Antidote Monographs provide definitive and authoritative guidance on the use of antidotes to treat poisoning. This series summarizes and assesses, on an antidote-by-antidote basis, their clinical use, mode of action, and efficacy. This series is an undertaking of IPCS and the European Commission.

IPCS International Chemical Safety Cards (ICSCs)

Summarized health and safety information on nearly 1300 chemicals for individuals at the workplace.

IPCS Environmental Health Criteria monographs (EHCs)

Comprehensive data from scientific sources for the establishment of safety standards and regulations.

CCOHS CHEMINFO Database

Chemical profiles of a wide variety of potential workplace hazards, including a detailed evaluation of health, fire and reactivity hazards, along with first aid recommendations.

FIGURE 75.5 WHO regions of the world

WHO/FAO Pesticide Data Sheets

Basic information for safe use of pesticides.

UK Poison Information Documents (UK PIDs)

Detailed chemical and pharmaceutical monographs produced for poison centers by the UK National Poisons Information Service Centers.

International Agency for Research on Cancer (IARC)

In 1969, the International Agency for Research on Cancer (IARC) initiated a program on the evaluation of the carcinogenic risk of chemicals to humans involving the production of critically evaluated monographs on individual chemicals. In 1980 and 1986, the program was expanded to include evaluations of carcinogenic risks associated with exposures to complex mixtures and other agents. The objective of the program is to elaborate and publish in the form of monographs critical reviews of data on carcinogenicity for agents to which humans are known to be exposed and on specific exposure situations; to evaluate these data in terms of human risk with the help of international working groups of experts in chemical carcinogenesis and related fields; and to indicate where additional research efforts are needed.

Candidate Substances Database

The Candidate Substances Database is a convenient tool for identifying over 120 000 chemical substances. This database allows users to conveniently and quickly locate information on chemical names and specific Chemical Abstracts Service (CAS) Registry Numbers. Each record contains identification information on a unique chemical substance, including chemical names and synonyms, the CAS registry number, and any other unique identifying numbers. Data are derived from authoritative CCOHS databases such as CHEMINFO, the RTECS® database from the U.S. National Institute for Occupational Safety and Health (NIOSH), and the Domestic Substances List/Non-Domestic Substances List (DSL/NDSL) database from Environment Canada.

WHO World Directory of Poisons Centers

As noted above, a world directory of poisons centers (Yellow Tox) is maintained by WHO. The Yellow Tox directory is a list of all Poison Centers in the world and is regularly updated. The directory is separated into the different WHO regions (see Figure 75.5), including the Americas region (the whole continent from the north to the south), Africa (different parts), European region inclusive of Greenland, Eastern Mediterranean Region (with different part of Africa and Middle East), South-East Asia and Western Pacific Region.

Based on the status of 2007 the world has in total 219 Poison Centers, 10 in the Africa Region, 79 Centers in the Americas' Region, 10 in the South-East Asia Region, 90 in the European Region, 14 in the Eastern

TABLE 75.1 WHO regions of the world and number of centers

WHO region	Number of centers
African Region	10
Region of Americas	79
South-East Asia Region	10
European Region	90
Eastern Mediterranean	14
Western Pacific Region	16
Total	219

TABLE 75.2 Countries and number of centers

Countries	Number of centers
USA	66
Italy	18
France	13
Germany	10
Poland	9
Canada	8
United Kingdom	6
India	4
Australia	4
Spain	4
South Africa	3
Indonesia	3
Japan	3
Tobago	2
Algeria	2
China	2
Vietnam	2
Greece	2
Kazachstan	2
Romania	2
Egypt	2
Iran	2
Pakistan	2
48 Countries	1
Total Centers	219

Mediterranean Region and 16 in the Western Pacific Region (see Table 75.1).

The largest concentration of poison centers exists in the Western industrial world (see Table 75.1), with the North American continent having 79 poison centers and the European Region with 90 poison centers. This means that there are only 55 in the rest of the world's countries.

The excellent medical care with Poison Centers in the Western industrial world is to be seen clearly if the number of the poison centers is listed by the countries (see Table 75.2). The U.S. has 66 centers, Italy 19, France 13, Germany 10, Poland 9, and the United Kingdom 6.

TABLE 75.3 Table of countries and the population served by a poison center

Countries	Population served by a poison center (millions of people per center)
USA	4.5
Italy	3.2
France	4.8
Germany	8.2
Poland	4.3
Canada	4.1
United Kingdom	10.1
India	273.8
China	657.0

The calculation of the number of poison centers by the countries' population shows the wide range of medical care in giving advice and treatment in poisoning matters (Table 75.3). Investigations in Germany showed that, under ideal conditions, a poison center could support 10–15 million people.

REPORTS ON POISONINGS

Regular reports on poisonings are published in many poison centers, some of them with a long tradition. Most of the reports of the countries are only in the national language, and not all are harmonized and standardized according to international recommendations. Information about reports is available via the world directory of poison centers (Yellow Tox) (http://www.who.int/ipcs/poisons/center/directory/en/index.html).

Substantial progress was made through the recommendations of the EAPCCT and the joint progress through the WHO INTOX Programme. Significant and nationwide reports on poisonings are available in English:

- USA: Annual Reports of the National Poisoning and Exposure Database since 1983 (http://www.aapcc.org/annual.htm)
- Sweden: Actual annual reports (http://www.giftinformationscentralen.se)
- Germany: BfR Reports of the Centre for Documentation and Assessment of Poisonings (http://www.bfr.bund.de/cd/1717).

LINKS/LITERATURE

American Association of Poison Control Centers (AAPCC)
Web: http://www.aapcc.org/.

Basic Analytical Toxicology
Web: http://www.who.int/ipcs/publications/training_poisons/basic_analytical_tox/en/index.html.

Chemical incidents and emergencies
Web: http://www.who.int/ipcs/emergencies/en/.

The European Association of Poisons Centres and Clinical Toxicologists (EAPCCT)
Web: http://www.eapcct.org/.

German Chemicals Law
web: http://www.gesetze-im-internet.de/chemg/index.html.

German Documentation of Poisonings
Web: http://www.bfr.bund.de/.

Human Case Documentation of Poisonings
Web: http://www.bfr.bund.de/.

International Programme on Chemical Safety
Web: http://www.who.int/ipcs/en/.

IPCS INCHEM
Web: http://www.inchem.org/.

IPCS INTOX Package
Web: http://www.who.int/ipcs/poisons/package/en/index.html.

The IPCS INTOX Programme
Web: http://www.who.int/ipcs/poisons/intox/en/index.html.

Poisoning Prevention and Management
Web: http://www.who.int/ipcs/poisons/en/.

World directory of poison centers
Web: http://www.who.int/ipcs/poisons/centre/directory/en/index.html.

Journal Articles

Casey PB, Dexter EM, Michell J, Vale JA (1998) The prospective value of the IPCS/EC/EAPCCT poisoning severity score in cases of poisoning. J. Toxicol. Clin. Toxicol. 36(3): 215–217.

Persson HE, Sjöberg GK, Haines JA, Pronczuk de Garbino J (1998) Poisoning severity score. Grading of acute poisoning. J. Toxicol. Clin. Toxicol. 36(3): 205–213.

CHAPTER

76

Patents

TODD STEDEFORD

INTRODUCTION

A patent is a property right granted to an inventor for an invention (Black's Law Dictionary 2004). The right conveyed by a patent is the power to exclude others from making, using, or selling an invention for a set period of time. In the United States (U.S.), a patent issued by the U.S. Patent and Trademark Office (USPTO) is only effective in the U.S. and U.S. territories, generally for a term of 20 years (USPTO 2007a). For inventors seeking protection outside of the U.S., a patent application must be filed within each country the inventor seeks patent rights or with a regional patent office. The World Intellectual Property Organization (WIPO) administers services, based on international agreements, which enable inventors from its 184 member states to file international patent applications (WIPO 2007). Once filed, the inventor's patent rights are preserved from the date of filing against subsequent patent applications from an inventor belonging to a member state (see http://www.wipo.int/pct/en/texts/articles/atoc.htm; http://www.wipo.int/treaties/en/ip/paris/trtdocs_wo020.html).

A wide variety of information is available in patent applications and patents that are relevant to toxicologists. For example, if the keywords 'hepatotoxicity' and 'prevention' are used to search the USPTO's Patent Application database (http://appft1.uspto.gov/netahtml/PTO/search-bool.html), 2935 applications are flagged (search conducted on 01/27/2008). These results can be scanned or further refined by adding or changing the search terms. For example, patent application number 20070275885 titled '*Microcystins as agents for treatment of cancer*' is one of the 2935 flagged applications. This invention relates to the use of microcystins for treating cancers, including liver cancer, and provides a method for screening microcystins to identify those with enhanced cytotoxicity. As another example, a search of the USPTO's Patent Database (http://www.uspto.gov/patft/) for abstracts that contain 'liver' and 'damage' as keywords (ABST/(liver and damage)) produces 58 issued patents (search conducted on 01/27/2008). Patent Number 7,235,523 titled '*Methods for the treatment of hepatic disorders*' describes an invention for inhibiting specific receptors involved in liver injury and damage.

Patents are a unique medium for conveying toxicological, and other, information because restrictions are placed on the granting of a patent for prior published work. In the U.S., if a description of the invention is published more than one year before a patent application is filed, a patent may not be granted (USPTO 2007b). For example, if a research group publishes their invention in the form of a meeting abstract or a journal article, they may lose the right to patent the invention if a patent application is not filed within one year of the date of publication. However, in many foreign countries, an inventor must file a patent application on the date of public use or disclosure in order to preserve patent rights.

Because of the time restrictions for filing patent applications based on prior published works, several advantages are gained by using patent applications and patents as an information resource. First, novel inventions may appear in the form of a patent application or patent prior to surfacing in the scientific literature. Second, patent data may assist researchers with making informed decisions when choosing strategies for

researching or developing new products. Third, patent data may aid with identifying competitors or possibly future collaborators. Fourth, patent applications and patents may contain solutions to technical problems experienced by researchers. Finally, patent data can assist with revealing research trends and emerging technologies, which may be used as guides for strengthening the competitiveness of research programs or grant applications.

This chapter provides resources for obtaining patents, information on patents, and patenting scientific information. A selection of books and journal articles is provided, along with an introduction to international patent organizations. In addition, an assortment of open access and fee-for-service databases which provide full-text patents has been compiled. The information resources are presented in the following order: 'Books', 'Journals', 'Journal articles', 'Organizations', 'Databases', and 'Other resources'.

References

Black's Law Dictionary, 8th edn (2004) Patents.

USPTO (2007a) What is a Patent?, General Information Concerning Patents. http://www.uspto.gov/web/offices/pac/doc/general/index.html#patent

USPTO (2007b) Novelty And Non-Obviousness, Conditions For Obtaining A Patent, General Information Concerning Patents. http://www.uspto.gov/web/offices/pac/doc/general/index.html

WIPO (2007) http://www.wipo.int/about-wipo/en/what_is_wipo.html

RESOURCES

Books

Durham AL (2004)
Patent Law Essentials: A Concise Guide, 2nd Edition
Praeger Publishers, Westport, CT

Contains 12 chapters dealing with general aspects of patent law, including an overview of the field, distinguishing patent rights from other rights, reading a patent, patent subject matter, and litigation. Special topics, such as design patents, plant patents, foreign patents, and patent computer programs, are also discussed.

Gilbert J (2004)
The Entrepreneur's Guide to Patents, Copyrights, Trademarks, Trade Secrets & Licensing
Berkley Publishing Group, New York

Deals with various aspects of intellectual property. Three of the 18 chapters are exclusively devoted to patent topics, including: what may be patented, filing a successful patent application, and avoiding, detecting and defending against patent infringement.

Gordon TT, Cookfair AS (2000)
Patent Fundamentals for Scientists and Engineers, 2nd Edition
CRC Press, Boca Raton, FL

Addresses a variety of themes in its 13 chapters including: a background on patents, the U.S. and Canadian patent systems, patentability, searching patents, record keeping, and patents around the world.

Grubb PW (2005)
Patents for Chemicals, Pharmaceuticals and Biotechnology: Fundamentals of Global Law, Practice and Strategy, 4th Edition
Oxford University Press, New York

In 25 chapters five major aspects of patents are addressed, including: an introduction and background to the modern patent system, patent law and procedure, patentability of inventions in specific technical fields, patenting in practice, and commercial exploitation of patents.

Knight HJ (2001)
Patent Strategy: For Researchers and Research Managers, 2nd Edition
John Wiley & Sons, New York

Contains nine chapters that address the following areas: basic intellectual property concepts, the value of patents, developing a patent strategy, researching, infringement, working with patent attorneys and agents, disclosure and filing, and future perspectives.

Mueller JM (2006)
An Introduction to Patent Law, 2nd Edition
Aspen Publishers, New York

An introductory text that covers the basic tenets of patent law. The 11 chapters discuss foundations of the U.S. patent system, patent claims, disclosure requirements, novelty and loss of right, the non-obviousness requirement, the utility requirement, potentially patentable subject matter, correcting issued patents, infringement, including defenses and remedies, and international patenting issues.

Stim R (2006)
Patent, Copyright & Trademark: An Intellectual Property Desk Reference, 8th Edition
Nolo, Berkeley, CA

Comprehensive resource divided into four parts with in-depth coverage of patent law, copyright law, trademark law, and trade secret law.

Thomas JR (2005)
Pharmaceutical Patent Law
BNA Books, Washington, DC

Eighteen chapters dedicated to a specific area of patent law. This text covers a variety of topics, including: patent acquisition, marketing approval procedures, infringement, and international and comparative aspects of pharmaceutical patent law.

Journals

Journal of Patent Associated Literature (JOPAL) (1988–)
World Intellectual Property Organization, Geneva
Web: http://www.wipo.int/scit/en/jopal/issue.htm

A monthly publication compiled by the World Intellectual Property Organization, which contains bibliographic details of articles published in leading scientific and technical periodicals arranged according to symbols of the International Patent Classification (IPC).

Journal of the Patent and Trademark Office Society (1918–)
Patent and Trademark Office Society, Arlington
Web: http://www.jptos.org/

A monthly publication produced by the Patent and Trademark Office Society that provides a forum for addressing legal and technical subjects relating to the useful arts and knowledge of the functional attributes of intellectual property law.

Patent, Trademark & Copyright Journal (1970–)
The Bureau of National Affairs, Inc., Washington, D.C.
Web: http://www.bna.com/products/ip/ptcj.htm

A weekly publication produced by the Bureau of National Affairs, Inc., which provides unique and comprehensive coverage of intellectual property cases, statutes, trends, and other key developments in all areas of intellectual property law.

World Patent Information (1979–)
Elsevier Inc., New York
Web: http://www.elsevier.com/wps/find/journaldescription.cws_home/654/description#description

A quarterly, peer-reviewed journal that provides a worldwide forum for the exchange of information between experts in industrial property documentation, information, classification, and statistics. Regular features include the following: papers addressing industrial property information and documentation, new regulations, short reports on relevant meetings and conferences, bibliographies, and book and literature reviews.

Journal Articles

American College of Obstetricians and Gynecologists (2003) Patents, medicine, and the interests of patients: applying general principles to gene patenting. Int. J. Gynaecol. Obstet. 80: 93–98.

Bobrow M, Thomas S (2002) Patenting DNA. Curr. Opin. Mol. Ther. 4: 542–547.

Brown WM (2003) Intellectual property law: a primer for scientists. Mol. Biotechnol. 23: 213–224.

Chan K, Fernandez D (2004) Patent prosecution in structural proteomics. Assay Drug Dev. Technol. 2: 313–319.

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Edfjall C (2006) Patent information from the EPO in 2005 – Recent developments and future plans. World Patent Information 28: 112–116.

Elliott GC (2002) A brief guide to understanding patentability and the meaning of patents. Acad. Med. 77: 1309–1314.

Ergenzinger ER, Jr, et al (2004) Patenting neuroscience: challenges and opportunities in an interdisciplinary field. Nat. Rev. Neurosci. 5: 657–661.

Ernst H (2003) Patent information for strategic technology management. World Patent Information 25: 233–242.

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Fleck B, Baldock C (2003) Intellectual property protection for plant-related inventions in Europe. Nat. Rev. Genet. 4: 834–838.

Landolt F (2004) "It's the chemistry, stupid!", or: The impact of early discovery patent applications on the drug development process. Curr. Top. Med. Chem. 4: 601–608.

Ludwig SP, Kosinski KB, Harris J (2005) Hatch-Waxman in the Federal Courts: from 1994–2004. Drug Dev. Ind. Pharm. 31: 215–222.

Makarov M (2006) The eighth edition of the IPC. World Patent Information 28: 122–126.

Moreira AC, et al (2006) Pharmaceutical patents on plant derived materials in Brazil: Policy, law and statistics. World Patent Information 28: 34–42.

O'Malley MA, Bostanci A, Calvert J (2005) Whole-genome patenting. Nat. Rev. Genet. 6: 502–506.

Schellekens H, Ryff JC (2002) 'Biogenerics': the off-patent biotech products. Trends Pharmacol. Sci. 23: 119–121.

Schutjens MH (1994) Patent law and pharmaceutical products. A comparative study of the legal aspects of medical-pharmaceutical inventions in patent law. Pharm. World Sci. 16: 161–163.

Scheu M, et al (2006) Mapping nanotechnology patents: The EPO approach. World Patent Information 28: 204–211.

Tansey M, Stembridge B (2005) The challenge of sustaining the research and innovation process. World Patent Information 27: 212–226.

Van Overwalle G (2003) Bio-patents, law and ethics. Critical analysis of the EU biotechnology directive. Law Hum. Genome Rev. 19: 187–203.

Yang D (2003) The development of intellectual property in China. World Patent Information 25: 131–142.

Organizations

European Patent Office (EPO)
80298 Munich, Germany
Phone: +49-89/23 99-0
Fax: +49-89/2399-4465 (Patent)
Web: http://www.european-patent-office.org/index.en.php

Established in 1973 by the Convention on the Grant of European Patents, the EPO administers a centralized patent grant system on behalf of the following current, contracting states: Austria, Belgium, Bulgaria, Switzerland, Cyprus, Czech Republic, Germany, Denmark, Estonia, Spain, Finland, France, Hellenic Republic, Hungary, Ireland, Iceland, Italy, Liechtenstein, Lithuania, Luxembourg, Latvia, Monaco, Netherlands, Poland, Portugal, Romania, Sweden, Slovenia, Slovakia, Turkey and the United Kingdom.

Japan Patent Office (JPO)
3-4-3, Kasumigaseki, Chiyoda-ku
Tokyo 100-8915 Japan
Phone: +03-3581-1101
Web: http://www.jpo.go.jp/index.htm

The 1885 Patent Monopoly Act created a foundation for a system of patent rights in Japan. The New Utility Model Law, enacted in 1905, served as a complement to the patent system. The JPO offices were completed nearly 30 years later followed by a complete revision of the patent law in 1959. In 1995, the JPO issued its two millionth patent.

The Trilateral Co-operation
Web: http://www.trilateral.net/

The Trilateral Co-operation was set up in 1983 and consists of the European Patent Office (EPO), Japan Patent Office (JPO), and the U.S. Patent and Trademark Office (USPTO). The Trilateral Offices process more than 85% of all patent applications filed worldwide, including Patent Cooperation Treaty applications.

United States Patent and Trademark Office (USPTO)
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450
Phone: +1-571-273-8300
Fax: +1-800-786-9199
Web: http://www.uspto.gov/

The USPTO was established based on the powers of the U.S. Congress as derived from Article 1, Section 8 of the U.S. Constitution – that is, to promote the progress of science and useful arts, by securing for limited times to inventors the exclusive right to their discoveries. The USPTO administers a patent grant system on behalf of the U.S. and foreign applicants for U.S. patents.

World Intellectual Property Organization (WIPO)
P.O. Box 18, CH-1211
Geneva 20 Switzerland
Phone: +41-22 338 9111
Fax: +41-22 733 54 28
Web: http://www.wipo.int/portal/index.html.en

The WIPO is a specialized agency of the United Nations. The WIPO Convention established the WIPO in 1967 with a mandate from its member states to promote the protection of intellectual property throughout the world through cooperation among states and in collaboration with other international organizations. WIPO currently consists of 184 members, including the United States.

Databases

Delphion (fee-for-service)
The Thomson Corporation
Web: http://www.delphion.com/

Delphion provides full-text access to over 35 million records from 70 patent offices worldwide. Value-add analysis, powerful search technology, and productivity tools are but a few of the many features provided.

Derwent World Patents Index (DWPI) (fee-for-service)
The Thomson Corporation
Web: http://scientific.thomson.com/products/dwpi/

A comprehensive database that is updated annually with 1.5 million patent documents from 41 patent-issuing authorities. As of October 2006, the database contains 14.85 million records covering 31.66 million patent documents. The subject experts for DWPI translate non-English language sources, such as Japanese, to English to aid searchers with identifying inventions filed in languages other than English. The database can be accessed in a number of different ways, including Dialog, Questel.Obit, STN, Delphion, Westlaw, and Data Feed.

esp@cenet – Europe's Network of Patent Databases
European Patent Office
Web: http://www.espacenet.com/

esp@cenet is a worldwide, open access patent database managed by the European Patent Office. The database provides information on more than 50 million patent documents from all over the world. Four search options are available to users, including a quick search, advanced search, number search, and classification search. Tutorials for using the database are freely available for download or provided online as e-learning modules. Search results contain bibliographic information and in many cases complete, full-text descriptions of the invention.

FreePatentsOnline – Patent Analytics and Patent Searching
Web: http://www.freepatentsonline.com/

FreePatentsOnline.com provides free searching of world patent data, PDF downloads, and account functions including alerts, and the ability to save, comment on, and share documents. Commercial services are also available including XML data feeds and patent analytics.

Google Patent
Web: http://www.google.com/patents

Google Patent Search provides open access to U.S. patents made available by the U.S. Patent and Trademark Office. Patents can be searched by patent number, inventor, and filing date and downloaded in PDF format.

Mayall's IP Links
Web: http://www.mayallj.freeserve.co.uk/

Mayall's IP Links provides links to a broad range of topics, including: patent databases, IP related software, patent laws, government patent offices, and miscellaneous resources.

PatentStorm: U.S. Patents
Web: http://www.patentstorm.us/

PatentStorm provides easy access to patents and full-text patents from the U.S. Patent and Trademark Office.

PATOLIS (PATent OnLine Information System) (fee-for-service)
PATOLIS Corporation
Web: http://www.patolis.co.jp/en/index.html

The PATOLIS database is the most comprehensive industrial property retrieval system in Japan. PATOLIS is used by more than 5000 Japanese companies, and provides non-Japanese speakers with an ultimate source to access Japanese intellectual property information.

The PATLIB Network
European Patent Office
Web: http://patlib.european-patent-office.org/directory/overview.pl

A network of patent information centers consisting of the national patent offices of each member state of the European Patent Organization. Over 323 offices are listed with complete contact information, including: mailing address, telephone, facsimile, e-mail, web, and key personnel.

Thomson Patent Store (fee-for-service)
The Thomson Corporation
Web: http://scientific.thomson.com/products/tps/

A fast and convenient web-based document delivery service for obtaining original patent documents from just €3 or $3 from major patenting authorities, including but not limited to the following: U.S. patents, World (PCT) patents, European patents, Japanese patents (English-language patent abstracts), and German patents.

United States Patent and Trademark Office
Web: http://www.uspto.gov/patft/

An open access database of patents issued in the U.S. since 1790. Patents issued from 1790 through 1975 are searchable by issue date, patent number, and current U.S. classification and available as full-page images. Patents issued from 1976 to present are available in full text with images of the original files. Published patent applications are available from 15 March 2001. Three search options are available for patents or patent applications: (1) quick search, (2) advanced search, and (3) patent number or publication number search.

Other Resources

Canadian Patent Office Record (CPOR)
Web: http://napoleon.ic.gc.ca/cipo/patgazarc.nsf/f_maincpor_e?OpenForm

A weekly publication that contains new patents, Canadian applications open to public inspection, and important notices. As of 2008, the Canadian patent database (http://patents.ic.gc.ca/cipo/cpd/en/introduction.html) has been updated daily. If the keywords 'toxicology' and 'risk assessment' are used to search the Canadian Patent Database, at least 50+ and 100+ applications are flagged, respectively (search conducted on January, 10, 2009). These results can be scanned or further refined by adding or changing the search terms.

Electronic Official Gazette – Patents (eOG:P) (U.S. Patent and Trademark Office)
Web: http://www.uspto.gov/web/patents/patog/

An online publication of patents issued for the week that is traditionally contained in the Official Gazette of the United States Patent and Trademark Office for Patents. Users can browse patents by number, classification, a range of classes, type of patent (e.g., utility, design, and plant), and patentee name.

The Estonian Patent Gazette
Web: http://www.epa.ee/default.asp?id=512

A bimonthly publication that contains information on the following: Estonian patents, European patents, supplemental protection of medicinal products and plant protection products, licenses and pawns, bibliographic information, and legal acts and information.

European Patent Bulletin
Web: http://www.european-patent-office.org/e_pub/bulletin/index.htm

A weekly publication that contains bibliographic data as well as data concerning the legal situation of European patent applications and patents.

The Official Gazette (Bulgaria)
Web: http://www.bpo.bg/en/index.html; Click 'Data bases' tab; then select 'BULETINS'

A monthly publication that includes bibliographic data and abstracts with drawings/chemical formulas of published applications and granted patents for inventions and utility models.

Official Journal of the EPO (European Patent Office)
Web: http://www.european-patent-office.org/epo/pubs/oj_index_e.htm

A monthly publication that provides coverage on general information from the EPO, the EPO Board of Appeal Case Law, regulations, schedule of fees and costs, information from contracting/extension states, international treaties, and upcoming events.

Patents Office Journal (Ireland)
Web: http://www.patentsoffice.ie/en/publications_download.aspx

A biweekly publication that provides information on a variety of topics, including the following: applications for patents, published applications, granted patents (including European patents), and expired patents.

PART

VI

The Global Arena

CHAPTER

77

Overview of International Activities

J. KUELLMER AND U. SCHLOTTMANN

The risks connected with chemical substances have been assessed in a number of conventions that have aimed to apply restrictions on the use of dangerous chemicals and control of their worldwide trade. The developments in chemicals policy at the European and world level are discussed, with an insight into the interlaced structure of international cooperation that exists at both the political and the technical level.

INTRODUCTION

The industrialization that the world has achieved in the past two hundred years is inextricably connected with the production and use of chemicals. According to OECD estimates, sales are twice as high as in the telecommunications sector (BMZ 2002). Chemical products have undoubtedly contributed to a substantial improvement in the quality of life. Plastics, surfactants, and a large number of basic chemicals are improving the medical and hygienic situation worldwide. However, numerous toxic substances present risks and hazards that occur during the entire life cycle of a substance: during production, during transport and trade, and during storage, use, and disposal. Awareness of environmental and health risks has grown over the last 20 years. Today this is making itself felt in an increasingly complex set of international regulations on chemical safety. The focus is increasingly shifting towards the developing countries and their populations, as people there are less aware of the risks and hazards than those in the industrialized countries. Today the worldwide spread of persistent, bio-accumulating, and toxic chemicals by air or water, their occurrence in places where they are not used, and the destruction of the ozone layer are making it clear to everyone that chemical safety is an international challenge and not just an empty phrase. But it should not be necessary for risks arising from chemicals to assume international dimensions before action is taken. That is why national or European regulations provide an appropriate framework for a large number of chemicals. Moreover, national laws and European Community (EC) legislation are enforceable law. Compliance with this law is monitored, while noncompliance is prosecuted and punished.

INTERNATIONAL ACTIVITIES

Protocols and Conventions

The Montreal Protocol

The gaps in the ozone layer over the polar region present a threat to humans, animals, and plants, because of the increase in UV-B radiation reaching the surface of the earth. This natural protective shield has been damaged by the worldwide use of ozone-depleting substances (ODS), such as chlorofluorocarbons (CFCs) and halons, which are used for fire protection materials. The Montreal Protocol (MP) is the international contractual basis for the United Nations worldwide program for discontinuing the use of ODS. The year 2007 marks two important milestones for the Montreal Protocol: it is the date by which developing countries must have reduced their CFC consumption and production by 85%, and it is also the 20th anniversary of the treaty's signature. It is thus an opportune time to reflect on why the Montreal Protocol is well on its way to achieving its goals.

Twenty years ago, 46 countries undertook to stop producing and using substances that were damaging to the ozone layer. In the meantime 191 countries have signed this protocol. The signatory states are responsible for a total of over 90% of the consumption of these substances. The original target (from 1987) of halving the consumption of CFCs by the year 2000 has since been raised considerably on a number of occasions in light of the alarming reports on the status of the ozone layer. For example, the production of CFCs in the industrialized countries was discontinued at the beginning of 1996. The amendment to the MP, which was passed in Beijing in 1999, states that from 2002 onwards the production and use of the substance bromochloromethane, which can be used as a solvent and fire extinguisher, is to be totally banned in the signatory states. This amendment and the treaty modifications adopted at the same meeting were transposed into European law by decree of the EC Council (European Council 2002). It follows from the reasons given for this decision that additional steps must be taken to monitor trade in ODS, especially partially halogenated CFCs and new substances. Methyl bromide remained unnoticed by the public for a very long time; this is despite the fact that one atom of bromine destroys 80 times more ozone than a chlorine atom (Zellner 2001). Thus the bromine content of a compound such as methyl bromide is more reactive and has a greater impact on stratospheric ozone than the chlorine content of CFCs. This pesticide has nevertheless been in use for decades as a preferred means of treating arable land. In Germany its use in the agricultural sector was banned in 1982 owing to its harmful effects on the groundwater. Since then, most industrialized countries have banned the use of methyl bromide. Under the MP, the USA agreed a ban on methyl bromide in 2005 and developing countries by 2015.

The Montreal Protocol is closely linked to the Convention on Climate Change (Kyoto Protocol, into force since February 2005). The climate protection already achieved by Montreal Protocol is far larger than the reduction target of the first commitment period of the Kyoto Protocol (Velders et al 2007). Additional climate benefits that are significant compared with the Kyoto Protocol reduction target could be achieved by actions under the Montreal Protocol, by managing the emissions of substitute fluorocarbon gases and/or implementing alternative gases with lower global warming potentials (http://www.uneptie.org/ozonaction).

The Stockholm Convention (POPs)

The POPs Convention implements international prohibition and restriction measures with regard to certain persistent organic pollutants (POPs). The core of the Convention is that 12 particularly dangerous POPs for the environment are to be prohibited or reduced until they are totally eliminated. The dynamic design of the rules of the Convention allows the original POPs substances to be joined by further substances that meet the four criteria of persistency, bioaccumulation, long-range transport potential, and harmful properties. The POPs Convention prohibits the following chemicals: aldrin, dieldrin, endrin, chlordane, mirex, toxaphene, heptachlor, hexachlorobenzene, di(para-chlorophenyl), trichloroethane (DDT), polychlorinated biphenyls (PCBs), polychlorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs). With the exception of DDT, which may still be produced and used on a country-specific basis for combating malaria, and of unwanted by-products, all other substances are listed in the Appendix (Appendix A) to the Convention, which regulates the phasing out of the production and use of these substances. The production and use of DDT for vector control will remain necessary until inexpensive alternatives become available. The relevant countries must inform the United Nations Environment Program (UNEP) on Chemicals and the World Health Organization (WHO) about the use of DDT. The Secretariat, in cooperation with WHO, reviews periodically to gather information about the amounts of DDT used by Parties, the conditions of such use and its relevance to that Party disease management strategy. The POPs Secretariat reported back to the third conference of the Parties 2007 in Dakar, Senegal. The use of DDT as a pesticide in the agricultural sector is, however, prohibited.

In May 2001 the signatory conference for the POPs Convention took place in Stockholm. The Convention entered into force once it had been ratified by 50 countries. This was the case on 17 May 2004. Up to date (February 2009) there are 162 ratifications. April 2004 saw the introduction of Regulation (EC) No. 850/2004 of the European Parliament and the Council on persistent organic pollutants (http://www.pops.int).

The Rotterdam Convention (PIC)

According to estimates by the World Health Organization (WHO), about one million accidents each year are caused worldwide through poisoning from pesticides. The worldwide trade in dangerous chemicals is merely the beginning of the life cycle of a chemical; it is followed by storage, use, and the disposal of residual stocks. That is why steps should be taken as early as the trade stage to ensure that dangerous chemicals do not adversely affect man and the environment. This applies particularly to developing countries, most of which are

today suffering from the effects of incorrect usage. For this reason, a meeting of the International Community of States in Rotterdam 1998 decided to adopt a convention defining binding rules for the trade in dangerous chemicals (PIC Convention). In accordance with the precautionary principle, this convention allows states to impose a ban on imports before a chemical is imported. This does not prohibit trade in chemicals, but makes it subject to very stringent rules, namely the 'PIC procedure', where PIC stands for 'prior informed consent'. In the context of imports, this means that the potential importing country must be informed about the chemical and take a decision before the chemical is actually imported.

The Convention covers pesticides and industrial chemicals that have been banned or severely restricted for health or environmental reasons by Parties and which have been notified by Parties for inclusion in the PIC procedure. One notification from each of two specified regions triggers consideration of addition of a chemical to Annex III of the Convention. Severely hazardous pesticide formulations that present a hazard under conditions of use in developing countries or countries with economies in transition may also be nominated for inclusion in Annex III. There are 39 chemicals listed in Annex III of the Convention and subject to the PIC procedure, including 24 pesticides, four severely hazardous pesticide formulations and 11 industrial chemicals. Many more chemicals are expected to be added in the future. The Conference of the Parties decides on the inclusion of new chemicals. Once a chemical is included in Annex III, a 'decision guidance document' (DGD) containing information concerning the chemical and the regulatory decisions to ban or severely restrict the chemical for health or environmental reasons, is circulated to all Parties. Parties have nine months to prepare a response concerning the future import of the chemical. The response can consist of either a final decision (to allow import of the chemical, not to allow import, or to allow import subject to specified conditions) or an interim response. Decisions by an importing country must be trade neutral (i.e., apply equally to domestic production for domestic use as well as to imports from any source). The import decisions are circulated and exporting country Parties are obligated under the Convention to take appropriate measure to ensure that exporters within its jurisdiction comply with the decisions.

The Convention promotes the exchange of information on a very broad range of chemicals, through:

- requirement for a Party to inform other Parties of each national ban or severe restriction of a chemical;
- possibility for a Party which is a developing country or a country in transition to inform other Parties that it is experiencing problems caused by a severely hazardous pesticide formulation under conditions of use in its territory;
- requirement for a Party that plans to export a chemical that is banned or severely restricted for use within its territory, to inform the importing Party that such export will take place, before the first shipment and annually thereafter;
- requirement for an exporting Party, when exporting chemicals that are to be used for occupational purposes, to ensure that an up-to-date safety data sheet is sent to the importer; and
- labeling requirements for exports of chemicals included in the PIC procedure, as well as for other chemicals that are banned or severely restricted in the exporting country.

The text of the Convention was adopted on 10 September 1998 by a Conference of Plenipotentiaries in Rotterdam, the Netherlands. The Convention entered into force on 24 February 2004 once it had been ratified by 50 countries. Up to date (Feb. 2009) there are 127 ratifications.

Spring 2003 saw the introduction of Regulation (EC) No. 304/2003 of the European Parliament and the Council on the Export and Import of Dangerous Chemicals. This superseded the existing Council Regulation (EEC) No. 2455/92 (July 1992) concerning the Export and Import of Certain Dangerous Chemicals. No reductions were to be made in the level of environmental and health protection in the importing countries. In order to achieve this goal, some of the provisions go beyond those of the PIC Convention. This conforms with Article 15, Paragraph 4 of the PIC Convention, which states that the contracting parties may take measures that provide more stringent protection for human health and the environment than laid down in the Convention, provided these measures are compatible with the Convention and with international law. The EC also considered it advantageous in terms of practicability that there should be a single agency responsible for contact between the EC, the PIC Secretariat, other contracting parties, and other countries. The Commission has assumed the function of the point of contact for this purpose. Exports of dangerous chemicals that are prohibited in the Community or subject to strict restrictions continue to be subject to a joint export notification procedure. In the case of imports, the EC must take decisions before the importation of chemicals that are subject to the international PIC procedure is allowed. The fact that exporters and importers are obliged to furnish information on the quantities of chemicals in international trade that are covered by this Regulation

makes for better monitoring and assessment of the impacts and effectiveness of this Regulation (http://www.pic.int).

The Basel Convention

The cross-border transport of hazardous wastes seized the public's attention in the 1980s after misadventures of 'toxic ships' sailing from port to port trying to offload the poisonous cargoes.

The Basel Convention regulates the transboundary movements of hazardous and other wastes applying the 'Prior Informed Consent' procedure. Shipments to and from non-Parties are illegal unless there is a special agreement. Each Party is required to introduce appropriate national or domestic legislation to prevent and punish illegal traffic in hazardous and other wastes. The Convention obliges its Parties to ensure that hazardous and other wastes are managed and disposed of in an environmentally sound manner. Therefore Parties are expected to minimize the quantities that are moved across borders, to treat and dispose of wastes as close as possible to their place of generation and to prevent or minimize the generation of wastes at source. Strong controls have to be applied from the movement of generation of hazardous waste to its storage, transport, treatment, reuse, recycling, recovery and final disposal. Recently the Basel Conventions handled issues like electronic and electrical wastes (e-waste), mercury and asbestos wastes and illegal dumping of hazardous wastes. The Convention entered into force 5 May 1992. Up to date (February 2009) there are 170 ratifications (www.basel.int).

In March 2007 a first meeting of an Ad Hoc Joint Working Group was convened in Helsinki, Finland, to prepare, in consultation with other relevant secretariats and the United Nations Environment Program, a study on how cooperation and synergies between the secretariats of the Basel Convention, the Rotterdam Convention, and Stockholm Convention could be improved (http://ahjwg.chem.unep.ch).

The Aarhus Convention

The United Nations Economic Commission for Europe (UNECE) Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters was adopted on 25 June 1998 in the Danish city of Aarhus at the Fourth Ministerial Conference as part of the 'Environment for Europe' process. It entered into force on 30 October 2001. The Convention establishes a number of rights of the public (individuals and their associations) with regard to the environment. It provides for the right of everyone to receive environmental information that is held by public authorities, to participate in environmental decision-making and the right to review procedures to challenge public decisions that have been made.

Autumn 2006 saw the introduction of Regulation (EC) No. 1367/2006 of the European Parliament and the Council on the application of the provisions of the Aarhus Convention in Environmental Matters to Community institutions and bodies. Bodies, offices, or agencies established by, or on the basis of the EC Treaty, had to adapt their internal procedures and practices to the provisions of the Regulation until 28 June 2007 (http://www.unece.org/env/pp/).

Intergovernmental Forums and Activities

The Stockholm Conference

The Stockholm Conference, held from 5 June to 16 June 1972 in Stockholm, was an environmental watershed (Engfeldt 2002). The Conference adopted recommendations for action at the international level. As a result of the Conference, environment ministries and agencies were established in more than 100 countries, a key requirement for carrying forth the results of the Conference. It also marked the beginning of the explosive increase in non-governmental and intergovernmental organizations dedicated to environmental preservation. The United Nations Environment Program was established. The Declaration and the Action Plan of Stockholm have been particular instruments in the rapid development of international environmental law.

The United Nations Conference on Environment and Development (UNCED)

The first Conference on Environment and Development (UNCED) was held in Rio de Janeiro in 1992, in which the positive experiences of the Montreal Protocol were maintained. Numerous heads of state and heads of government approved Chapter 19 of Agenda 21, which sets out details of the principles for internationally effective chemical safety. This chapter contains objectives for environmentally sound handling and use of chemicals, including measures to prevent illegal international trade in toxic and dangerous products. An important point is the intensification of international cooperation and the coordination of ongoing international and regional activities (www.un.org/geninfo/bp/enviro.html).

The World Summit on Sustainable Development (WSSD)

Ten years after the conference in Rio de Janeiro (UNCED), the World Summit for Sustainable

Development (WSSD) in Johannesburg ended with the approval of the declaration tabled by South Africa of the action plan that had been negotiated over a period of several months ('Johannesburg Plan of Implementation'). In the period leading up to the conference, the EU had urged that decisions be passed in Johannesburg on concrete targets, timetables, and implementation programs for chemical safety. Item 23 of the plan of implementation contains a renewal of the commitments in Agenda 21. Throughout their entire life cycle, chemicals are to be properly handled in the interests of sustainable development and the protection of human health and the environment, with the aim of ensuring by the year 2020 that chemicals are used and produced in such a way that significant negative impacts on human health and the environment are minimized. Transparent procedures for risk assessment and risk management that are based on scientific findings are to be used, and the precautionary principle in Principle 15 of the Rio Declaration for Environment and Development is to be taken into account. Developing countries are to be given technical and financial assistance with building up their capacities for the proper handling of chemicals and hazardous wastes (www.un.org/events/wssd).

The Strategic Approach to International Chemicals Management (SAICM)

The decision to develop a Strategic Approach to International Chemicals Management (SAICM) is based on the resolutions passed by the UNEP Global Ministerial Environment Forum (GMEF) in Cartagena in February 2002 and by the WSSD.

Adopted by the International Conference on Chemicals Management (ICCM) on 6 February 2006 in Dubai, United Arab Emirates, the Strategic Approach to International Chemicals Management (SAICM) is from now on the policy framework for international action on chemical hazards. The main goal of this Strategic Approach is thus to implement the sustainable use of chemicals as speedily and efficiently as possible. SAICM allows for a clear and meaningful statement of priorities that groups a number of different activities and brings together the existing chemicals management organizations. Therefore SAICM aims to encourage governments and other stakeholders from sectors such as agriculture, environment, health, industry, and labor to collaborate more effectively on minimizing potential risks. The Strategic Approach supports the achievement of the goal agreed at the 2002 Johannesburg World Summit on Sustainable Development of ensuring that, by the year 2020, chemicals are produced and used in ways that minimize significant adverse impacts on the environment and human health. To this end, SAICM promotes capacity building for developing countries and countries with economies in transition and better coordination of international efforts to improve chemicals management. Another reason to believe that SAICM will have a substantial regulatory role is that many proponents see it as the perfect vehicle for the European Union to globalize its REACH Regulation (Kuellmer 2006, Logomasini 2006, EurActiv 2007).

In order to put the strategic approach into practice, a chemicals secretariat has been established at UNEP Chemicals in Geneva. UN follow-up conferences will be held to guide and monitor the SAICM process. These International Conferences on Chemicals Management (ICCM 2–5) are scheduled for 2009, 2012, 2015, and 2020. The decisions adopted in Dubai by more than 140 States will hopefully allow the ambitious minimization goal of the 2002 Johannesburg Summit to be translated into practical actions by the year 2020 (http://www.chem.unep.ch/chemicals/default.htm).

The Classification and Labelling of Chemicals (Globally Harmonized System, GHS)

The GHS is the United Nations Globally Harmonized System of Classification and Labelling of Chemicals. The international mandate that provided the impetus for this work was adopted in the 1992 United Nations Conference on Environment and Development (UNCED), as reflected in Agenda 21. In its Plan of Implementation (para. 22 (c)) adopted in Johannesburg on 4 September 2002, the World Summit on Sustainable Development (WSSD) encouraged countries to implement the new GHS as soon as possible with a view to having the system fully operational by 2008. Being developed at UN level, the GHS provides a harmonized basis for globally uniform environmental, health, and safety information on hazardous chemical substances and mixtures.

The Globally Harmonized System for the Labelling and Classification of Chemicals was adopted in late 2002 by the UN Committee of Experts on the Transport of Dangerous Goods and the Globally Harmonized System of Classification and Labelling of Chemicals (CETDG/GHS), an Economic and Social Council (ECOSOC) subsidiary body serviced by the UNECE secretariat, in Geneva after a decade of efforts and cooperation amongst a broad number of countries and organizations, notably the Committee, ILO and OECD under the umbrella of the Inter-Organization Programme for the Management of Chemicals (IOMC). In July 2003 this draft was approved and published as

a United Nations recommendation. At its session December 2006, the Committee of Experts adopted a set of amendments to the first edition of the GHS, which will be included in a revised edition of the GHS to be published in 2007. Implementation has started with pilot countries introducing the system in their national practices in different regions of the world. The European Union is negotiating a draft proposal (European Commission 2006 a) for a Regulation which would introduce the GHS criteria in Community law. In accordance with the Commission's commitment to better regulation, the Commission Services have undertaken a public consultation on this draft proposal late autumn 2006. Adopted by the legislator on November 28, 2008 the GHS Regulation will repeal the currently existing EU Directives on classification and labeling, i.e. Directive 67/548/EEC and 1999/45/EC, after a transitional period. As soon as the GHS is implemented, trade barriers will be abolished and costs will be reduced. Animal experiments, many of which are unnecessary because of widespread repetition and duplication of tests, will be eliminated. Moreover, greater transparency will be achieved in the use of chemicals. The GHS is to address the fields of transport, workplace, consumers, and environment. The harmonization approach encompasses the classification criteria and labeling provisions on physicochemical, health-endangering, and environmentally harmful properties. On the one hand the new system is to be based on successful existing precursor models. At the same time, however, it is to introduce standardized safety data sheets worldwide and easily understood hazard symbols which make clear the risks to humans and the environment that arise when using chemicals. The labeling and information sheets would be used for the carriage of dangerous goods and the use of chemicals in industry and agriculture. This will unify the existing classification and labeling systems and supersede the separate systems for dangerous goods and hazardous substances (http://www.unece.org/trans/danger/danger.html).

The Intergovernmental Forum for Chemical Safety (IFCS)

As part of the implementation of UNCED 1992, the International Conference on Chemical Safety was held in Stockholm in April 1994, which was organized by the United Nations Environment Program (UNEP), the International Labor Organization (ILO) and the World Health Organization (WHO). The conference established the Intergovernmental Forum on Chemical Safety (IFCS), the central task of which is to promote, monitor, and harmonize the implementation of Chapter 19. The Forum is to draw up recommendations for governments and for international and intergovernmental organizations. Moreover, Forum I in 1994 laid down a concrete plan of action on the six key areas of Chapter 19 with a time scale extending until 2000. In 1995, to coordinate the work of the international organizations, the Inter-Organization Program for the Sound Management of Chemicals (IOMC) was set up, comprising UNEP, WHO, ILO, FAO, UNIDO, UNITAR (1998), and OECD. In 2000 the participants in the IFCS Forum III approved the Bahia Declaration and a concrete plan of action. This declaration makes recommendations on measures in the field of chemical safety after the year 2000. Forum IV 2003 in Bangkok was held under the motto 'Chemical Safety in a Vulnerable World' (Gaertner et al 2003). Djerassi (2004) argues that the 'absence of adequate knowledge in many less-developed countries of the extent and nature of their exposure to dangerous chemicals is their greatest vulnerability.' In order to overcome this deleterious situation, he calls for the formation of a steering committee to encourage and facilitate North/South interaction on new approaches to chemical safety. Forum V was held in September 2006 in Budapest, Hungary. Eighty-one governments participated in the meeting, together with representatives from 12 intergovernmental organizations (IGO) and 64 nongovernmental organizations (NGO). At Forum V the IFCS took stock of the progress achieved on the commitments and recommendations made at previous sessions and charted the course for work in a number of new areas. In light of the adoption of the SAICM by the ICCM in February 2006, Forum V the future role of IFCS as a contribution to the implementation of SAICM was considered (http://www.who.int/ifcs).

The International Programme on Chemical Safety (IPCS)

The IPCS was founded in 1980 as a joint venture by the UNEP, WHO, and ILO. The aim of the IPCS is to produce a fundamental scientific base for reducing the risks to human health and the environment that are caused by chemicals. It seeks to strengthen national and international efforts in the field of chemical safety. This benefits not only the participating states, but also, in particular, those states where the structures for chemical safety and the knowledge needed for building up such structures are not yet very well developed. One key area of the work of the IPCS is to compile and disseminate findings regarding risks to man and the environment arising from chemicals which may be of both industrial and natural origin. To this end numerous monographs on substances and assessment methods have been produced.

An invaluable tool for those concerned with chemical safety and the sound management of chemicals is IPCS INCHEM. Produced through cooperation between the International Programme on Chemical Safety (IPCS) and the Canadian Centre for Occupational Health and Safety (CCOHS) INCHEM directly responds to one of the Intergovernmental Forum on Chemical Safety (IFCS) priority actions to consolidate current, internationally peer-reviewed chemical safety-related publications and database records from international bodies, for public access. INCHEM offers quick and easy electronic access to thousands of searchable full-text documents on chemical risks and the sound management of chemicals.

The following items have been published (to date June 2007):

- Substance reports (Environmental Health Criteria, EHC). These reports prepared for scientific experts contain up-to-date information on health hazards and risks for a specific substance or group of substances. Recent EHCs also contain information on environmental impacts. There are currently 237 EHC reports, with more than 1000 CAS entries. There are over 800 000 INCHEM sessions in 2006 (WHO-web).
- Safety data sheets (International Chemical Safety Cards, ICSC). These summarize the principal data on a product and information on health protection and safe handling tailored to the use of the product; for example, in factories or the agricultural sector. There are currently more than 1400 ICSCs at the UN level. There were over 700 000 INCHEM sessions in 2006.
- Poisons Information Monographs (PIMs). These contain a brief description of the main chemical, physical, and toxicological properties of individual substances and provides information on diagnosis and the treatment of poisoning. PIMs are intended for poison emergency centers and other advisory units. There are currently 230 PIMs covering 462 substances.
- New substance reports (Concise International Chemical Assessment Documents, CICAD). These contain information on the hazard potential of a substance, dose–response relationships and, on the basis of sample exposure data, risk characterizations. As a rule, CICADs are based on existing substance reports. The intention is that national substance reports prepared in accordance with the CICAD procedure should be capable of easy transformation into internationally usable and recognized substance reports with a minimum of financial input. There are 71 CICADs, covering 200 chemicals. They are published by the Wissenschaftliche Verlagsgesellschaft in Stuttgart. There were over 400 000 INCHEM sessions in 2006 (http://www.who.int/ipcs/en/).

The World Library of Toxicology

The U.S. National Library of Medicine (NLM), through its Toxicology and Environmental Health Information Program (TEHIP), is a major electronic repository of worldwide toxicological data and literature citations. It has lately taken a more overt role in global activities through its forthcoming online World Library of Toxicology, Chemical Safety and Environmental Health (WLT). The WLT is being designed as an online web-based portal to information resources in toxicology, chemical safety, and environmental health, coordinated and managed by NLM and largely built by a network of Country Correspondents. Links to information resources available in specific countries will be provided in both English and the country's native language. Additionally, links to major multilateral organizations will be offered. Ancillary information such as a 'Global ert' news feature, international environmental laws, and a core list of toxicology resources, will also be available. The WLT will be accessible from http://sis.nlm.nih.gov/enviro.html.

The Governing Council of the United Nations Environment Program (GC UNEP)

The United Nations Environmental Program (UNEP) was founded as a UN institution in Stockholm in 1972 to address global problems of environment policy that can only be dealt with meaningfully by adopting a multilateral approach. The Governing Council of UNEP (GC UNEP) meets every two years to decide the UNEP work program, in line with the political objectives. For this reason delegates from 141 countries met in Nairobi for the 24th session of the GC UNEP in February 2007 to take the further steps towards the implementation of an action plan whose objective is to minimize the health and environmental impacts of chemicals by 2020. The final omnibus decision on chemicals management (UNEP/GC/CW/L.2 and UNEP/GC/CW/CRP.11) has sections on the prevention of illegal international traffic, SAICM, cooperation between UNEP and relevant Multilateral Environmental Agreements (MEAs). In the case of illegal traffic, the UNEP was particularly requested to assist the developing countries in their efforts to identify areas dangerous to humans through capacity building. On heavy metals, the GC urges filling information gaps regarding lead and cadmium, requests the UNEP Executive Director to compile an inventory of existing risk management measures, and encourages governments to reduce risks posed to human health and the environment. Following the UNEP's submission of a worldwide mercury evaluation in 2003/05, concrete steps to reduce the use of mercury worldwide are to follow. On mercury, the decision 2007: acknowledges progress made within UNEP's mercury program;

outlines priorities in reducing risks from releases of mercury; urges governments to gather information on means to reduce risk caused by supply of mercury; requests the UNEP Executive Director to prepare a report on mercury emissions, and strengthen the UNEP mercury partnerships; establishes an ad hoc open-ended working group of government and stakeholder representatives to review and assess options for enhanced voluntary measures and new or existing international legal instruments, and decides that the group will provide a progress report to GCSS-10/GMEF, and a final report to GC-25/GMEF, which will take a decision on the matter (http://www.unep.org/gc/gc24).

Sustainable Chemistry

The term 'sustainable chemistry' describes a fundamental strategy that aims not only to reduce the environmental impact of chemicals, but also to minimize all burdens on the environment and to conserve resources; it includes legal regulations (Eissen et al 2002). Its broadly based objective is a networked and closely coordinated design of chemical and product policy, environmental and health policy which takes account of social, economic, and ecological aspects (Tundo 2000). A sustainable chemicals policy can only be implemented jointly with industry and should not restrict its competitiveness (Lankey 2002). In the long term, ecological benefits go hand-in-hand with economic benefits. The chemical industry has been demonstrating this for years in cases where process innovations that make ecological sense have been systematically implemented, thus giving rise to profitable energy-saving effects. A global sustainability policy in the chemicals sector lends special significance to the responsibility of industry and the industrialized countries for the developing countries. For this reason the systematic implementation of modern knowledge management (e.g., through a GHS) and an approach based on substance flows should be an essential component of the future sustainability strategy in chemicals policy, since more transparency leads to greater safety. The OECD has initiated work to identify effective techniques and approaches in the field of sustainable chemistry and to identify activities in further development and use of sustainable chemistry programs. This includes such things as recognizing and rewarding sustainable chemistry accomplishments; disseminating technical information; promoting the incorporation of sustainable chemistry principles into various levels of chemical education; and promoting the research, discovery, and development of innovative sustainable chemistry technologies (http://www.chemistry-conferences.com).

INTERGOVERNMENTAL ORGANIZATIONS

The Organization for Economic Co-operation and Development (OECD)

The Organization for Economic Co-operation and Development (OECD) must continue to be regarded as a very important body for the development of international chemical safety; some 85% of worldwide production of chemicals takes place in the member countries of the OECD. The growing number of members (currently 30) combined with the shrinking budget has given rise to a substantive debate about the original work of the OECD. In the Environment Health and Safety Program (EHS), which has been in existence since 1971, the OECD has maintained its proven long-term key activities for the year 2008/9. Notable examples include good laboratory practice (GLP) in the testing of chemicals (Schlottmann 1997), the chemical test methods – physically, toxicologically and eco toxicologically – (Schlottmann 2002), the harmonization of classification and labeling (GHS), and risk assessment. The OECD can be expected to emerge strengthened from the initiated reform process if it plays an active part in shaping this process itself.

The OECD Mutual Acceptance of Data (MAD) system is a multilateral agreement that data generated in the testing of chemicals in accordance with the OECD Test Guidelines and OECD GLP Principles shall be accepted by other Member countries for the purposes of assessment and other uses relating to the protection of man and the environment. Test facilities which want to submit safety studies to regulatory authorities have to comply with the GLP principles. Member countries shall adopt the measures necessary for verification of compliance of test facilities located in their territory. These measures shall include GLP inspections and study audits in accordance with the recommendations of the OECD. The OECD GLP regulations are laid down in the OECD Series on GLP, which contains at present 15 documents such as the GLP Principles, Guidance for GLP monitoring procedures and specific interpretations of the GLP Principles. The OECD MAD system is open to adherence by non-member countries which express their willingness and demonstrate their ability to participate therein. Prerequisite for fully adhering MAD Decision is a full implementation of OECD GLP regulations and a successful on-site evaluation, so-called 'Mutual Joint Visits' (MJV). In a first round of MJV, most of the GLP monitoring programs of the European Union and the OECD Member countries have been successfully verified. Additionally South Africa, Slovenia, and Israel passed the verification process and are now full MAD Members with the

same rights and obligations as OECD Member countries. Provisional adherents to the MAD system are currently India and Singapore. Singapore is the fifth non-member economy to join the Council Decisions on Mutual Acceptance of Data in the Assessment of Chemicals. The period of provisional adherence, during which time Singapore will accept data from OECD member countries and other adhering economies while it establishes its GLP compliance monitoring program, began in March of 2007. The next round of the periodic evaluation program (MJV) started in 2008 and all monitoring programs in the MAD framework will be again evaluated until 2017. The GLP monitoring programs of the MAD Member countries give regulatory authorities confidence in the quality and integrity of submitted safety studies and enable the Mutual Acceptance of Data. The OECD MAD system saves governments and chemical producers over EUR 60 million every year by allowing the results of a variety of safety tests done on chemicals and chemical products such as industrial chemicals and pesticides to be shared across OECD (www.oecd.org/ehs/).

Other Intergovernmental Organizations, Agencies, and Associations

There are many additional multilateral organizations, agencies, and associations whose mission, in whole or in part, relates to various aspects of potentially hazardous chemicals. Some of these operate under forms of legal frameworks. Others are professional, scientific, or trade groups. While it is beyond the scope of this chapter to discuss them in depth, or even itemize them all, a small sampling would include: World Health Organization (WHO), International Labor Organization (ILO), Food and Agricultural Organization (FAO), United Nations Institute for Training and Development (UNITAR), United Nations Industrial Development Organization (UNIDO), International Agency of Research on Cancer (IARC), International Union of Toxicology (IUTOX) and International Council of Chemical Associations (ICCA).

MAIN FEATURES OF EC CHEMICALS LEGISLATION

The New EC Chemicals Policy

The EU legislative framework for chemical substances was a patchwork of many different Directives and Regulations which has developed historically. There have been different rules for 'existing' and 'new' chemicals. However, this system has not produced sufficient information about the effects of the majority of existing chemicals on human health and the environment. The identification and assessment of risks – covering the possible hazards of a substance as well as exposure of humans and the environment to it – have proved to be slow, as have been the subsequent introduction of risk management measures. The current system has hampered research and innovation. All chemicals that were reported as being on the European Community market between 1 January 1971 and 18 September 1981 (listed in the European Inventory of Existing Commercial Chemical Substances (EINECS)) were called 'existing' chemicals. In 1981, they numbered more than 100 000 different substances. Chemicals introduced to the market after 1981 (more than 3800) were termed 'new' chemicals. While new chemicals have been tested before they have been placed on the market, there have been no such provisions for 'existing' chemicals. Thus, although some information exists on the properties and uses of existing substances, there has been generally a lack of sufficient information publicly available in order to assess and control these substances effectively.

The allocation of responsibilities was also not appropriate: Public authorities have been responsible for undertaking risk assessments of substances rather than the enterprises that manufacture, import, or use the substances; and these risk assessments required to be comprehensive, rather than targeted and use-specific. Since 1993, only 141 high-volume chemicals have been identified as priority substances for risk assessment.

In the Strategy for a Future Chemicals Policy, published in COM (2001) 88, the European Commission (2001) outlined the results of a review of the current system and its new strategy for ensuring a high level of chemicals safety and a competitive chemicals industry through a system for the **R**egistration, **E**valuation and **A**uthorisation of **Ch**emicals – the REACH system. The REACH Regulation (EC) No 1907/2006 creates a level playing field for 'existing' and 'new' substances and entered into force on 1 June 2007. It simplifies EU level regulation in replacing 40 existing pieces of legislation and in creating a single system for all chemicals. By closing the knowledge gap for more than 30 000 existing substances it will provide information on both their acute and long-term effects. For industry, there will be an incentive for safer substances which will direct and stimulate innovation while REACH gives more flexibility for chemicals used for the purposes of research and development. As a result of globalization and ultrafast information exchange via networked media and the Internet, the different legal systems worldwide in place increasingly influence one another. REACH will fundamentally reshape the European legal system and give new priority to environmental

and health-protection concerns with an impact on non-EU countries (European Commission 2006 b). A European Chemicals Agency (in the following Agency) will manage the scientific, technical, and administrative work.

Aims of REACH

The important aims are to improve protection of human health and the environment from the risks of chemicals while enhancing the competitiveness of the EU chemicals industry. The seven objectives that needed to be balanced within the overall framework of sustainable development were (European Commission 2007):

- Protection of human health and the environment;
- Maintenance and enhancement of the competitiveness of the EU chemical industry;
- Prevention of fragmentation of the internal market;
- Increased transparency;
- Integration with international efforts;
- Promotion of non-animal testing.

REACH is based on the idea that industry itself is best placed to ensure that the chemicals it manufactures and puts on the market in the EU do not adversely affect human health or the environment. This requires that industry has certain knowledge of the properties of its substances and manages potential risks. Authorities should focus their resources on ensuring industries are meeting their obligations and taking action on substances of very high concern or where there is a need for EC action. REACH creates a single system for both what was described as 'existing' and 'new' substances; substances were described as non-phase-in substances (i.e. those not produced or marketed prior to the entry into force of REACH) and phase-in substances (those substances listed in the EINECS, or those that have been manufactured in the EC, but not placed on the EC market, in the last 15 years or the so-called 'no longer polymers' of Directive 67/548).

Scope

REACH is very wide in its scope covering all substances whether manufactured, imported, used as intermediates, or placed on the market, either on their own, in preparations, or in articles, unless they are radioactive, subject to customs supervision, or are non-isolated intermediates. Waste is specifically exempted. Food is not subject to REACH as it is not a substance, preparation, or article. Member States may exempt substances used in the interests of defense. Other substances are exempted from parts of REACH, where other equivalent legislation applies.

Registration

Registration means that a manufacturer or importer has provided a registration dossier to the Agency and not received any indication that it is incomplete. This does not by itself mean that the dossier is in compliance with the legislation nor does it mean all the properties of the registered substance have been identified.

Substances on their Own or in Preparations

There is a general obligation for manufacturers and importers of substances to submit a registration to the Agency for each substance manufactured or imported in quantities of 1 tonne or above per year. Failure to register means that the substance is not allowed to be manufactured or imported. However, the Regulation exempts certain substances that are adequately regulated under other legislation, like medicinal products, or that generally present such low risks as not to require registration, like water, oxygen, certain noble gases, and cellulose pulp. In other cases substances occurring in nature such as minerals, ores and ore concentrates, cement clinker, etc., are not required to be registered as long as they are not chemically modified. Polymers are also exempted from the requirement to register, since they usually are not very hazardous, but in certain circumstances monomers in polymers have to be registered. However, the registration of polymers may be reviewed later.

The Commission has to review some of these exemptions, those contained in Annexes IV and V, within 12 months after entry into force of REACH. The Commission will also review the scope of the regulation five years after entry into force. Manufacturers and importers of substances need to obtain information on the substances they manufacture or import and use this information to assess the risks arising from the uses and to ensure that the risks which the substances may present are properly managed. Registration documents the performance of this duty and requires manufacturers and importers to submit a technical dossier, for substances in quantities of 1 tonne or more, and a chemical safety report, for substances in quantities of 10 tonnes or more. The technical dossier contains information on the properties, uses, and on the classification of a substance as well as guidance on safe use.

To find out the properties of the substances, information requirements are set out in the testing annexes that vary according to the tonnage in which the substance is manufactured or imported, and to the needs of the

chemical safety assessment. The tonnage 'trigger' has been chosen as it gives an indication of the potential for exposure. Tonnage for phase-in-substances is calculated as a three year average as long as they have been manufactured or imported for three consecutive years. General rules are also set out for the use of existing information, techniques such as (Q)SARs ((Quantitative) Structure Activity Relationships) and read across, and for waiving of tests (omitting them if they are not required because of their use or it is not technically possible to carry them out). New tests are only required when it is not possible to provide the information in any other permitted way. Where new tests are carried out there are general provisions on the generation of information to ensure the quality of the information. Application of Good Laboratory Practice (GLP) is required only for toxicological and eco-toxicological tests and analyses. For substances in quantities of 1–10 tonnes, non-phase-in substances and phase-in substances meeting at least one of the two criteria set out in Annex III: either substances that are potentially CMR category 1 or 2, persistent, bio-accumulative and toxic (PBT) or very persistent and very bio-accumulative (vPvB) substances or substances that are potentially dangerous to health or the environment and are used in dispersive uses are prioritized and must submit a defined set of information (set out in Annex VII) along with any other available information. Other substances at this tonnage level have to submit a set of physico-chemical information and any available and relevant (eco-) toxicological information.

For substances in quantities of 10–100 tonnes, information derived from the application of the relevant testing annexes (VII and VIII) needs to be submitted with the registration as well as all available and relevant information the registrant has. For substances in quantities of 100 tonnes or more, information derived from the application of Annexes VII and VIII, as well as all other available information the registrant has, needs to be submitted with the registration. In addition, if the manufacturer or importer does not already possess the required information required by Annexes IX, and for substances at or above 1000 tonnes, Annex X, proposals for testing for the purpose of registration need to be submitted. As those tests might be costly or involve testing on vertebrate animals, the necessity for and the quality of the testing proposal will be checked by the Agency in the evaluation process to save animals' lives and unnecessary costs. The chemical safety report (CSR) for substances manufactured or imported in quantities starting at 10 tonnes, documents the hazards and classification of a substance and the assessment as to whether the substance is PBT or vPvB. The CSR also describes exposure scenarios for specific uses of substances that are classified as dangerous or that are PBT or vPvB substances. Exposure scenarios are sets of conditions that describe how substances are manufactured or used during their life-cycle and how the manufacturer or importer controls, or recommends to control, exposures of humans and the environment. The exposure scenarios must include the appropriate risk management measures and operational conditions that, when properly implemented, ensure that the risks from the uses of the substance are adequately controlled. Exposure scenarios need to be developed to cover all 'identified uses' which are the manufacturers' or importers' own uses, and uses which are made known to the manufacturer or importer by his downstream users and which the manufacturer or importer includes in his assessment. Relevant exposure scenarios will need to be annexed to the safety data sheets that will be supplied to downstream users and distributors. To reduce costs for industry, the Agency and Competent Authorities, registrants are required to jointly submit information on the hazardous properties of the substance and its classification, and can, if they agree, also jointly submit the chemical safety report. The intention is that registrants will save money by co-operating on the preparation of the dossier. The information is submitted by one lead registrant on behalf of the others; the other joint registrants have to submit other information individually, such as their company details and their production volume. However, manufacturers and importers are allowed to opt out of the joint submission of registration dossiers if this would result in excessive cost, if they disagree with the lead registrant on the interpretation of information, or if disclosure of confidential information would cause substantial commercial damage. A 'light' registration is required for certain isolated intermediates as long as they are being manufactured under strictly controlled conditions. Intermediates are substances that are used in the manufacturing process but are consumed or transformed into another substance and therefore are not present in the final manufactured substance. For those intermediates that do not leave the site on which they are used, and those that are transported between sites under controlled conditions, only the hazard classification, any information on the properties of the substance that is already available to the registrants and information on the risk management measures applied, or recommended, need to be submitted to the Agency. If more than 1000 tonnes of an intermediate are transported under controlled conditions, as the risk of exposure is potentially higher, information which is required in Annex VII needs to be included in the registration dossier and submitted to the Agency. To facilitate the transition to the

REACH system, the registration provisions will be applied in a step-wise fashion to phase-in substances manufactured/imported over one tonne per year. For these substances, a series of registration deadlines are established for the different tonnage ranges.

Notifications under Directive 67/548/EEC of 'new substances' are considered as registrations (European Commission 2006b). They will need to be updated when a higher tonnage range is reached. The Agency is responsible for managing all registrations. About 30 000 phase-in substances (excluding intermediates) are expected to be registered over the first 11 years after the entry into force of REACH, plus a number of 'non-phase-in' substances. Given the number of registrations expected, only a simple electronic completeness check will be performed by the Agency at this stage (the quality of the submitted dossiers may be checked in the evaluation process). If the registration is not rejected within a set deadline, then the registrant may begin (for non-phase-in substances) or continue (for phase-in substances) to manufacture or import the substance. However, this does not imply any form of approval by the Agency of the assessment or use of the substance.

Substances in Articles

For the registration of substances in articles (e.g. manufactured goods such as cars, textiles, electronic chips), a special regime applies. The rules for substances in articles have been developed bearing in mind the need to adopt a proportionate approach to the millions of articles placed on the market in the EU, and the potential some of them may have to cause harm to human health and the environment due to the chemical substances contained in them. REACH requires all substances that are intended to be released from articles during normal and reasonably foreseeable conditions of use to be registered according to the normal rules, including tonnage deadlines and information requirements, if those substances are present in the articles above 1 tonne per year. In addition, all substances of very high concern present in articles above a concentration limit of 0.1% weight by weight and present above 1 tonne per year must be notified to the Agency except where exposure to humans and environment can be excluded during normal conditions of use including disposal. In such cases safety instructions should be provided. Information will also be made available to consumers on request. As a safety net, the Agency can require a registration of a substance in an article at any time when it considers that its release poses a risk to human health or the environment.

Data Sharing

Persons intending to register phase-in substances are required to pre-register them between 12 and 18 months after the entry into force of REACH. This is to facilitate data sharing and so reduce testing on vertebrate animals and to reduce costs to industry. For both phase-in and non-phase-in substances, data gained by vertebrate animal testing are to be shared, in exchange for payment. Communication mechanisms are set up to enable manufacturers and importers to reach agreements on the sharing of studies on vertebrate animals. Information not involving tests on vertebrate animals (e.g. in vitro studies and QSARs) must be shared on the request of a potential registrant. For phase-in substances, a system is established to help registrants to find other registrants with whom they can share data and to get an overview about which studies are available (pre-registration). Pre-registrants of the same phase-in substance are then required to share existing vertebrate animal test data as well as other information and agree on the generation of new test data in a Substance Information Exchange Forum. Downstream users of a substance that has not been pre-registered may ask the Agency to extend the pre-registration period by 6 months to give them more time to find a supplier or pre-register the substance themselves.

Information in the Supply Chain

The communication requirements of REACH ensure that not only manufacturers and importers but also their customers, i.e. downstream users and distributors, have the information they need to use chemicals safely. Information relating to health, safety and environmental properties, risks and risk management measures is required to be passed both down and up the supply chain. Commercially sensitive information is not required to be exchanged. The primary tool for information transfer is the well-established and familiar safety data sheet (SDS) for all dangerous substances. The provisions of the Safety Data Sheets Directive (European Commission 1991) have been carried over into the REACH Regulation and in addition added the requirement for SDS to be provided for PBT or vPvB substances and preparations containing them. As more information will be available as a result of registrations the quality of SDS will improve. Where chemical safety assessments are performed according to the registration requirements, relevant exposure scenarios shall be annexed to the safety data sheet and shall thus be passed down the supply chain. New information on hazardous properties and information that challenges the quality of risk management measures in the SDS shall be passed up the supply chain.

Downstream Users

Downstream users (DU) may be any industrial user of chemicals, whether formulators of preparations (e.g. paint producers) or users of chemicals such as oils and lubricants in other industrial processes or producers of manufactured articles such as electronic components. They are required to consider the safety of their uses of substances, based primarily on information from their suppliers, and to apply appropriate risk management measures. DU will need to communicate effectively with their suppliers, to get the information they need in the SDS supplied to them. In particular they will have to check that their use(s) is 'covered' by the SDS, i.e. that they use a substance within the conditions described in the exposure scenarios in the Annex to the SDS, and apply these conditions. To get the relevant information, DU have the right to make their uses known to their suppliers so that the suppliers can include these uses in their chemical safety assessments as 'identified' uses or pass the request on up the supply chain. A DU can also choose to keep his use confidential or decide to use a substance outside the conditions described in the exposure scenario(s) communicated to him. In these cases he will have to perform a chemical safety assessment (CSA) developing the exposure scenarios for his intended uses and, if necessary, a refinement of the supplier's hazard assessment. This obligation does not apply if the DU uses less than 1 tonne of the substance per year. However, a DU relying on the 1 tonne exemption still needs to consider the use(s) of the substance and identify, apply, and recommend appropriate risk management measures. In rare cases, the DU may propose additional testing if he considers this necessary to complete their CSA.

Evaluation

There are two types of evaluation with different aims, the dossier evaluation and the substance evaluation. The Agency will do a quality check of the registration dossiers. It may check the compliance of registration dossiers with the requirements laid down for registration in the Regulation. At least 5% of dossiers should be checked. Secondly the Agency is checking the testing proposals. The aim here is to prevent unnecessary animal testing, i.e. the repetition of existing tests, and poor-quality tests. Therefore, the Agency will check the testing proposals submitted as part of the registrations before such tests are performed. The Agency will also invite third parties to submit information that would avoid the need for vertebrate testing. For the substance evaluation the Agency, in co-ordination with the Competent Authorities of Member States, may clarify suspicions of risks to human health or the environment by requesting further information from industry. To promote a consistent approach, the Agency will, in co-operation with the Member States, develop guidance on the prioritization of substances for further evaluation. The Agency will publish a Community rolling action plan on its website identifying the Member State who shall carry out the evaluation of those priority substances. Any draft decision prepared by a Competent Authority of a Member State requesting further information on a substance must either be accepted by all other Member States' Competent Authorities, in which case the Agency takes the decision, or if an agreement cannot be reached the Commission takes the decision. The Agency is also given responsibility for assuring the consistency of such decisions at the draft stage. Evaluation may lead authorities to the conclusion that action needs to be taken under the restrictions or authorization procedures in REACH, or that information needs to be passed on to other authorities responsible for relevant legislation. The evaluation process will ensure that reliable and useful data are provided and made available to the relevant bodies by the Agency.

Authorization

For substances of very high concern, an authorization is required for their use and their placing on the market. The substances required to be authorized are substances which are (European Commission 2006b):

- CMR category 1 and 2;
- PBT/vPvBs; and
- identified from scientific evidence a, such as endocrine disrupters.

The European Commission will develop guidance to clarify the criteria for such a case-by-case detection in close co-operation with industry, Member States, and other relevant stakeholders. These substances have hazardous properties of such high concern that it is essential to regulate them centrally through a mechanism that ensures that the risks related to their actual uses are assessed, considered, and then decided upon by the Community. This is justified because the effects on humans and the environment of these substances are very serious and normally irreversible. Substances that fall into these categories will be fed into the authorization system as resources allow. Their uses will not be banned by default. The Agency will publish a list of substances meeting the criteria above and reflecting its multi-annual work plan, taking into consideration comments from interested parties.

The authorization procedure consists of two steps: in the first step, a decision is taken via comitology as to which substances on the candidate list will be included in the system, which uses of the included substances will be exempted from the authorization requirement (e.g. because sufficient controls established by other legislation are already in place), and which deadlines will have to be met. This step is necessary to prioritize substances and to focus resources. Once a substance is included in the system, in the second step of the procedure, those using or making available such a substance will need to apply for an authorization for each use of the substance within the deadlines set, including an analysis of possible substitutes. If this analysis shows that suitable alternatives are available then the application must also include a substitution plan. If not, information on relevant research and development activities must be provided, if appropriate. An authorization will be granted if the applicant can demonstrate that the risk from the use of the substance is adequately controlled. If not then it may also be granted if the socioeconomic benefits outweigh the risks and there are no suitable alternative substances or processes. PBTs, vPvBs, and those CMR substances for which a safe level cannot be defined, cannot be authorized based on adequate control of risk. Six years after the entry into force of the regulation, the Commission will review whether endocrine disrupters should also be excluded from the adequate control route. The Agency will provide expert opinions on the application and the applicant has an opportunity to comment on draft opinions. The Commission will grant an authorization for each use, meeting the above conditions. All authorizations will be reviewed after a certain time which will be set on a case-by-case basis. In setting the length of this review period the Commission will take into account relevant information, including the risks of the substance and of alternatives, socio-economic benefits, analysis of alternatives, and any substitution plan. If suitable substitutes have become available by the time of the review, the Commission may amend or withdraw the authorization, even one given for adequate control. Downstream users may apply for their own authorizations or may use a substance for an authorized use provided they obtain the substance from a company to whom an authorization has been granted and that they keep within the conditions of that authorization. Such downstream users will need to notify the Agency that they are using an authorized substance (Figure 77.1).

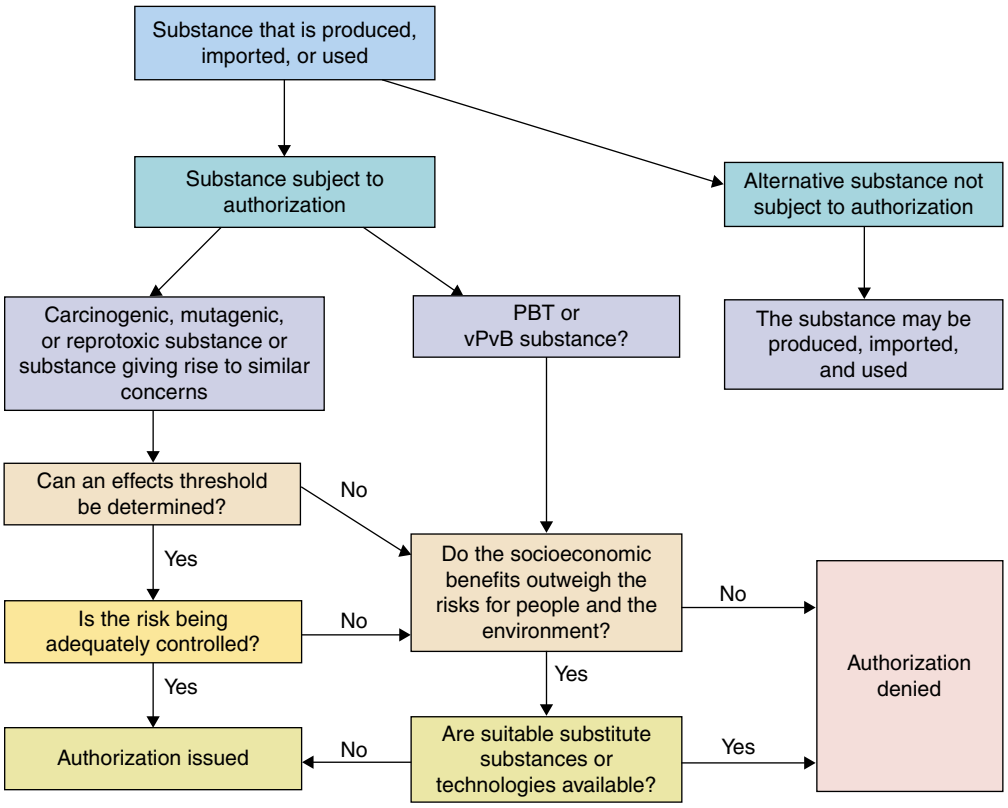

FIGURE 77.1 REACH authorization procedure step-by-step (Lahl et al 2006)

Restrictions

The restrictions procedure enables to regulate Community wide, yet in a focused way, conditions for the manufacture, placing on the market or use of certain substances where there is an unacceptable risk to health or the environment or the prohibition of any of these activities, if necessary. All activities with a substance which are not restricted are allowed under REACH unless the substance is included in the authorization system. Any substance on its own, in a preparation, or in an article may be subject to EC-wide restrictions if it is demonstrated that risks need to be addressed on an EC-wide basis. Thus, the restrictions provisions act as a safety net. Proposals for restrictions will be prepared by Member States or by the Agency on behalf of the Commission in the form of a structured Dossier. This Dossier is required to demonstrate that there is a risk to human health or the environment that needs to be addressed at EC level and to identify the most appropriate set of risk reduction measures. Deadlines for the procedure to prepare a Commission decision are set out in the Regulation. Interested parties will have an opportunity to comment and the Agency will provide opinions on any proposed restriction. The existing restrictions set out in Directive 76/769/EEC (such as the ban on asbestos and restrictions on the uses of certain azo-dyes) have been carried over in a consolidated version into the REACH Regulation.

The European Chemicals Agency (ECHA)

As already mentioned above, the ECHA was created to decide, to manage, and in some cases carry out the technical, scientific, and administrative aspects of REACH and to ensure consistency at Community level concerning these aspects. The ECHA manages the registration process, it carries out dossier evaluations and co-ordinates the substance evaluation process and generally takes decisions resulting from evaluations, except in cases of disagreement among Member States representatives when the Commission would decide. It provides expert opinions to the Commission in the authorization and restriction procedures and has duties with regard to confidentiality and access to information. It also handles requests for exemptions from the registration requirement for product and process-oriented research and development, and facilitates the sharing of animal test data at the pre-registration stage by enabling the formation of the Substance Information Exchange Forums (SIEFs). The ECHA will comprise the following elements (European Commission 2006b):

- Management Board;
- Executive Director, reporting to the Management Board;
- Committee on risk assessment and a Committee on socio-economic analysis
- Member State Committee;
- Forum for exchange of information on enforcement activities. This Forum integrates the current informal network of Member States authorities into the Agency;
- Secretariat that will provide technical, scientific, and administrative support for the Committees. It will also undertake a number of other tasks including under pre-registration, registration, evaluation, and information provision;
- Board of Appeal that will consider any appeals against the decisions of the Agency.

The ECHA is located in Helsinki and was operational as of 1 June 2008.

Access to Information

Non-confidential information on chemicals, for example to allow those exposed to chemicals to make decisions on the acceptability of the related risks, will be made available. This is done in such a way that the interests of the public's 'right to know' is balanced with the need to keep certain information confidential. Some information will be published on the Agency's website, some information will generally be always kept confidential, and some may be made available on request in accordance with the Commission's normal rules on access to information.

Benefits and Costs

With regard to the benefits, positive occupational impact and public health impact of REACH is expected as chemicals are linked to respiratory and bladder cancers, mesothelioma, skin disorders, respiratory diseases, eye disorders, asthma, etc. Increased information on hazards and controls will help better implementation of existing legislation. Authorization of substances of very high concern and speedier restrictions will also assist positive occupational and public health and positive environmental impact of REACH.

Combining the estimates of the direct and indirect costs, the Extended Impact Assessment of the Commission's proposal of October 2003 has estimated the overall costs to fall in the range of € 2.8–5.2 billion. These costs will be incurred over a period of 11–15 years. Therefore, from a macroeconomic perspective, the overall impact in terms of the reduction in the EU's Gross Domestic Product (GDP) is expected to be very limited.

The Extended Impact Assessment and several background documents can be found at:

http://europa.eu.int/comm/environment/chemicals/background/impact_assessment_intro.htm.

The EC Biocide Directive

A fundamentally different approach was taken for a group of special products known collectively as 'biocide products' (Gaertner 2000). Designed to control these products, the Directive 98/8/EC on the Marketing of Biocide Products (European Commission 1998) is still relatively young. The area of application of the EC Biocide Directive covers a large number of products ranging from disinfectants to mothballs, from large-volume industrially used material preservatives to niche products, from enclosed use in cooling circuits to open use as rat poisons. The only thing these products have in common is that they are used against living organisms that are regarded by humans as harmful. Thus biocides have by definition the effect of impairing or killing living organisms. In view of this property, which they share with plant protection agents, the model used for the EC Biocide Directive was not general chemical legislation, but the EC Plant Protective Directive.

In particular, the abovementioned heterogeneity of the products concerned is probably a major challenge for the competent authorities, which renders it difficult to arrive at correct assessments. For this reason, critics of the directive are already prophesying its failure. Compared with the aforementioned sets of rules, however, the EC Biocide Directive has a major advantage, which gives the authorities more enforcement power and probably exerts more pressure on the relevant industries to contribute to timely completion of the individual testing and decision procedures. What the EC Biocide Directive prescribes is an authorization, rather than a registration procedure. In other words, the marketing of a biocide product remains prohibited until the approval authority grants approval on the basis of comprehensive documents to be submitted by the applicant and the evaluation thereof; the onus of proof regarding the acceptability of the product rests with the applicant. This also has an impact on the testing program for old biocide-active substances, that is, for those active substances that were already on the European market when the implementation deadline expired in May 2000. Admittedly existing biocide-active substances and biocide products containing such active substances are subject to transitional rules. These, however, include an arrangement in which the existing active substances are fed into a multiphase review program. Existing active substances that have not cleared the first hurdle of this review program, in accordance with the First Review Regulation (EC) No. 1896/2000, will shortly cease to be marketable, as will the biocide products containing such active substances. The Biocide Directive is not affected by the amendments to EC chemicals legislation described above.

The EC Pesticide Directive

Plant protection products are (as in Directive 91/414/EC) substances which are intended to protect plants or plant products against animals, plants, micro-organisms, or diseases (European Council 1991). Substances which destroy plants, regulate growth, or inhibit germination are also regarded as plant protection products.

All EU Member States apply the same plant protection evaluation procedures and authorization criteria. A joint positive list of active substances permitted in plant protection products is also part of a harmonization process. Active substances are evaluated in a joint procedure and a decision on their inclusion in the positive list is made. Important aims for the authorization decisions are a sufficient protection of crops, avoiding harmful effects on human health, and avoiding unacceptable effects on the environment. Reports prepared by the three evaluation authorities involved and recommendations made by an independent scientific advisory committee form the basis for management decisions. Besides plant protection products, the e.g. German National Plant Protection Act also provides for adjuvants and plant resistance improvers. Adjuvants are added to plant protection products, for instance, in order to improve wetting of leaf surfaces. Plant resistance improvers are substances which improve the resistance of plants. Products for use on cut flowers also belong to this category. Adjuvants and plant resistance improvers may only be placed on the market if they have been included in a list with the national competent authority. This listing procedure is less complex than the authorization procedure for plant protection products.

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List of Important Abbreviations

BMU	Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit)CAS Chemical Abstracts Service
CFC	Chlorofluorocarbons
CICAD	Concise International Chemical Assessment Documents (WHO)
CMR	Substance which is carcinogenic, mutagenic or reproductively-toxic
COP	Conference of the Parties

DU	Downstream users, companies that use substances professionally or industrially on their own or in preparations
EC	European Community
ECHA	European Chemicals Agency, Helsinki
EHC	Environmental Health Criteria Documents (WHO)
EINECS	European Inventory of Existing Commercial Chemical Substances
EU	European Union
FAO	Food and Agriculture Organization (of the United Nations, Rome)
GC	Governing Council
GCSS	Governing Council Special Session
GLP	Good Laboratory Practice
GMEF	Global Ministerial Environment Forum
IFCS	Intergovernmental Forum on Chemical Safety
ILO	International Labor Organization (Geneva)
IPCS	International Program on Chemical Safety
IUTOX	International Union of Toxicology
MAD	Mutual Acceptance of Data
MP	Montreal Protocol
OECD	Organization for Economic Cooperation and Development (Paris)
ODS	Ozone-depleting substances
PBTs	persistent, bio-accumulative and toxic
PCB	Polychlorinated biphenyls
PCP	Pentachlorophenol
PIC	Prior Informed Consent (Procedure)
PIM	Poisons Information Monographs (of the WHO)
POPs	Persistent Organic Pollutants
QSAR	Quality-Structure–Activity Relationship
REACH	Registration, Evaluation and Authorisation of Chemicals
SAICM	Strategic Approach on International Chemicals Management
SDS	Safety Data Sheets
SIEFs	Substance Information Exchange Forums (SIEFs)
UN	United Nations
UNCED	United Nations Conference on Environment and Development (Rio 1992)
UNEP	United Nations Environment Program (Nairobi)
UNIDO	United Nations Industrial Development Organization
UNITAR	United Nations Institute for Training and Development
vPvBs	very persistent and very bio-accumulative
WHO	World Health Organisation
WSSD	World Summit for Sustainable Development (Johannesburg 2002)
DU	Downstream users
SDS	Safety Data Sheets

List of Important URLs

Agencies/Forums/Programs	
The European Chemicals Agency (ECHA)	http://ec.europa.eu/echa/
U.S. Environmental Protection Agency	www.epa.gov/
United Nations Environment Programme (UNEP)	www.unep.org/
Intergovernmental Forum on Chemicals Safety (IFCS)	www.who.int/ifcs
Intergovernmental Programme on Chemical Safety (IPCS)	www.who.int/ipcs/en
International Union of Toxicology (IUTOX)	www.iutox.org/ [Member societies at http://www.iutox.org/members.asp]
International Agency for Research on Cancer	www.iarc.fr

Conventions/Protocols:	
Montreal	www.uneptie.org/ozonaction
Stockholm	www.pops.int
Rotterdam	www.pic.int
Basel	www.basel.int
Aarhus	www.unece.org/env/pp/

Intergovernmental Organizations:	
OECD	www.oecd.org
WHO	www.who.int
ILO	www.ilo.org
FAO	www.fao.org
UNIDO	www.unido.org
UNITAR	www.unitar.org

National Library of Medicine (NLM)	http://sis.nlm.nih.gov/enviro.html.
Strategic Approach to International Chemicals Management (SAICM)	www.chem.unep.ch/saicm/ [National focal points at http://www.chem.unep.ch/saicm/focalpoints.htm]

CHAPTER

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Introduction to Country Chapters

The U.S. National Library of Medicine (NLM), through its Toxicology and Environmental Health Information Program (TEHIP), is a major electronic repository of worldwide toxicological data and literature citations. It has lately taken a more overt role in global activities through its support and sponsorship of the recently released online World Library of Toxicology, Chemical Safety and Environmental Health (WLT), available through Toxipedia, and with the partnership of the International Union of Toxicology. The WLT is designed as an online Web-based portal to information resources in toxicology, chemical safety, and environmental health, largely built by a network of Country Correspondents. Links to information resources available in specific countries is provided in both English and the country's native language. Additionally, links to major multilateral organizations are offered. Ancillary information such as a "Globalert" news feature, international environmental laws, and a core list of toxicology resources, is also available. The WLT can be accessed at www.wltox.org.

Following is a brief selection of chapters representing countries outside the United States, to give readers a flavor of the diversity and extent of toxicological activities worldwide. A country's absence from this group of chapters does not imply that its toxicological activities are insignificant. More often than not, size limitations, difficulties in identifying appropriate contributors, and other logistical issues, have limited this selection.

The Word Library of Toxicology, Chemical Safety, and Environmental Health (WLT) is a new multilingual, multi-lateral web-based resource presenting an online, expanded, and up-to-date look at toxicological activities around the globe. It is a good source for keeping up on the toxicology information infrastructure of the countries in this chapter, and others. The WLT, a project of Toxipedia and the International Union of Toxicology, is sponsored and supported by the U.S. National Library of Medicine. It can be accessed at www.wltox.org.

CHAPTER

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European Union*

PERTTI J. HAKKINEN

INTRODUCTION

The European Union (EU) includes 27 Member States. The EU countries are Austria, Belgium, Bulgaria, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom.

The EU is a unique international organization in that its member countries have delegated some of their sovereignty so that decisions on specific matters of joint interest can be made on an EU-wide basis. One example of an EU-wide agency involved with toxicology-related matters is the European Environment Agency (EEA). The EEA gathers information on the state of the EU environment. Another EU-wide agency is the European Chemicals Agency (ECHA), created in Helsinki, Finland to work on and implement the Registration, Evaluation, Authorisation, and Restriction of CHemicals (REACH) legislation.

The safe uses of chemicals in consumer products and articles (e.g., in toys, clothing, and furniture) within the EU are covered in part by the General Product Safety Directive (GPSD). The GPSD includes a rapid exchange notification system named RAPEX to quickly share suspected or known safety issues about non-food consumer products.

The EU's European Commission non-food scientific committees include experts in toxicology and other areas of science from academia and elsewhere. The Scientific Committee on Consumer Products (SCCP), Scientific Committee on Health and Environmental Risks (SCHER), and Scientific Committee on Emerging and Newly Identified Health Risks (SCENIHR) provide the EU with a proactive and flexible approach to risk assessment. They work together as needed with other Community bodies responsible for scientific advice such as the European Food Safety Authority (EFSA), the European Agency for the Evaluation of Medicinal Products (also known as the European Medicines Agency, EMEA), and the European Centre for Disease Prevention and Control (ECDC).

The SCCP provides advice on the safety of non-food consumer products. Examples of the types of issues within the scope of the SCCP include the safety of cosmetic products, toys, textiles, clothing, etc. The SCHER deals with toxicity and ecotoxicity issues relevant to chemical, biochemical, and biological compounds. The SCENIHR provides advice on emerging or newly identified risks and issues requiring a comprehensive assessment of risks to consumer safety or public health. Further, the SCENIHR provides opinions on human health issues not covered by other EU risk assessment bodies such as new technologies (nanotechnology has been a topic of interest), physical hazards such as noise and electromagnetic fields (e.g., from mobile phones), and methodologies for assessing new risks.

The European Commission's Joint Research Centre (JRC) is a source of independent scientific and technical reference for European policy makers, serving the

*Adapted from P.J. Hakkinen, European Union and Its European Commission, Encyclopedia of Toxicology, 2nd edition. P. Wexler (Ed.) (2005). Appendix 1.16, pp. 507–510.

European Commission, the Member States, and others. The JRC's seven scientific institutes carry out research of direct concern to EU citizens, working with industry, universities, other research institutes, and Member States. The JRC is among the European Commission's 36 Directorates-General (DGs). The DGs are specialized services within the European Commission. Examples of other DGs include the Brussels, Belgium-based Directorate General (the JRC's central coordination and administrative body), the Institutional and Scientific Relations Directorate, and the Programme and Resource Management Directorate. In addition, the DG Health and Consumer Protection has the overall goal of promoting a better quality of life by ensuring a high level of protection of consumers' health, safety, and economic interests as well as of public health. The seven JRC institutes are the Institute for Health and Consumer Protection (IHCP), the Institute for Environment and Sustainability (IES), and the Institute for Protection and Security of the Citizen (IPSC) in Ispra, Italy, the Institute for Reference Materials and Measurements (IRMM) in Geel, Belgium, the Institute for Transuranium Elements (ITU) in Karlsruhe, Germany, the Institute for Energy (IE) in Petten, the Netherlands, and the Institute for Prospective Technological Studies (IPTS) in Seville, Spain.

In addition, among the IHCP's units are the European Chemicals Bureau (ECB) and the European Centre for the Validation of Alternative Methods (ECVAM) to animal experimentation. The working areas of the ECB, until the new European Chemicals Agency (ECHA) begins full operations, are collecting information on new and existing chemicals, and providing scientific and technical support to the conception, development, implementation, and monitoring of EU policies on dangerous chemicals. Further, the ECB has supported the development and harmonization of testing methods such as quantitative structure activity relationships, the legal classification and labeling of substances, the management of risk assessment of substances, the notification of new substances, the authorization of biocides, and the information exchange on import and export of dangerous substances.

The European Chemical Substances Information System (ESIS) serves as a portal to the existing chemicals data sets maintained by ECB. ESIS includes information related to the European Inventory of Existing Chemicals (EINECS), the European List of Notified Chemical Substances (ELINCS), High Production Volume Chemicals (HPVCs) and Low Production Volume Chemicals (LPVCs), Classification, and Labeling, IUCLID (International Uniform Chemical Information Data Base) Chemical Data Sets, and the EU's chemical risk assessment process. IUCLID, currently IUCLID version 5 (IUCLID5), is the basic tool for data collection and evaluation within the EU Risk Assessment Programme, as well as under the OECD Existing Chemicals Programme, and it will be used by the ECHA for REACH purposes. The Risk Assessment Reports (RARs) are extensive documents written in first draft by EU member states, and the ECB also mediates meetings that attempt to reach consensus on the conclusions of the risk assessments.

Another example of an EU-wide database established by the European Commission is the European Pollutant Emission Register (EPER), developed as a register of industrial emissions into air and water. Member States have to produce reports on the emissions of industrial facilities into the air and waters, and the reports covers 50 pollutants. EPER gives access to information on the annual emissions of thousands of industrial facilities in the Member States as well as Norway. It lets users group information easily, by pollutant, activity (sector), air and water (direct or via a sewerage system), or by country. In addition, it is possible to see detailed data on individual facilities by searching by name or by clicking on a map. Users can also look for the sources of a particular pollutant. The European Commission has made these data publicly accessible on a website hosted by the European Environment Agency (EEA).

The EU has been very active in helping European research achieve scientific excellence, and European industry to be innovative and competitive globally. In a variety of sectors covering the whole spectrum of modern technology, the EU finances projects undertaken by research centers, universities, and industry. The emphasis is on putting research and innovation to work for socioeconomic objectives, including job creation and improved quality of life. Current research priorities include, among others, life sciences, nanotechnology, space, food quality, sustainable development, and the knowledge-based society. The support of research includes the European Commission-led multi-year Framework Programmes for Research. The EU is currently in the 7th Framework Programme (2007–2013), supporting research in toxicology, risk assessment, and numerous other areas such as those noted above as research priorities.

WEBSITES

European Agency for the Evaluation of Medicinal Products (also known as the European Medicines Agency, EMEA)

Web: www.emea.europa.eu/

European Centre for Disease Prevention and Control (ECDC)
Web: www.ecdc.eu.int/

European Chemicals Agency (ECHA)
Web: www.echa.europa.eu

European Commission
Web: http://europa.eu.int

European Commission, 'Health and Consumer' e-News
Web: http://ec.europa.eu/dgs/health_consumer/dyna/enews/enews.cfm?al_id=569

European Commission, Health and Consumer Protection Directorate-General (DG SANCO)
Web: http://ec.europa.eu/dgs/health_consumer/index_en.htm

European Commission, Institute for Health and Consumer Protection (IHCP)
Web: http://ihcp.jrc.it

European Commission, Institute for Health and Consumer Protection, European Chemicals Bureau (ECB)
Web: http://ecb.jrc.it

European Commission, Research
Web: http://ec.europa.eu/research/

European Commission, Seventh Framework Programme (FP7, 2007–2013), bundling together EU-funded research-related initiatives
Web: http://cordis.europa.eu/fp7/home_en.html

European Environment Agency (EEA)
Web: www.eea.europa.eu/

European Food Safety Authority (EFSA)
Web: www.efsa.europa.eu/en.html

European Pollutant Emission Register (EPER)
Web: www.eper.cec.eu.int

CHAPTER

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Australia

PAUL WRIGHT

INTRODUCTION

Australia is a continent of great biodiversity and natural resources, with a predominantly dry climate that makes environmental sustainability a constant issue. Its population of 20 million is mainly concentrated in coastal urban and industrial centers. Mining, agricultural, and livestock industries are major export contributors and important chemical users.

Medicinal Toxicity

During the early part of the 20th century, there was a general acceptance in Australia that therapeutic compounds provided great benefits and their potential risks were not emphasized. Nonetheless, there were some notable local episodes of medicinal toxicities, including the chronic overuse between the 1950s and 1970s of very popular analgesic 'APC' powders (a mixture of aspirin, phenacetin, and caffeine) that produced gastric ulcers and an epidemic of chronic renal failure ('analgesic nephropathy') in Australia (Michielsen 2007). However, it was the thalidomide episode in Australia (marketed between 1957–61), which led to the establishment in 1963 of the Australian Drug Evaluation Committee (ADEC) as an independent committee to advise on drug safety. The Therapeutic Goods Administration (TGA, Australian equivalent to FDA) and ADEC have since played a pivotal role in the genesis of Australia's drug regulatory system.

The recent rapid increase in public use and access to complementary medicines, resulting in both adverse reactions and interactions with pharmaceuticals, has raised concerns throughout Australia about the appropriate regulation of these therapies. This led to the establishment of a specific evaluation committee within the TGA in 1997, and additional government reforms and regulations followed. During 2003, in what may be the world's largest medicines recall, the TGA withdrew over 1300 complementary medicine products marketed by Pan Pharmaceuticals, Australia's largest contract manufacturer of complementary medicines at that time. The recall was the result of initial reports of serious adverse events associated with Pan's travel sickness tablets, which led to an extensive TGA audit of Pan that found widespread serious deficiencies in the company's manufacturing and quality control procedures, including substitution of ingredients, manipulation of test results, and substandard manufacturing processes (TGS 2003).

Occupational Toxicity

Australia has always relied heavily on the mining industry for export income, including specific industries with recognized potential health problems through occupational exposure, e.g. lead mining and smelting, and uranium mining with associated processing and usage, e.g. the Anglo-Australian atomic test sites in 1953, near Woomera in South Australia.

Of particular note are the extensive ongoing health issues surrounding asbestos mining, processing/manufacture, usage, and waste removal. Poor workplace conditions at the major asbestos mine that operated between 1938–66 in Wittenoom, Western Australia, led to the diagnosis of Australia's first mesothelioma case in 1962. Following the diagnosis of numerous cases in subsequent years, the Australian Mesothelioma Surveillance

Program (later the Australian Mesothelioma Register) was established in 1980.

Environmental Toxicity

Intensive agricultural practices during the 200 years of European settlement have seen the extensive use of pesticides and herbicides to control insect pests and introduced noxious weeds. Important examples include: the ongoing legacy of contaminated sites from arsenic trioxide cattle dip baths used between 1895 and 1950 to control cattle tick infestations originating from Java; and more recently, the excessive use of organochlorine insecticides to control the heliothis moth, a devastating and increasingly resistant cotton pest.

Australia's unique flora and fauna provide an astounding range of natural toxins. Toxic Australian fauna include 17 of the world's 20 most venomous snakes, as well as venomous spiders and marine animals, such as the blue-ringed octopus and various species of fish, jellyfish, and cone snails. Of the thousand species of plants in Australia that are toxic to livestock and humans, around 60% are native plants and these commonly result in poisoning of the livestock grazing on native pastures. Algae toxins are also found in freshwater and marine environments, with contaminated drinking water being the most common problem presented by cyanotoxins. Consequently, aspects of clinical toxicology and toxinology have been of particular interest in Australia, including antivenom development and the treatment of acute poisonings.

Toxicology Research

Australian toxicologists are making significant contributions from academia, government, and the commercial sector towards assessing the level of risk associated with chemicals and protecting the community from environmental hazards. Most Australian academic and research toxicologists were initially based in small groups within university departments of pharmacology. The growing importance of toxicology in Australia was recognized by the establishment in the mid-1980s of the Key Centre for Applied and Nutritional Toxicology at the Royal Melbourne Institute of Technology (RMIT) in Melbourne, Victoria, Australia. Funded by the Australian Research Council's (ARC) Key Centre for Teaching and Research program, it delivered the first general toxicology masters degree program in Australasia, in addition to extensive research activities into detoxication biochemistry, biochemical mechanisms of toxicity, immunotoxicology, toxicokinetics, ecotoxicology, and food toxicology. Now located within the RMIT School of Medical Sciences, the toxicology faculty delivers the world's first and only fully online toxicology postgraduate degrees (i.e. Graduate Diploma in Toxicology and Master of Toxicology), which commenced in 2001.

A second national toxicology research center was established in 1991 at Queensland University, in partnership with Queensland Health, by the National Health and Medical Research Council (NHMRC). This National Research Centre for Environmental Toxicology (NRCET, now known as EnTox) was specifically established to conduct extensive research activities into human environmental toxicology. Recently, the Australian Centre for Human Health Risk Assessment (ACHHRA) was established at Monash University in 2001, by a consortium of four universities with federal health department support. This center has expertise in epidemiology, toxicology, and environmental sciences and is concerned with risk assessment of human exposure to hazardous chemicals and micro-organisms (Priestley et al 2007).

Most recently, NanoSafe Australia was established in 2006 as a nationwide nanosafety/nanotoxicology research network. It is co-ordinated from RMIT and is providing occupational and environmental health and safety information, research and services to the ARC Nanotechnology Network (ARCNN) and the NHMRC Advisory Committee on Health and Nanotechnology, as well as government, industry, and non-government organizations.

Toxicology-related Societies

Toxicology is, by its nature, a multidisciplinary science and Australian toxicologists come from many scientific fields. Many academic and research toxicologists received a pharmacology or biomedical-related education, but the majority of the >1000 persons actively engaged in toxicology-related employment in Australia are employed in government regulatory areas. Consequently there are several cognate professional societies of which Australian toxicologists are active members, including pharmacology, pharmaceutical, pathology, chemistry, environmental, regulatory, and forensic societies.

Of particular note is the Australasian Society of Clinical and Experimental Pharmacologists (ASCEP), which established the Toxicology Section as its first subgroup in 1982, then became the Australasian affiliate in the International Union of Toxicology in May 1988, and finally changed its name to include Toxicologists in 1991. Since then, ASCEPT established a lecturer-exchange program with the British Toxicology

Society in 1996, and the Clinical Toxicology Section in 2001. Australian toxicologists have also served as directors on the executive committee of IUTOX for 12 continuous years (Priestly BG, Di Marco P, Wright PFA, from 1992–2004) and ASCEPT hosted the first International Congress of Toxicology to be held in the southern hemisphere (ICT-IX, Brisbane July, 2001).

In the ecotoxicology arena, the Australasian Society for Ecotoxicology (ASE) was established in 1994 and simultaneously launched its main publication the *Australasian Journal of Ecotoxicology* (AJE). The most recent significant event in Australian toxicology was the establishment of the Australasian College of Toxicology and Risk Assessment (ACTRA) in July 2006, in order to provide a program of continuing education and establish a registration scheme for practitioners in toxicology and health risk assessment in Australia and New Zealand.

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Priestly BG, Di Marco P, Sim M, Moore MR, Langley A (2007) Toxicology in Australia: A key component of environmental health. J. Toxicol. Environ. Health, 70(19): 1578–1583.

Therapeutic Goods Administration (TGA) Medicine recalls 2003. "Pan Pharmaceuticals Limited – Regulatory action and product recall information". (http://www.tga.gov.au/recalls/2003/pan.htm)

RESOURCES

Books

Covacevich J, Davie P, Pearn J (Eds.) (1987)
Toxic Plants and Animals: A Guide for Australia
Brisbane, Australia: Queensland Museum
504 pp. ISBN 0724223819.

Murray L, Daly F, Little M, Cadogan M (2007)
Toxicology Handbook
Sydney, Australia: Churchill Livingstone
ISBN-13: 978-0-7295-3789-6.

Pearn J, Covacevich J (1988)
Venoms and Victims
Brisbane, Australia. Queensland Museum and Amphion Press

Rossi S (Ed.) (2007)
Australian Medicines Handbook 2007
Adelaide, Australia: Australian Medicines Handbook.
ISBN 0-9757919-5-8.
Also eAMH (CD-ROM) and pAMH (palm pilot) editions.
Web: http://www.amh.net.au/

Seawright AA (1989)
Chemical and Plant Poisons, 2nd Edition, Volume 2, Animal Health in Australia.
Canberra, Australia: Australian Government Publishing Service

Sutherland SK, Tibballs J (2001)
Australian Animal Toxins: The Creatures, Their Toxins and Care of the Poisoned Patient, 2nd Edition
Melbourne, Australia: Oxford University Press.

White J (1996)
CSL Antivenom Handbook
Melbourne, Australia: CSL Ltd.
Web: http://www.toxinology.com/generic_static_files/cslavh_contents.html

Williamson JA, Fenner PJ, Burnett JW, Rifkin JF (Eds.) (1996)
Venomous and Poisonous Marine Animals
Sydney, Australia: University of NSW Press

Journals

Australasian Journal of Ecotoxicology
Sydney, Australia: Australasian Society for Ecotoxicology
ISSN 1323-3475
Web: http://www.ecotox.org.au/aje.html

The Journal of Occupational Health and Safety – Australia and New Zealand
Sydney, Australia: CCH Australia Limited
ISSN 0815-6409
Web: http:www.cch.com.au/journalohs

Marine and Freshwater Research
Melbourne, Australia: CSIRO Publishing
ISSN 1323-1650
Web: http://www.publish.csiro.au/journals/mfr/

Online Journal of Veterinary Research
Brisbane, Australia: Pestsearch International Pty. Ltd.
ISSN 1328-925X
Web: http://www.comcen.com.au/~journals/jvet196a.htm

Safety at Work
Sydney, Australia: Workplace Safety Services
ISSN 1444-6995
Web: http://www.safetyatwork.biz/

SafetyLine
Perth, Australia: WorkSafe Western Australia
ISSN 1326-4672
Web: http://www.worksafe.wa.gov.au/newsite/worksafe/content/safetyline/wswaslmg0001.html)

Safety Science Monitor
Melbourne, Australia: IPSO Australia
ISSN 1443-8844
Web: http://www.monash.edu.au/muarc/ipso/

Technical Reports and Other Documents

Australian Mesothelioma Register

Reports provided by the Australian Safety and Compensation Council (ASCC) of the incidence of mesothelioma in the Australian population (11th–5th reports for 1994–2000 are available online).

Web: http://www.ascc.gov.au/ascc/aboutus/publications/statreports/australianmesotheliomaregister.htm

Australian Native Poisoning Plants

Online article by Dr Ross McKenzie, Queensland Animal Research Institute (ARI) and curator of the ARI Poisonous Plants Files, provided by the Association of Societies for Growing Australian Plants (ASGAP) – this has been reprinted from the March 1994 issue of Bulletin for the SGAP Queensland Region.

Web: http://asgap.org.au/APOL7/sep97-4.html

Australian Occupational Health and Safety (OHS) Statistics

Statistical reports provided by the ASCC of work-related injuries and fatalities.

Web: http://www.ascc.gov.au/ascc/AboutUs/Publications/StatReports/

Health based risk assessment of contaminated land involving carcinogens

Published as: Wright PFA (Ed.) (1996) Health based risk assessment of contaminated land: Focus on carcinogens: proceedings of an ASCEPT toxicology workshop (Chief editor, Wright, PFA) Australasian Society of Clinical & Experimental Pharmacologists & Toxicologists (ASCEPT), Sydney, ISBN 0-646-30641-7. 124 pages.

NanoSafe Australia's position paper on OHS best practices for the Australian nanotechnology industry

Published as: Harford A, Edwards J, Priestly B, Wright P. Current OHS best practices for the Australian Nanotechnology industry. Journal of Occupational Health and Safety – Australia and New Zealand 23(4): 315–331. ISSN 0815-6409.

Databases

Australian Inventory of Chemical Substances (AICS)

Maintained by NICNAS, this chemical inventory currently lists >38 000 chemical entities available for use in Australia. Chemicals listed in AICS can be imported or manufactured in Australia without having to notify NICNAS as a new chemical, unless exempt.

Web: http://www.nicnas.gov.au/industry/AICS/Search.asp

Australian OHS Sites

This website is provided by the National Research Centre for Occupational Health and Safety Regulation, and lists important Australian OHS weblinks, including OHS legislation (by jurisdiction), authorities, centers, institutes, and general OHS sites.

Web: http://www.ohs.anu.edu.au/links/index.php

Australian Safety and Compensation Council (ASCC) – Health and safety topics

This government website includes much of the information that was available via the Australian OHS Index and OHS Research Database of the former NOHSC websites (http://natindex.nohsc.gov.au/ and http://www.nohsc.gov.au/applications/researchDB/mb.aspx, respectively).

Web: http://www.ascc.gov.au/ascc/HealthSafety/

Clinical Toxinology Resources

This website is provided by the Toxinology Dept, Women's & Children's Hospital, Adelaide, and the Dept of Paediatrics, University of Adelaide. It provides a range of toxinology references and first aid information with specific sections for snakes, spiders, and marine life.

Web: http://www.toxinology.com/

Environmental Resources Information Network (ERIN)

This unit of the federal Department of the Environment, Water, Heritage and the Arts (formerly Department of the Environment and Water Resources), develops and manages a comprehensive, accurate and accessible information base for environmental decisions. Information services provided or hosted by ERIN

include: Australian Government Environment Portal, Australian Natural Resources Atlas, Australian Wetlands Database, Environment Image Database, National Chemical Information Gateway, and the National Pollutant Inventory (see separate listing below).

Web: http://www.environment.gov.au/erin/index.html

Hazardous Substances and Dangerous Goods

This website contains information on the ASCC National Standards and Codes of Practice, along with guidance material, for hazardous substances and dangerous goods. Other information is provided on the Exposure Standards, Regulatory Framework for Hazardous Substances, and the Globally Harmonised System (GHS) of classification and labeling of chemicals. Information is also provided on specific chemicals, i.e. arsenic, asbestos, cyanide, ethylene oxide, hydrogen fluoride, industrial organic solvents, isocyanates, lead, synthetic fibers, timber, tobacco, and vinyl chloride.

Web: http://www.ascc.gov.au/ascc/HealthSafety/HazardsSafetyIssues/HazardousSubstances/

Hazardous Substances Information System (HSIS)

The HSIS is a web resource providing information on substances classified as hazardous and/or having National Exposure Standards.

Web: http://hsis.ascc.gov.au/Default.aspx

HyperTox

A poison information program written by Australian clinical toxicologists originally based in Newcastle University, with modules available for download as trial shareware.

Web: http://www.hypertox.com/

National Coroners Information System (NCIS)

This is a national database of Australian coronial cases, including information about every death reported to an Australian coroner since July 2000. The NCIS is a valuable hazard identification and death prevention tool for coroners and research agencies and is based at the Victorian Institute of Forensic Medicine (VIFM).

Web: http://www.ncis.org.au/

National Pollutant Inventory (NPI)

This program is run by the federal Department of the Environment and Water Resources, in cooperation with state/territory government departments. The National Pollutant Inventory (NPI) provides Australians with free access to information on the types and amounts of pollutants being emitted in their community.

Web: http://www.npi.gov.au/index.html

Veterinary Education and Information Network (VEIN)

Provided by the Faculty of Veterinary Science, University of Sydney, this veterinary database includes information on production animal clinical toxicology, pesticides and veterinary chemicals, and toxic plants in Australasia.

Web: http://vein.library.usyd.edu.au/links/toxicology.html

Virtual Anaesthesia Textbook: Poisonings, Bites and Envenomations

An online database with useful Australian links for toxicology and toxinology, provided by Chris Thompson at the Royal Prince Alfred Hospital, Sydney, Australia.

Web: http://www.virtual-anaesthesia-textbook.com/vat/poisoning_bites.html

Organizations – Government

National Government (Federal Commonwealth Agencies)

Author's note:
Following the November 24th 2007 federal election, a new Australian Government was sworn in on December 3rd 2007, including Ministerial appointments with greatly revised portfolios. All federal Australian government websites listed in this chapter are current for January 2008, however website URLs may subsequently change due to the renaming and reorganization of various departments.

Australian Institute of Health and Welfare (AIHW)

Australia's national agency for health and welfare statistics and information.

Web: http://www.aihw.gov.au/
Postal address: AIHW, G.P.O. Box 570, Canberra, ACT 2601, Australia
Phone: +61-2-6244 1000
Fax: +61-2-6244 1299
Email: info@aihw.gov.au

Australian Pesticides and Veterinary Medicines Authority (APVMA)

Australian government authority (formerly the National Registration Authority, NRA) that is responsible for the evaluation and registration of pesticides and veterinary medicines. It also administers the National Registration Scheme for Agricultural and Veterinary Chemicals (NRS) in partnership with the States and Territories.

Web: http://www.apvma.gov.au/
Postal address: APVMA, P.O. Box E240, Kingston, ACT 2604, Australia
Phone: +61-2-6210 4700
Email (Public Affairs): Communications@apvma.gov.au

Australian Radiation Protection and Nuclear Safety Agency (ARPANSA)

Federal Government agency with the responsibility for protecting the health and safety of people and the environment from the harmful effects of ionizing and non-ionizing radiation. It includes the Radiation Health Committee, Nuclear Safety Committee, and Radiation Health & Safety Advisory Council.

Web: http://www.arpansa.gov.au/index.htm
Postal address: ARPANSA, 619 Lower Plenty Road, Yallambie, VIC 3085, Australia
Phone: +61-3-9433 2211
Fax: +61-3-9432 1835
Email: info@arpansa.gov.au

Australian Safety and Compensation Council (ASCC)

Commonwealth authority for matters relating to occupational health and safety (OHS). ASCC was formerly the National Occupational Health and Safety Commission (NOHSC) and there is a progressive migration of webpages and information from http://www.nohsc.gov.au/ to the ASCC webpages.

Web: http://www.ascc.gov.au/
Postal address: Office of the Australian Safety and Compensation Council, Department of Employment and Workplace Relations, Loc 64N1, G.P.O. Box 9879 Canberra, ACT 2601, Australia
Phone: +61-2-6121 5317
Fax: +61-2-6121 9138
Email: info@ascc.gov.au

Department of Agriculture, Fisheries and Forestry (DAFF)

This federal government department includes the APVMA, Australian Quarantine and Inspection Service (AQIS), and Biosecurity Australia.

Web: http://www.affa.gov.au/
Postal address: Australian Government Department of Agriculture, Fisheries and Forestry, G.P.O. Box 858, Canberra, ACT 2601, Australia
Phone: +61-2-6272 3933

Department of Health and Ageing

This federal government department contains several regulatory authorities, including those related to therapeutics (TGA), industrial chemicals (NICNAS), food standards (FSANZ), radiation safety (ARPANSA), and health statistics (AIHW) – these authorities are listed separately.

Web: http://www.health.gov.au/
Postal address: Department of Health and Ageing, G.P.O. Box 9848, Canberra, ACT 2601, Australia
Phone: +61-2-6289 1555
Fax: +61-2-6281 6946

Department of the Environment, Water, Heritage and the Arts

This federal government department (formerly Environment Australia, then Department of the Environment and Heritage, and then Department of the Environment and Water Resources) contains the Australian Antarctic Division, Australian Greenhouse Office and the Supervising Scientist Division.

Web: http://www.environment.gov.au/
Postal address: Department of the Environment, Water, Heritage and the Arts, G.P.O. Box 787, Canberra, ACT 2601, Australia
Phone: +61-2-6274 1111
Fax: +61-2-6274 1666

Australian Greenhouse Office (AGO)

This office delivers the majority of programs under the Australian government's climate change strategy.

Web: http://www.greenhouse.gov.au/
Postal address: Australian Greenhouse Office, G.P.O. Box 787, Canberra, ACT 2601, Australia
Phone: +61-2-6274 1888

Supervising Scientist Division

Conducts environmental research and monitoring, environmental supervision, audit and inspection of uranium mining in the Alligator Rivers Region and wetlands.

Web: http://www.environment.gov.au/ssd
Postal address: Supervising Scientist, G.P.O. Box 461, Darwin, NT 0801, Australia
Phone: +61-8-8920 1101
Fax: +61-8-8920 1190

Environment Protection and Heritage Council (EPHC) of Australia and New Zealand

The EPHC was formed in 2001 from the merging of the National Environment Protection Council (NEPC), the environment protection components of the Australian and New Zealand Environment and Conservation Council (ANZECC), and Heritage Ministers' Meetings. EPHC incorporates the National Environment Protection Measures (NEPM) of the NEPC.

Web: http://www.ephc.gov.au/
Postal address: EPHC Secretariat, Level 5, 81 Flinders Street, Adelaide, SA 5000, Australia
Phone: +61-8-8419 1200
Fax: +61-8-8224 0912
Email: exec@ephc.gov.au

Food Standards Australia New Zealand (FSANZ)

This statutory agency sets food standards governing the use of food additives, and maximum contamination limits in food, for Australia and New Zealand.

Web: http://www.foodstandards.gov.au/
Postal address: FSANZ, P.O. Box 7186, Canberra BC, ACT 2610, Australia
Phone: +61-2-6271 2222
Fax: +61-2-6271 2278
Email: reception@foodstandards.gov.au

National Public Health Partnership (NPHP)

The NPHP was responsible for identifying and developing a strategic and integrated response to public and environmental health priorities in Australia. In June 2006 it was replaced by the Australian Health Protection Committee (AHPC) and the Australian Population Health Development Principal Committee (APHDPC).

Web: http://www.nphp.gov.au/
Postal Address: NPHP Secretariat, G.P.O. Box 4057, Melbourne, VIC 3001, Australia
Phone: +61-3-9603 8338
Fax: +61-3-9603 8310
Email: nphp@dhs.vic.gov.au
Email to AHPC: ahpc@health.gov.au
Email to APHDPC: aphdpc@health.gov.au

National Environmental Health Strategy (enHealth)

Located within the NPHP, the enHealth Council is specifically concerned the environmental health aspects of public health.

Web: http://enhealth.nphp.gov.au/

Therapeutic Goods Administration (TGA)

Located in the Department of Health & Ageing, the TGA evaluates and registers therapeutic products (medicines and medical devices). It administers the Australian Register of Therapeutic Goods (ARTG). Certain committees and sections are listed below with special relevance to toxicology, chemical risk assessment and public and environmental health.

Web: http://www.tga.gov.au/
Postal address: TGA, PO Box 100, Woden, ACT 2606, Australia
Phone: +61-2-6232 8444
Fax: +61-2-6232 8605
Email: info@health.gov.au

TGA Committees

Adverse Drug Reactions Advisory Committee (ADRAC)

A subcommittee of ADEC that advises the TGA on the safety of medicines.

Web: http://www.tga.gov.au/adr/adrac.htm

Australian Drug Evaluation Committee (ADEC)

An expert committee providing independent, scientific advice on new drugs.

Web: http://www.tga.gov.au/docs/html/adec/adec.htm

Complementary Medicines Evaluation Committee (CMEC)

An expert committee providing scientific and policy advice relating to controls on the supply and use of complementary medicines.

Web: http://www.tga.gov.au/docs/html/cmec/cmec.htm

National Drugs and Poisons Schedule Committee (NDPSC)

Sets the Standard for the Uniform Scheduling of Drugs and Poisons (SUSDP) to promoting uniform scheduling of substances and uniform labeling and packaging requirements throughout Australia.

Web: http://www.tga.gov.au/ndpsc/index.htm

TGA Sections

Complementary Medicines

This section regulates complementary medicines, i.e. 'traditional' or 'alternative' medicines, including vitamins, minerals, nutritional supplements and herbal, aromatherapy, and homoeopathic products.

Web: http://www.tga.gov.au/cm/cm.htm

Office of Chemical Safety (OCS)

The Canberra office provides health risk assessments of new and existing pesticides and veterinary medicines to the APVMA and NDPSC. The Sydney office is the National Industrial Chemicals Notification and Assessment Scheme (NICNAS).

Web: http://www.tga.gov.au/chemicals/index.htm (safety information about chemicals)
http://www.health.gov.au/internet/wcms/publishing.nsf/Content/ohp-ocs.htm (OCS archive website)

National Industrial Chemicals Notification and Assessment Scheme (NICNAS)

This agency assesses applications to introduce new chemical entities into Australia, and selectively reviews existing priority industrial chemicals listed on the Australian Inventory of Chemical Substances (AICS) which currently lists >38 000 chemical entities available for use in Australia. NICNAS also runs the Advisory Group on Chemical Safety (AGCS).

Web: http://www.nicnas.gov.au/
AICS link: http://www.nicnas.gov.au/industry/AICS/Search.asp
http://www.tga.gov.au/chemicals/agcs.htm

Over-the-counter (OTC) Medicines

This section is involved in the regulation of over-the-counter medicines for self-treatment from pharmacies, supermarkets, health food stores, and other retailers.

Web: http://www.tga.gov.au/npmeds/npmeds.htm

Prescription Medicines

This section is involved in the regulation of medicines that require a doctor's prescription for purchase from a pharmacist, or use in a hospital.

Web: http://www.tga.gov.au/pmeds/pmeds.htm

State and Territory Governments (Locations Shown in Map)

Australian Capital Territory, ACT	South Australia, SA
Queensland, QLD	Tasmania, TAS
New South Wales, NSW	Victoria, VIC
Northern Territory, NT	Western Australia, WA

The following are lists of links to the government departments in the various states and territories that are relevant to toxicology, chemical risk assessment, and public and environmental health. An example of one corresponding state government department is shown in each case. Due to the separation of powers between the federal commonwealth and the states/territories, roles are divided, with the assessment, evaluation, and registration of chemicals occurring federally (by the four main regulatory agencies of the TGA, NICNAS, FSANZ, and APVMA) and the legislation administered by the states. These federal regulatory agencies are summarized in 'Chemicals Schemes at a Glance' (http://www.nicnas.gov.au/Chemicals_In_Australia/Chemical_Schemes.asp).

Australian Environment Departments

A regional listing of the state environment departments in Australia, provided by the EPHC.

Web: http://www.ephc.gov.au/nepc/links_nepc.html

NSW Department of Environment and Climate Change

Formerly the NSW Department of Environment and Conservation, and incorporating the NSW Environment Protection Authority.

Web: http://www.environment.nsw.gov.au/home.htm
Postal address: NSW Department of Environment and Climate Change, P.O. Box A290, Sydney South, NSW 1232, Australia
Phone: +61-2-9995 5000
Fax: +61-2-9995 5999

Australian Health Departments

A regional listing of the state health departments from the federal Dept Health & Aging. Each health department has units for Public/Population Health and Environmental Health, with Toxicology and Epidemiology sections.

Web: http://www.health.gov.au/internet/main/publishing.nsf/Content/health-related.htm

Public Health SA

Located in the Dept Health SA, this section provides information and services on environmental health, drugs and poisons.

Web: http://www.dh.sa.gov.au/pehs/
Postal address: Public Health SA, Dept of Health, P.O. Box 6 Rundle Mall, Adelaide, SA 5000, Australia
Phone: +61-8-8226 7100
Fax: +61-8-8226-7102
Email: public.health@health.sa.gov.au

Australian OHS Departments

A regional listing of the state OHS-related departments in Australia, from the ASCC.

Web: http://www.ascc.gov.au/ascc/AboutUs/StateContacts/

Worksafe Online (WA)

A division within the Western Australian Dept of Consumer and Employment Protection (DOCEP), providing extensive work safety information, including hazardous substances.

Web: http://www.worksafe.wa.gov.au/newsite/worksafe/default.html
Postal address: Worksafe, P.O. Box 294, West Perth, WA 6872, Australia
Phone: +61-8-9327 8777
Email: safety@docep.wa.gov.au

Government Research Organizations

Antarctic Climate & Ecosystems (ACE) CRC

This research partnership focuses on the sustainable management of Antarctic marine ecosystem resources and the study of atmospheric and oceanic processes of the Southern Ocean.

Web: http://www.acecrc.org.au/
Postal address: ACE CRC, Private Bag 80, Hobart, TAS 7001, Australia
Phone: +61-3-6226 7888
Fax: +61-3-6226 2440
Email: enquiries@acecrc.org.au

Australian Institute of Marine Science (AIMS)

Conducts research into marine environments and their resources, including bioproducts and sustainable management.

Web: http://www.aims.gov.au/
Postal address: AIMS, PMB 3, Townsville MC, Townsville QLD 4810, Australia
Phone: +61-7-4753 4444
Fax: +61-7-4772 5852
Email: reception@aims.gov.au

ARC Nanotechnology Network (ARCNN)

The ARCNN is a research network of the various groups within Australia working in the field of nanotechnology and related areas (nanosafety/nanotoxicology).

Web: http://www.ausnano.net/
Postal address: ARCNN Convenor, Prof. Chennupati Jagadish, Dept of Electronic Materials Engineering, ANU, Canberra, ACT 0200, Australia
Phone: +61-2-6125 0363
Fax: +61-2-6125 3915
Email: arcnn@ausnano.net

Australian Research Council (ARC)

A statutory authority within the federal Dept of Education, Science and Training (DEST) portfolio, which advises on research matters and manages the National Competitive Grants Program.

Web: http://www.arc.gov.au/
Postal address: ARC, G.P.O. Box 2702, Canberra, ACT 2601, Australia
Phone: +61-2-6287 6600
Fax: +61-2-6287 6601
Email: info@arc.gov.au

Australian Research Network for Algal Toxins (ARNAT)

A network co-ordinated by AIMS to facilitate communication between researchers of toxic algae found in Australian waters.

Web: http://www.aims.gov.au/arnat/arnat-00001.htm

Centre for Environmental Contaminants Research (CECR)

Conducts research into contaminants in water, sediments, soils, groundwater, and the atmosphere, including water and sediment quality assessment, and aquatic ecotoxicology.

Web: http://www.clw.csiro.au/cecr/
Postal address: Dr Graeme Batley, Director of CECR, CSIRO Energy Technology, Private Mailbag 7, Bangor, NSW 2234, Australia
Phone: +61-2-9710 6830
Email: Graeme.batley@csiro.au

Commonwealth Scientific and Industrial Research Organisation (CSIRO)

This is Australia's national science agency and includes Divisions that are concerned with environmental sustainability, i.e. Energy Technology (CET), Land and Water (CLW), Marine and Atmospheric Research (CMAR) and Sustainable Ecosystems (CSE).

Web: http://www.csiro.gov.au/
Postal address: CSIRO Enquiries, Bag 10, Clayton South, VIC 3169, Australia
Phone: +61-3-9545 2176
Fax: +61-3-9545 2175
Email: Enquiries@csiro.au

Cooperative Research Centres (CRC)

The CRC Program of DEST includes several collaborative research centers concerned with environmental sustainability and chemical contamination.

Web: https://www.crc.gov.au/
Postal address: CRC Program, DEST, G.P.O. Box 9880, Canberra City, ACT 2601, Australia
Phone: +61-2-6240 5011
Fax: +61-2-6240 9096
Email: crc.program@dest.gov.au

CSIRO Human Nutrition

Conducts research into food and nutrition and its effects, including diagnostic genotoxicity assays developed by its Genome Health Nutrigenomics group.

Web: http://www.csiro.au/people/Michael.Fenech.html
Postal address: Dr Michael Fenech, CSIRO Human Nutrition, Kintore Ave, Adelaide, SA 5000, Australia
Phone: +61-8-8303 8880
Fax: +61-8-8303 8899
Email: Michael.Fenech@csiro.au

Cooperative Research Centre for Water Quality and Treatment

This research partnership focuses on issues relating to water quality management and health risk reduction.

Web: http://www.waterquality.crc.org.au/
Postal address: Dr Dennis Steffensen, CEO CRC for Water Quality & Treatment, Australia Water Quality Centre, Private Mail Bag 3, Salisbury, SA 5108, Australia
Phone: +61-8-8259 0326
Fax: +61-8-8259 0228
Email: dennis.steffensen@sawater.com.au

Cooperative Research Centre for Contamination Assessment and Remediation of the Environment (CRC-CARE)

This research partnership develops advanced new technologies for dealing with land, groundwater, and air contamination.

Web: http://www.crccare.com/
Postal address: CRC CARE, P.O. Box 486, Salisbury South, SA 5106, Australia
Phone: +61-8-8302 5041
Fax: +61-8-8302 3057
Email: ravi.naidu@unisa.edu.au

CRC Reef Research Centre

This research partnership focuses on the sustainable use of the Great Barrier Reef World Heritage Area.

Web: http://www.reef.crc.org.au/
Postal address: CRC Reef Research Centre, PO Box 772, Townsville, QLD 4810, Australia
Phone: +61-7-4729 8400
Fax: +61-7-4729 8499
Email: info@crcreef.com

Environmental Biotechnology CRC (EBCRC)

This research partnership develops advanced technologies based on biological systems to improve efficiency and reduce (or utilize) industrial waste to the environment.

Web: http://www.ebcrc.com.au/
Postal address: EBCRC, Suite G01 Bay 3, Locomotive Workshop Building, Australian Technology Park, Eveleigh, 1430 NSW, Australia
Phone: +61-2-9209 4963
Fax: +61-2-9209 4980
Email: crcwmpc@unsw.edu.au

National Health and Medical Research Council (NHMRC)

Main government granting body for medical research, which is also responsible for human and animal research ethics.

Web: http://www.nhmrc.gov.au/
Postal address: NHMRC, G.P.O. Box 1421, Canberra, ACT 2601, Australia
Phone: +61-2-62179000
Fax: +61-2-6217 9100
Email: nhmrc@nhmrc.gov.au

Australian Health Ethics Committee (AHEC) & Human Research Ethics Committees (HREC)

These committees are concerned with human research ethics and have provided guidelines for these activities in the 'National Statement on Ethical Conduct in Human Research (2007)'.

Web: http://www.nhmrc.gov.au/ethics/human/).

Animal Ethics Committees (AEC) & Animal Welfare Committee (AWC)

These committees are concerned with animal research ethics and have defined the appropriate ethical procedures for animal experimentation in Australia in the 'Australian code of practice for the care and use of animals for scientific purposes (7th Edition, 2004)'.

Web: http://www.nhmrc.gov.au/ethics/animal/index.htm

National Institute of Forensic Science (NIFS)

This institute supports research in forensic science, conducts training programs for registering practitioners, and conducts quality assurance programs.

Web: http://www.nifs.com.au/
Postal address: NIFS, P.O. Box 13075, Law Courts Post Office, VIC 8010, Australia
Phone: +61-3-9640 0707
Fax: +61-3-9640 0709
Email: info@nifs.com.au

Rural Industries Research and Development Corporation (RIRDC)

The RIRDC manages and funds priority research, including the sustainable use of the environment, and translates the results into practical outcomes for industry development.

Web: http://www.rirdc.gov.au/
Postal address: RIRDC, P.O. Box 4776, Kingston, ACT 2604, Australia
Phone: +61-2-6272 4819
Fax: +61-2-6272 5877
Email: rirdc@rirdc.gov.au

Victorian Institute of Forensic Medicine (VIFM)

The VIFM provides forensic pathology and related services, training and research in Victoria. It has academic status as the Monash University Dept of Forensic Medicine and administers the National Coroners Information System (NCIS) database.

Web: http://www.vifm.org/
Postal address: VIFM, 57–83 Kavanagh St, Southbank, VIC 3006, Australia
Phone: +61-3-9684 4444
Fax: +61-3-9682 7353

Organizations – Non-Government

Alcohol and other Drugs Council of Australia (ADCA)

NGO working to reduce the harm caused by alcohol and other drugs.

Web: http://www.adca.org.au/
Postal address: ADCA, P.O. Box 269, Woden, ACT 2606, Australia
Phone: +61-2-6281 0686
Fax: +61-2-6281 0995
Email: adca@adca.org.au

Australian Cancer Research Foundation (ACRF)

A charity that funds cancer research, including epidemiology.

Web: http://www.acrf.com.au/
Postal address: ACRF, Suite 409, The Strand Arcade, 412 George Street, Sydney, NSW 2000, Australia
Phone: +61-2-9223 7833
Fax: +61-2-9223 1800
Email: info@acrf.com.au

Australian Drug Foundation

A foundation working to prevent and reduce alcohol and other drug-related problems.

Web: http://www.adf.org.au/
Postal address: Australian Drug Foundation, P.O. Box 818, North Melbourne, VIC 3051, Australia
Phone: +61-3-9278 8100
Fax: +61-3-9328 3008
Email: adf@adf.org.au

Australian Medical Council

Independent national standards body for medical education and training.

Web: http://www.amc.org.au/
Postal address: Australian Medical Council, P.O. Box 4810, Kingston, ACT 2604, Australia
Phone: +61-2-62709777
Fax: +61-2-62709799
Email: amc@amc.org.au

Australian Patient Safety Foundation (APSF)

Non-profit independent organization for the advancement of patient safety; has developed classification systems and database software for coding and reporting of incidents and adverse events.

Web: http://www.apsf.net.au/
Postal address: APSF, G.P.O. Box 400, Adelaide, SA 5001, Australia
Phone: +61-8-8222 5115
Fax: +61-8-8232 6938
Email: research@apsf.net.au

Royal Society for the Prevention of Cruelty to Animals (RSPCA Australia)

Australian branch of Society for the Prevention of Cruelty to Animals, including animal experimentation.

Web: http://www.rspca.org.au/
Postal address: RSPCA Australia Inc., P.O. Box 265, Deakin West, ACT 2600, Australia
Phone: +61-2-6282 8300
Fax: +61-2-6282 8311

Rural Health Education Foundation (RHEF)

Provides accredited education services (including clinical toxicology) to general practitioners and other

health professionals working in rural and remote Australia.

Web: http://www.rhef.com.au/
Postal address: RHEF, P.O. Box 324, Curtin, ACT 2605, Australia
Phone: +61-2-6232 5480
Fax: +61-2-6232 5484
Email: rhef@rhef.com.au

Walter and Eliza Hall Institute (WEHI) of Medical Research

The Molecular Genetics of Cancer Division conducts significant research into apoptosis.

Web: http://www.wehi.edu.au/
Postal address: WEHI, 1G Royal Parade, Parkville, VIC 3050, Australia
Phone: +61-3-9345 2555
Fax: +61-3-9347 0852
Email: information@wehi.edu.au

Commercial Organizations with Toxicology and Regulatory Activities

Association of Therapeutic Goods Consultants

Professional association of technical consultants to the therapeutic goods industry.

Web: http://www.atgc.com.au/
Postal address: ATGC, P.O. Box 273, Annandale, NSW 2038, Australia
Email: info@atgc.com.au

Austox Program

AUSTOX Urine Toxicology Proficiency Program administered by a reference facility for drug screening (Toxicology Unit, Pacific Laboratory Medicine Services).

Web: http://www.austox.com/
Postal address: Toxicology Unit, PaLMS, Macquarie Hospital Campus, P.O. Box 53, North Ryde, NSW 1670, Australia
Phone: +61-2-9887 5666
Fax: +61-2-9805 1259
Email: info@toxicologyunit.com

Australian Centre for Occupational Health and Safety

A company that provides MSDS services to industry via its Infosafe database.

Web: http://www.acohs.com.au/
Postal address: ACOHS Pty Ltd, 2–4 Burleigh Court, Nunawading, VIC 3131, Australia
Phone: +61-3-9875 6900
Fax: +61-3-9875 6956
International Email: international@acohs.com.au

Australian Water Association (AWA)

Australia's largest water industry association that promotes the sustainable management of water, including public health issues.

Web: http://www.awa.asn.au/
Postal address: AWA, P.O. Box 388, Artarmon, NSW 1570, Australia
Phone: +61-2-9413 1288
Fax: +61-2-9413 1047
Email: info@awa.asn.au

National Association of Testing Authorities, Australia (NATA)

Government-endorsed provider of accreditation for laboratories and testing facilities, Australia's GLP compliance monitoring authority for the OECD Principles of GLP and Australia's representative on the OECD GLP Working Group.

Web: http://www.nata.asn.au/
Postal address: NATA, P.O. Box 7507, Silverwater, NSW 2128, Australia
Phone: +61-2-9736 8222
Fax: +61-2-9743 5311
Email: nswmanager@nata.asn.au

National Safety Council of Australia (NSCA)

Provides commercial OHS training and consulting services.

Web: http://www.nsca.org.au/
Postal address: NSCA, Building 4, Brandon Office Park, 540 Springvale Road Glen Waverley, VIC 3150, Australia
Phone: +61-3-8562 1555
Fax: +61-3-8562 1590
Email: melbourne@nsca.org.au

Plastics and Chemicals Industries Association (PACIA)

Main national body representing Australia's fourth largest manufacturing sector.

Web: http://www.pacia.org.au/
Postal address: PACIA, Level 1, Unit 7, Skipping Girl Place, 651 Victoria Street, Abbotsford, VIC 3067, Australia
Phone: +61-3-9429 0670
Fax: +61-3-9429 0690
Email: info@pacia.org.au

Risk Management Institution of Australasia Limited (RMIA)

Professional association for risk management practitioners, providing accreditation and involved in the development and promotion of the Risk Management Standard, AS/NZS 4360.

Web: http://www.rmia.org.au/
Postal address: RMIA, P.O. Box 97, Carlton South, VIC 3053, Australia
Phone: +61-3-8341 1000
Fax: +61-3-9347 5575
Email: admin@rmia.org.au

Waste Management Association of Australia (WMAA)

Peak national forum for the Australian waste management industry.

Web: http://www.wmaa.asn.au/
Postal address: WMAA, Suite 4D, Level 4, 5 Belmore Street, Burwood NSW 2134, Australia
Phone: +61-2-8746 5000
Fax: +61-2-9701 0199
Email: enquiries@wmaa.asn.au

Interest Groups with a Toxicology, Environmental and Occupational Safety and Health Focus

The information on these websites should be compared with websites and refereed sources of the relevant government authorities and scientific literature.

Asbestos Diseases Society of Australia (ADSA)

A charitable organization that provides the Asbestos Diseases Advisory Services (ADAS), and counseling/support services to those who develop asbestos-related diseases and their families. It also provides information on asbestos toxicity and conducts fund-raising for medical research.

Web: http://www.asbestosdiseases.org.au/
Postal address: ADSA, P.O. Box 1394, Osborne Park, WA 6916, Australia
Phone: +61-8-9344 4077
Fax: +61-8-9345 0422

Australasian Society of Oral Medicine And Toxicology (ASOMAT)

Association of dentists and doctors to promote concepts of bio-compatible dentistry (as opposed to mercury amalgam).

Web: http://www.asomat.org/
Postal address: ASOMAT, P.O. Box A860, Sydney South, NSW 2000, Australia

Clean Air Society of Australia and New Zealand (CASANZ)

Organization for people interested in environmental management affairs with particular reference to air quality and related issues.

Web: http://www.casanz.org.au/
Postal address: CASANZ – Admin. Officer, 70 Olinda-Monbulk Road, Olinda, VIC 3788, Australia
Phone/fax: +61-3-9751 0393
Email: admin.officer@casanz.org.au

Friends of the Earth Australia

A federation of independent local groups working for an environmentally sustainable future.

Web: http://www.foe.org.au/
Postal address: Friends of the Earth, P.O. Box 222, Fitzroy, VIC 3065, Australia
Phone: +61-3-9419 8700
Fax: +61-3-9416 2081
Email: cam.walker@foe.org.au

Global Lead Advice and Support Service (GLASS)

This is run by the Lead Education and Abatement Design Group 'LEAD Group', a community organization providing information on lead poisoning and contamination prevention and management.

Web: http://www.lead.org.au/fs/fst1.html
Postal address: LEAD Group, P.O. Box 161, Summer Hill, NSW 2130, Australia
Phone: +61-2-9716 0014
Fax: +61-2-9716 9005

Greenpeace Australia Pacific

Independent campaigning organization concerned with global environmental problems.

Web: http://www.greenpeace.org.au/
Postal address: Greenpeace, Level 4, 35–39 Liverpool St, Sydney, NSW 2000, Australia
Phone: +61-2-9261 4666
Fax: +61-2-9261 4588
Email: greenpeace@au.greenpeace.org

National Toxics Network (NTN)

A community-based network concerned with pollution reduction and protection of environmental health.

Web: http://www.oztoxics.org/ntn/
Postal address: National Toxics Network Inc., P.O. Box 173, Bangalow, NSW 2479, Australia
Email: evolve@joimmig.com

Total Environment Centre (TEC)

Australian environmental movement concerned with the public health effects of toxic chemicals.

Web: http://www.tec.org.au/
Postal address: TEC, P.O. Box A176, Sydney South, NSW 1235, Australia
Phone: +61-2-9261 3437
Fax: +61-2-9261 3990

World Wildlife Fund Australia (WWF-Australia)

Environmental conservation group concerned with industrial effects on the environment and biodiversity.

Web: http://www.wwf.org.au/
Postal address: WWF-Australia, P.O. Box 528, Sydney, NSW 2001, Australia
Phone: +61-2-9281 5515
Fax: +61-2-9281 1060

Universities

Universities Researching and Teaching Toxicology and OHS

List of Australian Universities

The Australian Education Network website provides direct links to Australian universities. There are four main groupings of Australian universities, which help them to promote mutual objectives, i.e.

- Group of Eight (Go8): oldest 'sandstone' universities and/or strong overall research capability.
- Australian Technology Network (ATN): originally technical institutions, these have strengths in the practical application of research.
- Innovative Research Universities Australia (IRU Australia): founded in the 1960s–1970s and containing areas of specialization.
- New Generation Universities (NGU): received university accreditation since 1970 (http://www.australian-universities.com/list/).

Australian National University (ANU)

A Go8 research-intensive university established in the nation's capital in 1946.

Web: http://www.anu.edu.au/
Postal address: The Australian National University, Canberra, ACT 0200, Australia
Phone: +61-2-6125 5111
Email: enquiries@anu.edu.au

ANU College of Medicine and Health Sciences

Research activities include clinical toxicology.

Web: http://cmhs.anu.edu.au/

Centre for the Study of Bioactive Molecules (CSBM)

Multidisciplinary research centre, including research into natural toxins.

Web: http://csbm.anu.edu.au/home.html

National Centre for Epidemiology and Population Health (NCEPH)

Includes environmental health and epidemiology research groups.

Web: http://nceph.anu.edu.au/

National Research Centre for Occupational Health and Safety Regulation

Research centre funded by the ASCC to conduct research into OHS regulation, which also publishes seminar papers and working papers in OHS, including 'Regulation at Work'.

Web: http://www.ohs.anu.edu.au/

Curtin University of Technology (Curtin)

Western Australian technical university and ATN member.

Web: http://www.curtin.edu.au/
Postal address: Curtin University of Technology, G.P.O. Box U1987, Perth, WA 6845, Australia
Phone: +61-8-9266 9266
Fax: +61-8-9266 2255

School of Public Health

Conducts research and teaching in environmental health, epidemiology and OHS.

Web: http://www.publichealth.curtin.edu.au/index.cfm

Muresk Institute

Research areas include ecotoxicology.

Web: http://muresk.curtin.edu.au/

Flinders University of South Australia (Flinders)

Second university established in South Australia in 1966 and IRUA member.

Web: http://www.flinders.edu.au/
Postal address: Flinders University, G.P.O. Box 2100, Adelaide, SA 5001, Australia
Phone: +61-8-8201 3911
Fax: +61-8-8201 3000
Email: central.records@flinders.edu.au

Department of Clinical Pharmacology

Research and teaching areas include drug and xenobiotic metabolism, and human and molecular toxicology.

Web: http://som.flinders.edu.au/FUSA/ClinPharm/index.htm

Department of Environmental Health

Research and teaching areas include environmental toxicology, risk assessment, bioremediation, and epidemiology.

Web: http://som.flinders.edu.au/FUSA/EnvHealth/Default.htm

Griffith University (Griffith)

Queensland University with a School of Public Health and School of Environmental Studies and IRUA member.

Web: http://www.griffith.edu.au/
Postal address: Griffith University Gold Coast Campus, PMB 50 Gold Coast Mail Centre, QLD 9726, Australia
Phone: +61-7-5552 8800

Centre for Aquatic Processes and Pollution

Conducts ecotoxicology research in coastal aquatic ecosystems and is now part of the Australian Rivers Institute.

Web: http://www.griffith.edu.au/environment-planning/australian-rivers-institute

James Cook University (JCU)

Leading tropical research university in north Queensland.

Web: http://www.jcu.edu.au/
Postal address: James Cook University, Townsville, QLD 4811, Australia
Phone: +61-7-4781 4111
Fax: +61-7-4779 6371

Tropical Australian Stinger Research Unit

Conducts medical and biological research on cubozoans (box jellyfish).

Web: http://www.jcu.edu.au/interest/stingers/index.htm

La Trobe University (La Trobe)

An IRUA member with a School of Pharmacy and Applied Science at the Bendigo campus in regional Victoria.

Web: http://www.latrobe.edu.au/
Postal address: La Trobe University, VIC 3086, Australia
Phone: +61-3-9479 1111
Fax: +61-3-9478 5814

Vaux Laboratory, Dept Biochemistry, School of Molecular Sciences

Research laboratory of David Vaux, a world leader in apoptosis research.

Web: http://www.latrobe.edu.au/biochemistry/lab/vaux/index.htm

Monash University (Monash)

Second university established in Victoria in 1958 and G08 member.

Web: http://www.monash.edu.au/
Postal address: Monash University, VIC 3800, Australia
Phone: +61-3-9902 6000
Fax: +61-3-9905 4007

Accident Research Centre (MUARC)

Conducts research into the causes and prevention of road accidents.

Web: http://www.monash.edu.au/muarc/

Australian Centre for Human Health Risk Assessment (ACHHRA)

A multi-institutional and disciplinary center located in the Department of Epidemiology and Preventive Medicine, concerned with risk assessment of human exposure to hazardous chemicals and microorganisms.

Web: http://www.med.monash.edu.au/epidemiology/achhra/

Monash Venoms and Toxins Group

Located in the Department of Pharmacology, it conducts research into snake, spider and jellyfish venoms.

Web: http://www.med.monash.edu.au/pharmacology/research/index.html

Victorian College of Pharmacy

Includes the Centre for Drug Candidate Optimisation conducting preclinical development and evaluation.

Web: http://www.vcp.monash.edu/

Queensland University of Technology (QUT)

This ATN member was formerly the Queensland Institute of Technology (QIT) that became a university

in 1989. The School of Life Sciences has a pharmacy program and the School of Physical and Chemical Sciences has a forensic science program.

Web: http://www.qut.edu.au/
Postal address: QUT, G.P.O. Box 2434, Brisbane QLD 4001, Australia
Phone: +61-7 3138 2111
Email: qutinformation@qut.edu.au

International Laboratory for Air Quality and Health (ILAQH)

Conducts interdisciplinary research into air quality and its impact on human health, with a specific focus on fine and ultrafine particles.

Web: http://www.ilaqh.qut.edu.au/

School of Public Health

Contains the Centre for Health Research including activities in health and safety, environmental health and epidemiology.

Web: http://www.hlth.qut.edu.au/ph/

RMIT University (RMIT)

Royal Melbourne Institute of Technology, is one of Australia's oldest technical institutions that became a university in 1992. It has a long-standing strength in toxicology expertise and education, and is an ATN member.

Web: http://www.rmit.edu.au/
Postal address: RMIT University, G.P.O. Box 2476V, Melbourne, VIC 3001, Australia
Phone: +61-3-9925 2000
Fax: +61-3-9663 2764

Key Centre for Applied and Nutritional Toxicology

Established the first general toxicology degree program in Australasia in the mid-1980s. Initially supported by Australian Research Council Key Centre funding, it conducts research into detoxication biochemistry, biochemical mechanisms of toxicity, immunotoxicology, toxicokinetics, ecotoxicology, and food toxicology.

Web: http://www.rmit.edu.au/browse;ID=tp3btm6v20gc1
Postal address: School of Medical Sciences, RMIT University, P.O. Box 71, Bundoora, VIC 3083

NanoSafe Australia

Australia's nanotoxicology research network co-ordinated from RMIT and providing occupational and environmental health and safety services to the Australian Research Council Nanotechnology Network (ARCNN), as well as government, industry and NGOs.

Web: http://www.rmit.edu.au/nanosafe/

RMIT Drug Discovery Technologies (RDDT)

Contract research organization providing preclinical drug development services.

Web: http://www.rddt.com.au/

School of Applied Sciences

Includes the occupational health and safety group and programs, and the ecotoxicology and environmental biology research group.

Web: http://www.rmit.edu.au/applied-sciences

School of Medical Sciences

Location of the RMIT toxicology expertise, which commenced the world's first and only fully online toxicology postgraduate degrees (Graduate Diploma in Toxicology and Masters of Toxicology) in 2001.

Web: http://www.rmit.edu.au/medical-sciences/toxicology-pg

University of Adelaide (Adelaide)

Oldest university in South Australia and Go8 member.

Web: http://www.adelaide.edu.au/
Postal address: The University of Adelaide, SA 5005, Australia
Phone: +61-8-8303 4455

Department of Public Health

Conducts research into occupational and environmental health and safety, and runs the National Short Course in Environmental Health.

Web: http://www.public-health.adelaide.edu.au/

Molecular Toxicology

A research area within the Pharmacology Discipline, including cyanobacterial toxins and drug metabolism leading to toxicity.

Web: http://www.adelaide.edu.au/health/pharm/research/toxicology.html

University of Queensland (UQ)

Oldest university in Queensland and Go8 member.

Web: http://www.uq.edu.au/

Postal address: The University of Queensland, Brisbane, QLD 4072, Australia
Phone: +61-7-3365 1111

National Research Centre for Environmental Toxicology (EnTox)

Originally the NHMRC-funded centre 'NRCET', it conducts research into human environmental toxicology.

Web: http://www.entox.uq.edu.au/
Postal address: 39 Kessels Road, Coopers Plains, QLD 4108, Australia
Phone: +61-7-3274 9009
Fax: +61-7-3274 9003

TetraQ

Contract research organization providing preclinical drug development services.

Web: http://www.tetraq.uq.edu.au/index.html

University of Melbourne (UniMelb)

Oldest university in Victoria and Go8 member.

Web: http://www.unimelb.edu.au/
Postal address: The University of Melbourne, VIC 3010, Australia
Phone: +61-3-8344 4000
Fax: +61-3-8344 5104

Australian Venom Research Unit

Toxinology expertise located in the pharmacology department.

Web: http://www.avru.org/

Centre for Environmental Stress and Adaptation Research (CESAR)

A joint Melbourne and Monash university centre with research in environmental biomonitoring and chemical stress.

Web: http://www.cesar.org.au/

Faculty of Medicine, Dentistry and Health Sciences

Offers the Graduate Diploma in Drug Evaluation and Pharmaceutical Sciences, co-ordinated by Austin Health.

Web: http://www.mdhs.unimelb.edu.au/

University of New South Wales (UNSW)

Second university established in NSW and Go8 member.

Web: http://www.unsw.edu.au/
Postal address: The University of New South Wales, Sydney, NSW 2052, Australia
Phone: +61-2-9385 1000

Institute of Environmental Studies (IES)

Runs postgraduate programs in Environmental Management and Environmental Network (EN) project.

Web: http://www.ies.unsw.edu.au/

School of Safety Science

Research and teaching programs in safety, the environment, and general risk management, including applied toxicology research.

Web: http://www.safesci.unsw.edu.au/

University of Newcastle (Newcastle)

An IRUA university located in Newcastle, NSW.

Web: http://www.newcastle.edu.au/
Postal address: University of Newcastle, Callaghan Campus, University Drive, Callaghan, NSW 2308, Australia
Phone: +61-2-4921 5000
Fax: +61-2-4921 5656
Email: EnquiryCentre@newcastle.edu.au

School of Medicine and Public Health

Contains the Discipline of Clinical Pharmacology and Clinical Toxicology in association with the Hunter Area Health Service.

Web: http://www.newcastle.edu.au/school/medprac-pop/

University of South Australia (UniSA)

An ATN member founded in 1991 through the amalgamation of South Australian Institute of Technology and South Australian College of Advanced Education.

Web: http://www.unisa.edu.au/
Postal address: University of South Australia, G.P.O. Box 2471, Adelaide, SA 5001, Australia
Phone: +61-8-8302 6611
Fax: +61-8-8302 2466
Email: campuscentral.cityeast@unisa.edu.au

Centre for Environmental Risk Assessment and Remediation (CERAR)

Multidisciplinary research center focusing specifically on both environmental risk assessment and remediation.

Web: http://www.unisa.edu.au/cerar/default.asp

Centre for Pharmaceutical Research

Provides pre-clinical services.

Web: http://www.unisa.edu.au/cpr/default.html

School of Pharmacy and Medical Sciences

Research participant in the CRC Water Quality and Treatment.

Web: http://www.unisa.edu.au/pmbs/

University of Sydney (USyd)

Oldest university in Australia and Go8 member.

Web: http://www.usyd.edu.au/
Postal address: The University of Sydney, NSW 2006, Australia
Phone: +61-2-9351 2222

Faculty of Veterinary Science

Provides the Veterinary Education and Information Network (VEIN).

Web: http://www.vetsci.usyd.edu.au/

Reproductive Toxicology and Chemical Hazard Assessment Laboratory (CHALUS)

Located in the Discipline of Anatomy and Histology, this lab specialises in teratology research.

Web: http://www.anatomy.usyd.edu.au/research/groups/webster/index.html

University of Tasmania (UTas)

The main university in Tasmania.

Web: http://www.utas.edu.au/
Postal address: University of Tasmania, G.P.O. Box 252, Hobart, TAS 7001, Australia
Phone: +61-3-6226 2999
Fax: +61-3-6226 2018

School of Aquaculture

Research activities include aquatic toxicology.

Web: http://www.utas.edu.au/aqua
Postal address: Locked Bag 1370, Launceston, TAS 7250, Australia
Phone: +61-3-6324 3801
Fax: +61-3-6324 3804
Email: Enquiries@aqua.utas.edu.au

School of Pharmacy

Research activities include chemical ecology and toxicology.

Web: http://www.utas.edu.au/pharmacy
Postal address: Private Bag 26, Hobart, TAS 7001, Australia
Phone: +61-3-6226 2190
Fax: +61-3-6226 2870

University of Technology Sydney (UTS)

An ATN university with ecotoxicology and forensic science degrees.

Web: http://www.uts.edu.au/
Postal address: University of Technology, Sydney, P.O. Box 123, Broadway, NSW 2007, Australia
Phone: +61-2-9514 2000

Centre for Ecotoxicology (CET)

This research centre is a joint venture of the UTS and the Environment Protection Authority of New South Wales; activities include sediment toxicity testing, and laboratory and field studies in aquatic toxicology.

Web: http://www.science.uts.edu.au/centres/ecotox/index.html

Neurotoxin Research Group

Located in the Department of Medical and Molecular Biosciences, its activities include the isolation and bioactivity characterization of animal neurotoxins.

Web: http://www.science.uts.edu.au/health/nrgresearch.html

University of Western Australia (UWA)

Oldest university in Western Australia and Go8 member.

Web: http://www.uwa.edu.au/
Postal address: The University of Western Australia, 35 Stirling Highway, Crawley, WA 6009, Australia
Phone: +61-8-6488 6000
Fax: +61-8-6488 1380
Email: general.enquiries@uwa.edu.au

Centre for Forensic Science

Runs postgraduate research and coursework programs in forensic science.

Web: http://www.forensicscience.uwa.edu.au/

School of Medicine and Pharmacology

Laboratories include molecular toxicology and oxidative stress and clinical toxicology (in association with PathWest pathology services).

Web: http://www.pharm.uwa.edu.au/

School of Population Health

Research programs include cancer epidemiology.

Web: http://www.sph.uwa.edu.au/

Victoria University (VU)

This vocationally orientated NGU member was formerly the Victoria University of Technology (VUT).

Web: http://www.vu.edu.au/
Postal address: Victoria University, P.O. Box 14428, Melbourne VIC 8001, Australia
Phone: +61-3-9919 4000
Fax: +61-3-9689 4069

Centre for Environmental Safety and Risk Engineering (CESARE)

Conducts research primarily in the area of fire safety and risk engineering.

Web: http://www.vu.edu.au/Faculties_and_TAFE/Health_Engineering_and_Science/Centre_for_Environmental_Safety_and_Risk_Engineering_CESARE/indexdl_89402.aspx

Other Universities also Teaching Toxicology and Environmental and Occupational Health and Safety

Central Queensland University (CQU)

This NGU member has a Centre for Environmental Management.

Web: http://www.cqu.edu.au/
Postal address: Centre for Environmental Management, CQU, Bryan Jordan Drive, Gladstone QLD 4680, Australia
Phone: +61-7-4970 7310
Fax: +61-7-4970 7207
Email: cem-enquiries@cqu.edu.au

Charles Darwin University (CDU)

The School of Science and Primary Industries includes research into toxicology of aquatic snakes.

Web: http://www.cdu.edu.au/
Postal address: Charles Darwin University, Darwin, NT 0909, Australia
Phone: +61-8-8946 6666
Fax: +61-8-8927 0612

Charles Sturt University (CSU)

Provides a course in Forensic Toxicology.

Web: http://www.csu.edu.au/
Postal address: Charles Sturt University, P.O. Box 789, Albury, NSW 2640, Australia
Phone: +61-2-6051 6000
Fax: +61-2-6051 6629

Deakin University (Deakin)

The School of Life & Environmental Science includes environmental management, and the School of Biological & Chemical Sciences, offers a bachelor degree in forensic science.

Web: http://www.deakin.edu.au/
Postal address: Deakin University, Geelong VIC 3227
Phone: +61-3-5227 2333
Email: enquire@deakin.edu.au

Edith Cowan University (ECU)

This NGU member has a School of Natural Sciences, which offers a degree in Environmental Health.

Web: http://www.ecu.edu.au/
Postal address: Edith Cowan University, 100 Joondalup Drive, Joondalup, WA 6027, Australia
Phone: +61-8-6304 0000
Email: enquiries@ecu.edu.au

Murdoch University (Murdoch)

This IRUA member has a School of Biological Sciences and Biotechnology and a School of Veterinary & Biomedical Sciences.

Web: http://www.murdoch.edu.au/
Postal address: Murdoch University, South Street, Murdoch, WA 6150, Australia
Phone: +61-8-9360 6000

Southern Cross University (SCU)

This NGU member has a School of Environmental Science and Management.

Web: http://www.scu.edu.au/
Postal address: Southern Cross University, P.O. Box 157, Lismore, NSW 2480, Australia
Phone: +61-2-6620 3000
Fax: +61-2-6620 3700

Swinburne University of Technology (Swinburne)

This university has an Environment and Biotechnology Centre and programs in Public and Environmental Health.

Web: http://www.swin.edu.au/
Postal address: Swinburne University, P.O. Box 218, Hawthorn, VIC 3122, Australia
Phone: +61-3-8676 7002

University of Canberra (UC)

This NGU member has a School of Health Sciences offering degrees in forensic science.

Web: http://www.canberra.edu.au/
Postal address: University of Canberra, ACT 2601 Australia
Phone: +61-2-6201 5111

University of Wollongong (UOW)

The Faculty of Health and Behavioural Sciences offers degrees in OHS.

Web: http://www.uow.edu.au/
Postal address: University of Wollongong, Wollongong, NSW 2522, Australia
Phone: +61-2-4221 3555

Professional Societies

Association of Regulatory and Clinical Scientists (ARCS Australia)

Professional association that supports scientists involved in the development of therapeutic products, including regulatory affairs.

Web: http://www.arcs.com.au/
Postal address: ARCS, Suite 904, 28 Clarke Street, Crows Nest, NSW 2065, Australia
Phone: +61-2-8905 0829
Fax: +61-2-8905 0830
Email: arcs@arcs.com.au

Australasian College of Toxicology and Risk Assessment (ACTRA)

Recently established in July 2006 to provide a registry, continuing education and accreditation for toxicologists and health risk assessment professionals.

Web: http://www.actra.org.au/
Postal address: ACTRA Secretariat, Meetings First P/L, 4/184 Main Street, Lilydale, VIC 3140, Australia
Phone: +61-3-9739 7697
Fax: +61-3-9737 7076
Email: actra@meetingsfirst.com.au

Australasian Faculty of Occupational Medicine (AFOM)

This Faculty undertakes the professional training of occupational physicians and other roles of the former Australian College of Occupational Medicine.

Web: http://afom.racp.edu.au/
Postal address: AFOM, 145 Macquarie St, Sydney, NSW 2000, Australia
Phone: +61-2-8247 6219
Fax: +61-2-9247 8082 http://images/Copy_of_Vivien Haslam.jpg
Email: afom@racp.edu.au

Australasian Faculty of Public Health Medicine (AFPHM)

This Faculty undertakes the professional training of doctors in public health and community medicine in Australia and New Zealand.

Web: http://afphm.racp.edu.au/
Postal address: AFPHM, 145 Macquarie St, Sydney, NSW 2000, Australia
Phone: +61-2-8247 6224
Fax: +61-2-9252 3526
Email: afphm@racp.edu.au

Australasian Pharmaceutical Science Association (APSA)

Professional society that represents all branches of the pharmaceutical sciences, including regulatory areas.

Web: http://www.apsa-online.org/
Postal address: APSA, School of Pharmacy & Medical Sciences, University of South Australia, SA 5000, Australia
Phone: +61-8-8302 2391
Fax: +61-8-8302 2389
Email: info@apsa-online.org

Australasian Radiation Protection Society Inc. (ARPS)

Professional society of members engaged in one or more aspects of radiation protection.

Web: http://www.arps.org.au/
Postal address: ARPS, P.O. Box 7108, Upper Fern Tree Gulley, VIC 3156, Australia
Phone: +61-3-9756 0128
Fax: +61-3-9753 6372
Email: arps@21century.com.au

Australasian Society for Ecotoxicology (ASE)

Professional society representing all branches of ecotoxicology and publishes the *Australasian Journal of Ecotoxicology* (AJE).

Web: http://www.ecotox.org.au/
Postal address: Ross Hyne (ASE), Centre for Ecotoxicology, DEC NSW, Lidcombe, NSW 2141, Australia
Phone: +61-2-9995 5081
Fax: +61-2-9995 5183
Email: Ross.Hyne@environment.nsw.gov.au

Australasian Society of Clinical and Experimental Pharmacologists and Toxicologists (ASCEPT)

This society has separate sections representing toxicology and clinical toxicology. It is the IUTOX affiliate for

Australasia and hosted the 9th International Congress of Toxicology ('ICT-IX', Brisbane, 2001).

Web: http://www.ascept.org/
Postal address: ASCEPT Secretariat, Meetings First P/L, 4/184 Main Street, Lilydale, VIC 3140, Australia
Phone: +61-3-9739 7697
Fax: +61-3-9737 7076
Email: ascept@meetingsfirst.com.au

Australian and New Zealand Forensic Science Society (ANZFSS)

Professional society representing all branches of forensic science.

Web: http://anzfss-vic.blogspot.com/
Postal address: Tahnee Dewhurst, http://photos1.blogger.com/blogger2/5532/906561639777752/1600/contact.jpghttp://photos1.blogger.com/blogger2/5532/906561639777752/1600/contact.0.jpgANZFSS-Victorian Branch, P.O. Box 130, Rosanna, VIC 3084, Australia
Phone: +61-3-9450 3540
Fax: +61-3-9450 3660

Australian and New Zealand Society of Occupational Medicine (ANZSOM)

Professional organization for registered medical practitioners involved or interested in occupational medicine.

Web: http://www.anzsom.org.au/
Postal address: ANZSOM Federal Secretariat, P.O. Box 717, East Bentleigh, VIC 3165, Australia
Phone: +61-3-9570 1859
Fax: +61-3-9579 4808
Email: anzsom@westnet.com.au

Australian Institute of Occupational Hygienists (AIOH)

Professional organization providing certification for occupational hygienists.

Web: http://www.aioh.org.au/
Postal address: AIOH , P.O. Box 1205, Tullamarine, VIC 3043, Australia
Phone: +613 9335 2577
Fax: +613 9335 3454
Email: admin@aioh.org.au

Australian Marine Sciences Association (AMSA)

Professional association for marine scientists from all related disciplines, including ecotoxicology and aquatic toxicology.

Web: http://www.amsa.asn.au/
Postal address: AMSA, P.O. Box 8, Kilkivan QLD 4600, Australia
Phone: +61-7 4772 4858
Fax: +61-7 4772 4858
Email: secretary@amsa.asn.au

Australian Society for Medical Research (ASMR)

Peak professional society representing Australian health and medical researchers, including 49 affiliated professional societies and medical colleges (e.g. ASCEPT).

Web: http://www.asmr.org.au/
Postal address: ASMR, 145 Macquarie Street, Sydney NSW 2000, Australia
Phone: +61-2-9256 5450
Fax: +61-2-9252 0294
Email: asmr@world.net

Australian Society for Veterinary Pathology (ASVP)

Professional body to promote the practice of veterinary pathology in improving animal and human health.

Web: http://www.asvp.asn.au/
Postal address: ASVP President, Paul Canfield, Dept. Vet. Anatomy & Pathology
University of Sydney, NSW 2006, Australia

Federation of Australian Scientific and Technological Societies (FASTS)

Federation of 69 professional organizations, representing the interests of >60 000 Australian scientists and technologists and promoting their views on a wide range of policy issues to government, industry, and the community.

Web: http://www.fasts.org/
Postal address: FASTS Office, L.P.O. Box 8283, ANU, Acton, ACT 2601, Australia
Fax: +61-2-6257 2897

Mutagenesis and Experimental Pathology Society of Australasia (MEPSA)

This society was formed in 1999 from the amalgamation of the Australia and New Zealand Environmental Mutagen Society (ANZEMS) and the Australasian Society for Experimental Pathology (ASEP).

Web: http://www.mepsa.org/
Postal address: A/Prof. Terry Piva, Hon. Secretary of MEPSA, School of Medical Sciences, RMIT University, Bundoora, VIC 3083, Australia
Phone: +61-3-9925 6503
Fax: +61-3-9925 7063
Email: terry.piva@rmit.edu.au

Pharmaceutical Society of Australia (PSA)

Professional organization for pharmacists in Australia.

Web: http://www.psa.org.au/
Postal address: PSA, P.O. Box 21, Curtin, ACT 2605, Australia
Phone: +61-2-6281 1366 or +61-2-6283 4777
Fax: +61-2-6285 2869
Email: psa.nat@psa.org.au

Royal Australian Chemical Institute (RACI)

The qualifying body for professional chemists and society promoting the science and practice of chemistry in Australia. It is the IUPAC affiliate for Australia, with toxicology-related activities in the Biomolecular Chemistry Division.

Web: http://www.raci.org.au/
Postal address: RACI, 21 Vale Street, North Melbourne, VIC 3051, Australia
Phone: +61-3-9328 2033
Fax: +61-3-9328 2670
Email: member@raci.org.au

Royal College of Pathologists of Australasia (RCPA)

This medical diagnostic organization promotes the science and practice of pathology.

Web: http://www.rcpa.edu.au/
Postal address: RCPA, Durham Hall, 207 Albion Street, Surry Hills, NSW 2010, Australia
Phone: +61-2-8356 5858
Fax: +61-2-8356 5828
Email: contact@rcpa.edu.au

Safety Institute of Australia (SIA)

A professional body of safety and health practitioners that also provides peer review/accreditation, and is a member of International Network of Safety & Health Practitioner Organizations.

Web: http://www.sia.org.au/
Postal address: SIA, P.O. Box 2078, Gladstone Park, VIC 3043, Australia
Phone: +61-3-8336 1993
Fax: +61-3-8336 1179

Society for Free Radical Research (Australasia) (SFRR Australasia)

This professional society includes scientists investigating free radical-mediated disease, oxidative stress, and apoptosis.

Web: http://www.sfrra.org/
Postal address: Clare Hawkins (SFRR Aust.), Heart Research Institute, 114 Pyrmont Bridge Road, Camperdown, NSW 2050, Australia
Phone: +61-2 8208 8900
Fax: +61-2 9565 5584
Email: hawkinsc@hri.org.au

Society of Environmental Toxicology and Chemistry (SETAC) Asia/Pacific

The local unit undertaking SETAC's activities, which involve multidisciplinary approaches to examine the impacts of chemicals and technology on the environment.

Web: http://www.setac.org/htdocs/who_guap.html
Postal address: Prof Mike McLaughlin, President of SETAC Asia Pacific,
CSIRO Land and Water/University of Adelaide, PMB 2, Glen Osmond SA 5064, Australia
Phone: +61-8-8303 8433
Fax: +61-8-8303 8572
Email: Mike.McLaughlin@csiro.au

Poison Control Centers

Poison Information Centres in Australia

List of Poison Information Centres in Australia, provided by Therapeutics Information Resources Australia P/L.

Web: http://ausdi.hcn.net.au/poisons.html

SAFETYvictoria

Authorized Victorian State Government site for safety and emergency information, providing links to poisons information, food poisoning and first aid.

Web: http://www.safety.vic.gov.au/
Postal address: SAFETYvictoria, Office of the Emergency Services Commissioner, 23/121 Exhibition St, GPO Box 4356QQ, Melbourne, VIC 3000, Australia
Phone: +61-3-8684 7933
Fax: +61-3-8684 7956

Victorian Poisons Information Centre

The Centre is located at the Royal Children's Hospital, Melbourne, and its role is to provide the Victorian public with a timely, safe information service in poisonings and suspected poisonings.

Web: http://www.rch.unimelb.edu.au/poisons/
Postal address: Victorian Poisons Information Centre, Royal Children's Hospital, Flemington Road, Parkville, VIC 3052, Australia
Fax: +61-3-9349 1261
Email: poison.centre@rch.org.au

Federal Government Legislation (State Government Legislation not Shown)

Agricultural and Veterinary Chemicals & Medicines

Relevant legislation for AgVet chemicals governing the APVMA (NRA).

Web: http://www.apvma.gov.au/about_us/legislat.shtml

Australian code of practice for the care and use of animals for scientific purposes

This code is provided by the NHMRC and defines the appropriate ethical procedures for animal experimentation in Australia (currently in 7th Edition, 2004).

Web: http://www.nhmrc.gov.au/publications/synopses/ea16syn.htm

Australian Commonwealth Law (ComLaw)

A web portal to all legislation, provided by the Attorney-General's Department, and incorporating the Federal Register of Legislative Instruments (FRLI). All items are progressively being migrated to ComLaw from the older database 'SCALEplus' (http://scaletext.law.gov.au/), which has not been updated since 2005.

Web: http://www.comlaw.gov.au/

Australian Therapeutic Goods Legislation

All TGA-related legislation setting out the requirements for inclusion of therapeutic goods in the Australian Register of Therapeutic Goods.

Web: http://www.tga.gov.au/legis/

Environment-related Legislation

Information and links to the legislation administered by the Australian Government Environment and Water Resources Portfolio.

Web: http://www.environment.gov.au/about/legislation.html

Food Safety Standards

The Food Standards Code for Australia.

Web: http://www.foodstandards.gov.au/thecode/foodsafetystandardsaustraliaonly/index.cfm

Health Legislation

A listing of legislation administered by the Minister for Health and Ageing.

Web: http://www.health.gov.au/internet/main/publishing.nsf/Content/health-eta2.htm

National statement on ethical conduct in human research

These guidelines are provided by the NHMRC and defines the appropriate ethical procedures for research in humans in Australia (March 2007 Edition).

Web: http://www.nhmrc.gov.au/publications/synopses/e72syn.htm

OHS National Standards and Codes of Practice

This main webpage links to the 'Index of National Standards Codes of Practice and related Guidance Notes', e.g. the 'National Standard for the Storage and Handling of Workplace Dangerous Goods' [NOHSC: 1015(2001)]. These National OHS standards and codes of practice are not legally enforceable unless State and Territory governments adopt them as regulation or codes of practice under their principal OHS Acts.

Web: http://www.ascc.gov.au/ascc/HealthSafety/OHSstandards/OHSstandardsandcodesofpractice.htm

Miscellaneous Resources

Chemical Detective

An educational program by the Deakin University's School of Biological & Chemical Sciences to encourage the study of molecular and physical science in regional secondary school students. Web: http://caligula.bcs.deakin.edu.au/bcs_courses/forensic/Chemical%20Detective/index.htm

MSDS Australia

Australian online MSDS database (by subscription).

Web: http://www.msds.com.au/)

International MEDLARS Center
National Library of Australia
Canberra ACT 2600, Australia
Phone: 61-2-6262-1531
Fax: 61-2-6273-1180
Email: networks@nla.gov.au
Web: http://www.nla.gov.au/medline/

IFCS National Focal Point
Environmental Protection Branch
Department of Environment and Heritage
Attn: Mr Barry Reville, Assistant Secretary,
PO Box 787, Canberra ACT 2601, Australia
Phone: +61-2-6274 1622
Fax: +61-2-6274 1640

CHAPTER

81

Brazil

CRISTIANA L. CORREA, MARIANA P. SOARES, AND FLAVIO A.D. ZAMBRONE

INTRODUCTION

In Brazil, concerns over poisoning date back to the end of the 19th century, when, between 1880 and 1903, a number of doctoral theses were written on occupational lead intoxication. In the late 1950s and early 1960s, the first papers in clinical toxicology appeared in the Brazilian literature. Two outstanding centers were established in the city of São Paulo, one at the Instituto Biológico (Biological Institute), represented by Dr. Waldemar Ferreira de Almeida, and another in the Hospital das Clínicas of the University of São Paulo, headed by Dr. Samuel Schvartsman; the first dedicated to pesticide intoxication and the second to toxicological emergencies.

Poison Control Centers were introduced in Brazil by Samuel Schvartsman and Eduardo Marcondes in 1963. About 1980, the Health Ministry established the Sistema Nacional de Informações Fármaco-Toxicológicas (SNIFT) (National Pharmaco-Toxicological Information System) co-ordinated and administered by Fundação Oswaldo Cruz (Oswaldo Cruz Foundation), with the objective of developing new regional poison control centers and supporting the existing ones by collecting and disseminating toxicological information.

One of the most important roots of Toxicology in Brazil, principally due to its Analytical Toxicology approach, was planted in the Faculdade de Ciências Farmacêuticas (FCF) (College of Pharmaceutical Sciences) at University of São Paulo by the renowned Professor Ester Camargo Fonseca Moraes, among others. In 1966, the effective establishment of a toxicology curriculum within a course of pharmaceutical sciences proved to be of paramount importance for the development of toxicology in Brazil.

Toxicology consolidated its leadership when in 1973 the first postgraduate course in the country dedicated to toxicology and toxicological analysis was established in a Master's degree program at the Universidade de São Paulo. A PhD doctoral program was established at the same institution in 1978.

One of the important milestones of toxicology in Brazil was the foundation of the Sociedade Brasileira de Toxicologia (Brazilian Society of Toxicology) in 1973. Today it has approximately 382 members and is instrumental in the profession's integration, creating a channel for discussion and setting forth topics related to this science, be it by organizing meetings, workshops, and congresses or by publishing and issuing magazines and newsletters dedicated to toxicology. An example of the activities of the society is the Congresso Brasileiro de Toxicologia (Brazilian Congress of Toxicology) that is held every 2 years and aims at promoting research in general toxicology and its sub-disciplines, emphasizing scientific knowledge and technological progress within an ethical framework. The most recent congress (XIV Congresso Brasileiro de Toxicologia) took place in 2005, with a registration of 725 participants, among them researchers, students, professors, professionals, and registration agents.

Today, professional toxicologists are able to pursue specialization through a number of graduate courses (specialized certificate, master and doctoral degree courses) offered at universities throughout the country. Interdisciplinary programs with representation

from areas related to healthcare are becoming increasingly common.

Despite the lack of estimates in the number of professionals who work with toxicology in Brazil, it is known that they perform functions in research institutes, forensic medical institutes, public and private institutes, governmental agencies, universities, companies rendering consulting services, laboratories, and others.

RESOURCES

Books

Azevedo FA (2003)
Toxicologia do Mercúrio (Mercury Toxicology)
S.I.: Rima Editora

This publication approaches several aspects of mercury toxicology and its biogeochemical cycle. The author presents the subject skillfully and purposefully, which makes this a reference work for discussion of queries regarding environment management. Besides these attributes, the historical approach concerning mercury is particularly enlightening.

Azevedo FA, Chasin AAM (2003)
Metais: Gerenciamento da Toxicidade (Metals: Toxicity Management)
S.I.: Editora Atheneu

Includes chapters on the main metals: 1. Aluminum, 2. Chrome, 3. Manganese, 4. Iron, 5. Nickel, 6. Copper, 7. Zinc, 8. Arsenic, 9. Selenium, 10. Cadmium, 11. Mercury, 12. Lead, 13. Metal Immunotoxicology, 14. Diagnosis and Treatment of Intoxications, 15. Risks to the Environment and Reported Accidents, 16. Management of Residues, 17. Analytical Aspects.

Azevedo FA, Chasin AAM (2004)
As Bases Toxicológicas da Ecotoxicologia (Toxicological Basis of Ecotoxicology)
S.I.: Rima Editora.

By discussing the basis of toxicology that sustains ecotoxicology, the topics presented in this work reflect, didactically and objectively, the support of toxicological knowledge, not only for the specific field of ecotoxicology, but also for environmental toxicology. The text focuses on the relationship between ecology and toxicology. In order to do so, a classical focus, attained through the presentation of fundamental topics of toxicology, enables the establishment of standard terminology and concepts in toxicology, and at the same time covers the rationale for its inclusion in ecological sciences. In this way, it encompasses the scope of ecotoxicology, the knowledge of which has become indispensable for the good practice of environment management.

Carlini EA, Mansur J (2004)
Drogas e Subsídios para uma Discussão (Drugs and Data for Discussion)
São Paulo: Brasiliense

This work opens a discussion on the issue of drugs of abuse, covering areas such as legalization, discriminalization, and consumption prohibition. Initially a series of arguments are listed with current pros and cons on liberation, but without discussing the merit of each statement. Having presented such arguments, the authors go on to discuss the possible effect of the main illicit drugs (cocaine, hemp, heroin, etc.) and compare them to the licit ones (alcohol, tobacco, etc.), suggesting the relative nature of legalization and prohibition in terms of the 'noxiousness' of the substances.

Graff S, Lopes AC (2006)
Fundamentos de Toxicologia Clínica (Principles of Clinical Toxicology)
São Paulo: Editora Atheneu

Principles of Clinical Toxicology, within the scope of the series 'Clínica Médica Ciência e Arte' (Internal Medicine Science and Art), presents the basic principles of toxicology, in a clear and simple form, focusing on important concepts whose knowledge will allow the treatment of a patient who is accidentally or otherwise poisoned.

Guimaraes MA, Mazaro R. (col.) (2004)
Princípios éticos e práticos do uso de animais de experimentação (Ethical and practical principles for the use of experimentation animals)
São Paulo: UNIFESP – Universidade Federal de São Paulo

This work presents information, in summarized and objective form, regarding the appropriate use of experimental animals in research. The principles discussed in this book provide those working with laboratory animals, a knowledge of the techniques used in their management by considering the well-being of the animals and the ethics involved in their care. The work also aims at strengthening the consciousness of the importance of the animal as a study subject, as well as offering guidance and assistance in the conduct of research, teaching or laboratory assays.

Larini L (1993)
Toxicologia, 2nd Edition (Toxicology)
São Paulo: Manole

The work offers an introduction to toxicology that allows the student or the professional to comprehend basic aspects of this science and, at the same time, presents guidance for solving problems that might appear during the activities involving human intoxications.

Larini L (1999)
Toxicologia dos Praguicidas (Toxicology of Pesticides)
São Paulo: Manole Ltda.

The work covers toxicological aspects involving the use of pesticides. It was written for students of pharmacy and biochemistry, medicine, veterinary medicine, and other related professionals.

Mendes R (Org.) (2003)
Patologia do Trabalho (Occupational Pathology)
Atualizada e Ampliada. São Paulo: Editora Atheneu

In its 2nd updated and extended edition, the treatise on occupational pathology consolidates its position achieved in the last decade as the most complete encyclopedia on occupational health produced in Brazil. The virtue and strength of this work lie in the consolidation of the thought and expertise of the most prominent Brazilian academic leaders in occupational health, along with the experience acquired by the professional work of occupational physicians, general physicians, epidemiologists, engineers, toxicologists, hygienists, ergonomists, and many others, who are renowned and respected throughout Brazil and abroad.

Michel OD (2000)
Toxicologia Ocupacional (Occupational Toxicology)
Rio de Janeiro: Revinter.

Concerns to avoid the development of diseases due to exposure of individuals to chemical agents in the workplace lead to the undertaking of preventive measures. The latter are the basis of biological monitoring which consists in determining if the concentration of these agents or their metabolites in workers is within levels established by governmental agencies or the scientific community.

Midio AF (1992)
Glossário de Toxicologia: com versão em Inglês e Espanhol (Glossary of Toxicology)
São Paulo: Roca

Aiming at facilitating dynamic, more comprehensible, homogeneous, and credible communication, terms and concepts that are used in toxicology were compiled and adapted from dozens of foreign publications to compose this Glossary. Nevertheless, this should be considered a core rather than a comprehensive compilation of terms in toxicology.

Midio FA, Martins DI (2000)
Toxicologia de Alimentos (Food Toxicology)
São Paulo: Livraria Varela

This book has the objective of introducing basic concepts associated with food toxicology and safety conditions for food ingestion, expecting that other sources of information will extend knowledge in this area.

Midio AF, Silva ES (1995)
Inseticidas-Acaricidas: Organofosforados e Carbamatos (Insecticides-Acaricides: Organophophate and Carbamate)
São Paulo: Roca

This publication aims at presenting in a comprehensible manner, options of analytical methodology that are applicable to the control of occupational exposure to insecticides–acaricides of the organophosphate and carbamate groups.

Moreira AHP, Caldas LQA (2001)
Intoxicações Agudas: Bases do Diagnóstico Clínico-Laboratorial de Urgência (Acute Intoxication)
Rio de Janeiro:Editora Revinter Ltda.

This work presents the most important aspects of diagnosis and the main steps of toxicological therapy. Moreover, there is an extensive description of toxicological analysis methods, many of which can be considered classical. The methods are rapid and simple. Most of them can be carried out in the emergency room without the need of expensive equipment or extensive academic knowledge.

Mezadri TJ, Tomaz VA, Amaral VLL (2004)
Animais de Laboratório: Cuidados na iniciação experimental (Laboratory Animals: Concerns in Experimental Initiation)
Florianópolis: Editora UFSC

This manual was written for professors, researchers, students, and laboratory technicians who work in the Biological and Health Sciences area regarding the basis of fundamental procedures in the management, biosafety, clarification of legal rules, and ethical guidance, aiming at the well-being of the animal and protection of laboratory personnel.

Oga S (2008)
Fundamentos de Toxicologia, 3rd Edition (Principles of Toxicology)
São Paulo: Atheneu

The present book was realized by a group of professors of Faculdade de Ciências Farmacêuticas (College of Pharmaceutical Sciences) of the University of São Paulo and has as its basic objective to contribute to the

teaching of toxicology. Thus, pertinent and state-of-the-art themes are approached in a succinct fashion, and presented in the same sequence as is taught in most of the pharmacy colleges in Brazil.

Pires RC (2005)
Toxicologia Veterinária: Guia Prático para Clínico de pequenos animais (Veterinary Toxicology: Practical Guide for Small Animal Veterinarians)
S.I.: Editora Paidéia

This work is a practical guide for veterinarians specializing in small animals. It presents general treatment for intoxications, toxic plants, poisonous animals, pesticides, metals, food, and drugs. It further discusses mechanisms of action, signs, diagnosis, and treatment with dose prescriptions.

Ribeiro LR, Salvadori DMF, Marques EK (2003)
Mutagênese Ambiental (Environmental Mutagenesis)
Canoas: ULBRA

This book focuses on the importance of mutagenesis in the carcinogenesis process. The criteria used to select the tests described in the book were: mutagenicity tests that can be used as indicators of potential carcinogenicity to mammals, assays that are part of the minimum required battery of tests suggested for the registration of chemical products and, finally, some tests, that in spite of not fulfilling the aforementioned criteria, can be easily performed in Brazilian laboratories.

Schvartsman S (1991)
Intoxicações agudas, 4th Edition (Acute Intoxications)
São Paulo: Sarvie

Despite the title – Acute Intoxications – this book also presents several aspects concerning chronic exposure, due to the frequency and importance of this type of exposure. For the same reason, although the book focuses basically on childhood intoxication, there are also some commentaries about adult problems. There are references to some medications and processes that are rarely available in our area. Considering that this is not a pharmacology or clinical therapy publication, discussions about side effects were avoided.

Schvartsman S, Almeida WF (1989)
Tratamento das Intoxicações Agudas, 4th Edition (Treatment of Acute Intoxications)
São Paulo: Associação Nacional de Defensivos Agrícolas

This book aims at attaining the objective of giving simple and quick information on the handling of toxic accidents. The potentially toxic agents are listed in alphabetical order to facilitate navigation through the text. It often refers the reader to another intoxication type for which the treatment is similar, but not necessarily identical. The objective is to stabilize the patient while detailed information is sought elsewhere.

Seibel SD, Toscano Junior A (2001)
Dependência de Drogas (Drug Addiction)
São Paulo: Editora Atheneu

This work presents a broad overview of the drug addiction problem. It discusses the most recent information on the subject and demonstrates that Brazil has an expert body of researchers/scholars in this subject. Two editors have compiled the work of 56 authors.

Spinosa HS, Gorniak SL, Palermo Neto J (2008)
Toxicologia aplicada à Medicina Veterinária (Applied Toxicology to Veterinary Toxicology)
São Paulo: Editora Manole

This book focuses on the importance of toxicology applied to veterinary medicine, since it offers essential information about relevant toxic agents that can affect animals in general. It was made for students and professionals of the veterinary area, helping them to be updated and well prepared for their daily work.

Journals

Brazilian Journal of Pharmaceutical Science
English: http://www.bcq.usp.br/revista_brasileira_de_ciencias.htm
Portuguese: http://www.bcq.usp.br/revista_brasileira_de_ciencias.htm

Brazilian Journal of Psychiatry
English: http://www.scielo.br/scielo.php?pid=1516-4446&script=sci_serial
Portuguese: http://www.scielo.br/scielo.php/script_sci_serial/lng_pt/pid_1516-4446/nrm_iso

Brazilian Journal of Toxicology
Portuguese only: http://www.sbtox.org.br/

Journal of Public Health
English: http://www.fsp.usp.br/rsp/index_i.html
Portuguese: http://www.fsp.usp.br/rsp/

Reports in Public Health
English: http://www.ensp.fiocruz.br/csp/indexi.html
Portuguese: http://www.ensp.fiocruz.br/csp/

Technical Reports and Other Documents

Kotaka ET, Zambrone FAD (2001)
Contribuição para a Construção de Diretrizes para Avaliação de Risco Toxicológico de Produtos Agrotóxicos

S.I.: ILSI
Portuguese only: http://brasil.ilsi.org/publications/gp/Risco_Toxicológico_de_Produtos_Agrotóxicos.htm

Trevisan RMS, Zambrone FAD (2002)
Regulamentação do Registro de Agrotóxicos – Abordagem da Avaliação da Exposição e do Risco Toxicológico Ocupacional
S.I.: ILSI
Portuguese only: http://brasil.ilsi.org/publications/gp/Regulamentação_do_Registro_de_Agrotóxico.htm

Lajolo F, Nutti M (2003)
Transgênicos: Bases Científicas para sua Segurança
S.I.: ILSI
Portuguese only: http://brasil.ilsi.org/publications/gp/Bases_Científicas_para_sua_Segurança.htm

Databases

National System of Toxic-Pharmacological Information – SINITOX
English: http://www.fiocruz.br/sinitox/english/intoxicacoeshumanas/index.htm
Portuguese: http://www.fiocruz.br/sinitox/

Pesticide Information System – SIA
Portuguese only: http://www4.anvisa.gov.br/agrosia/asp/default.asp

Government Agencies

Ministry of Agriculture, Livestock and Supply – MAPA
Portuguese only: http://www.agricultura.gov.br/
Address: Ministério da Agricultura, Pecuária e Abastecimento
Esplanada dos Ministérios, Bloco D
CEP: 70043-900 – Brasília/DF – Brazil
Phone: +55 61 3218-2828

Public Companies

Brazilian Agricultural Research Corporation – EMBRAPA
English: http://www.embrapa.br/english
Portuguese: http://www.embrapa.br/
Address: Empresa Brasileira de Pesquisa Agropecuária
Parque Estação Biológica – PqEB s/n°
CEP: 70770-901 – Brasília/DF – Brazil
Phone: +55 61 3448 4433
Fax: +55 61 3347 1041

Agrochemicals System – AGROFIT
Portuguese only: http://extranet.agricultura.gov.br/agrofit_cons/principal_agrofit_cons

Ministry of Environmental – MMA
Portuguese only: http://www.mma.gov.br/
Address: Ministério do Meio Ambiente
Av. Esplanada dos Ministérios, Bloco B, 5° ao 9° andar
CEP: 70068-900 – Brasília/DF – Brazil
Email: webmaster@mma.gov.br

Commission of Safety Chemistry Action Plan – COPASQ
Portuguese only: http://www.mma.gov.br/port/sqa/copasq/doc/reg_aprov.pdf

Brazilian Institute for the Environmental and Renewable Natural Resources – IBAMA
Portuguese only: http://www.ibama.gov.br/
Address: Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis
Setor de Clubes Esportivo Norte – SCEN, Trecho 2, Ed. Sede do IBAMA, Bloco A
CEP 70818-900 – Brasília/DF– Brazil

Ministry of Health – MS
Portuguese only: http://portal.saude.gov.br/saude/
Address: Ministério da Saúde
Av. Esplanada dos Ministérios – Bloco G
CEP: 70058-900 – Brasília/DF – Brazil
Phone: +55 61 3315 2425

National Council of Health
Portuguese only: http://conselho.saude.gov.br/
Address: Conselhos de Saúde
Av. Esplanada dos Ministérios, Bloco B, Anexo B, Sala 104B
CEP: 70058-900 – Brasília/ DF – Brazil

National Foundation of Health – FUNASA
Portuguese only: http://www.funasa.gov.br/

Oswaldo Cruz Foundation – FIOCRUZ
English: http://www.fiocruz.br/cgi/cgilua.exe/sys/start.htm?UserActiveTemplate=template_ingles&tpl=home
Portuguese: http://www.fiocruz.br/cgi/cgilua.exe/sys/start.htm?tpl=home
Address: Fundação Oswaldo Cruz
Av. Brasil, 4365 – Manguinhos
CEP: 21040-360 – Rio de Janeiro/RJ – Brazil
Phone: +55 21 2598 4242

Center of Scientific and Technological Information – CICT
Portuguese only: http://www.cict.fiocruz.br/cgi/cgilua.exe/sys/start.htm
Address: Centro de Informação Científica e Tecnológica

Av. Brasil, 4.365 – Pavilhão Haity Moussatché – Manguinhos CEP: 21040-900 – Rio de Janeiro/RJ – Brazil

National System of Toxic-Pharmacological Information – SINITOX
English: http://www.fiocruz.br/sinitox/english/intoxicacoeshumanas/index.htm
Portuguese: http://www.fiocruz.br/sinitox/
Address: Sistema Nacional de Informações Tóxico-Farmacológicas – SINITOX
Av. Brasil, 4365 – Prédio Biblioteca de Manguinhos, 2° andar
CEP 21045-900 – Rio de Janeiro/RJ – Brazil
Phone: +55 21 3865 3247 / 3865 3246
Fax: +55 21 2290 1696 / 2260 9944

National Health Surveillance Agency – ANVISA
English: http://www.anvisa.gov.br/eng/index.htm
Portuguese: http://www.anvisa.gov.br/anvisa.htm
Address: Agência Nacional de Vigilância Sanitária
SEPN 515, Bl.B - Edifício Ômega
CEP: 70770-502 – Brasília/DF – Brazil
Phone: +55 61 3448-1000

Toxicology
English: http://www.anvisa.gov.br/eng/toxicology/index.htm
Portuguese: http://www.anvisa.gov.br/toxicologia/index.htm

Ministry for Labour – MTE
Portuguese only: http://www.mte.gov.br/
Address: Ministério do Trabalho e Emprego
Av. Esplanada dos Ministérios, Bloco F
CEP: 70059-900 – Brasília/DF – Brazil
Phone: +55 61 3317 6000

Workplace Safety and Health
Portuguese only: http://www.mte.gov.br/seg_sau/default.asp

Safety and Occupational Medicine Foundation "Jorge Duprat Figueiredo" – FUNDACENTRO
Portuguese only: http://www.fundacentro.gov.br/

Non-Government Organizations

International Life Science Institute Brazil – ILSI
Portuguese only: http://brasil.ilsi.org/
Address: International Life Sciences Institute
Rua Hungria, 664, 11°andar , cj.113
CEP: 01455-904 – São Paulo/SP – Brazil
Phone/Fax: +55 11 3035 5585

Pan-American Health Organization – Brazil – OPAS
Portuguese only: http://www.opas.org.br/
Address: Organização Pan-Americana da Saúde
Setor de Embaixadas Norte, Lote 19
CEP: 70800-400 – Brasília/DF – Brazil
Phone: +55 61 3426 9595
Fax: +55 61 3426 9591

Laboratories and Consulting Services

CSD GEOKLOCK – Geology and Ambient Engineering
English: http://www.geoklock.com.br/default.asp?idiomaId=2
Portuguese: http://www.geoklock.com.br/default.asp?idiomaId=1
Address: Geoklock
Av. Nações Unidas, 13797 - Bloco II 14° andar
Cep: 04794-000 – São Paulo/SP – Brazil
Tel: 55 11 5501 3777
Fax: +55 11 5506 4492

GEOKLOCK has been performing geological and engineering environmental services and providing a complete range of specialized services in the environmental science area for more than 25 years for the main national and multinational companies throughout Brazil and Latin America.

Fleury Institute
English: http://www.fleury.com.br/English/Pages/About.aspx
Portuguese: http://www.fleury.com.br/
Address: Av. General Valdomiro de Lima, 508
Jabaquara - São Paulo – CEP: 04344-903
Phone: +55 11 3179-0822

Fleury is the most complete center for medical diagnosis of the country. It performs more than 2000 types of exams in 37 medical areas, including several toxicological exams.

InterTox – Intelligent Solutions in Environmental Health
Portuguese only: http://www.intertox.com.br
Address: Intertox – Soluções inteligentes em saúde ambiental
Rua Monte Alegre, 428, cj 73
CEP: 05014-000 – São Paulo/SP – Brazil
Phone/Fax: +55 11 3872 8970

InterTox renders services to individuals, companies, public and private entities, and labor union representatives offering consulting services in the health and environmental area, with the aid of Clinical and Toxicological Analysis Laboratories, both in the analytical and business administration areas.

PLANITOX – Science-based Toxicology Company
English/Portuguese: http://www.planitox.com.br/
Address: Planitox – Science-based Toxicology Company
Rua Dr. José Inocêncio de Campos, 153, 3° andar, Ed. Metropolitan Plaza
CEP: 13024-230 – Campinas/SP – Brazil
Phone: +55 19 2103 6900
Fax: +55 19 2103 6906
Email: planitox@planitox.com.br

Planitox is a planning, consulting and information in toxicology company founded in 1994, whose purpose is to render services within the different toxicological areas, with technical-scientific rigor, quality and ethics, aimed at the protection of human health and the environment, as well as the assurance of economical sustainability.

TOXICLIN Medical Services – Toxicology solutions
Portuguese only: http://www.toxiclin.com.br/
Phone: +55 11 5054 5511
Email: toxiclin@toxiclin.com.br

The company was founded in 1990, and renders consulting services with the main objective of constantly searching for toxicological knowledge aiming at a better quality of life of the population.

TOXIKON – Occupational Toxicology and Industrial Hygiene Laboratory
English: http://www.toxikon.com.br/ENGLISH/TOXIKON.HTML
Portuguese: http://www.toxikon.com.br/
Address: Toxikon
Rua Salvador Correa, 38 e 346, Aclimação
CEP: 04109-070 – São Paulo/SP – Brazil
Email: toxikon@toxikon.com.br

Established in 1979, TOXIKÓN is a private company specialized in occupational health. Acting in an integrated form to render services of biological and environmental monitoring of occupational exposure to chemicals, the company has two divisions: Toxicological consulting services and Industrial hygiene.

Universities

University of São Paulo – USP

Portuguese only: http://www2.usp.br/portugues/index.usp
Address: Reitoria da Universidade de São Paulo
Rua da Reitoria, 109 – Butantã
CEP: 05508-900 – São Paulo/SP – Brazil
Phone: +55 11 3091 3500

Faculty of Pharmaceutical Sciences – Biochemistry and Toxicological Department
Portuguese only: http://www.fcf.usp.br/Departamentos/FBC/
Address: Faculdade de Ciências Farmacêuticas
Av. Professor Lineu Prestes, 580, Blocos 13 a 17
CEP: 05508-900 – São Paulo/SP – Brazil
Phone: +55 11 3091 3661
Email: anadanta@usp.br; doralima@usp.br; ednabatista@usp.br; sprovi@usp.br

Post-graduation Course in Toxicology and Toxicological Analysis
Portuguese only: http://www.fcf.usp.br/Departamentos/FBC/br/toxico.asp

Laboratory of Toxicological Analysis
Portuguese only: http://www.fcf.usp.br/LAT/
Phone: +55 11 3091 2194
Fax: +55 11 3031 9055

Faculty of Public Health
Portuguese only: http://www.fsp.usp.br/boletim.php?lang=pt&homepage=true&style=homepage
Address: Faculdade de Saúde Pública
Av. Dr. Arnaldo, 715 – Cerqueira Cesar
CEP: 01246-904 – São Paulo/SP – Brazil
Phone: +55 11 3061 7000/ 3061 7717
Fax: +55 11 3088-3756
Email: fsp@edu.usp.br

Department of Environmental Health – Post-graduation Course in Environmental Health
Portuguese only: http://www.fsp.usp.br/boletim.php?lang=pt&homepage=true&style=homepage

Faculty of Medicine
Portuguese only: http://www.fm.usp.br/
Address: Faculdade de Medicina
Av. Dr. Arnaldo, 455 – Cerqueira César
CEP: 01246903 – São Paulo/SP – Brazil
Phone: +55 11 3061 7000

Institute and Department of Psychiatry
Portuguese only: http://urutu.hcnet.usp.br/ipq/

Multi Subject Group of Studies on Alcohol and Drugs – GREA
Portuguese only: http://www.grea.org.br/
Address: Instituto e Departamento de Psiquiatria
Rua Ovídio Pires de Campos, 785
Caixa Postal 3671
CEP 01060-970 – São Paulo/SP – Brazil

University of Campinas

Portuguese only: http://www.unicamp.br/
Address: Universidade de Campinas

Cidade Universitária "Zeferino Vaz", s/n – Barão Geraldo
Cep 13083-970 – Campinas/SP – Brazil
Phone: +55 19 3788 2121

Faculty of Food Engineering
Portuguese only: http://www.fea.unicamp.br/
Address: Faculdade de Engenharia de Alimentos da Unicamp
Rua Monteiro Lobato, 80
Caixa Postal 6121
CEP: 13083-862 – Campinas/SP – Brazil
Phone: +55 19 3521 4097
Fax: +55 19 3289 1513

Department of Food Science
Portuguese only: http://www.fea.unicamp.br/
Phone: +55 19 3521 2154/3521 2155
Fax: +55 19 3521 2153

Faculty of Medical Science
Portuguese only: http://www.fcm.unicamp.br/index.html
Address: Hospital das Clínicas
Av. Vital Brasil, 251, Cidade Universitária "Zeferino Vaz" – Barão Geraldo
Caixa Postal 6142
CEP 13083-970 – Campinas/SP – Brazil
Phone: +55 19 3788 2121

Department of Pharmacology
Portuguese only: http://www.fcm.unicamp.br/index.html
Address: Departamento de Farmacologia
Caixa Postal 6111
CEP: 13081-970 – Campinas/SP – Brazil
Phone: +55 19 3521 9531/ 3521 9532

Department of Social and Preventive Medicine – Post-graduation program in Collective Health
Portuguese only: http://www.fcm.unicamp.br/index.html
Address: Departamento de Medicina Preventiva e Social
Rua Tessália Vieira de Camargo, 126 – Barão Geraldo
Caixa postal 6111
CEP: 13083-970 – Campinas/SP – Brazil
Phone: +55 19 3521 8036

Multi Subject Center of Research in Chemistry, Biology and Agricultural of University of Campinas – CPQBA
Portuguese only: http://www.cpqba.unicamp.br/
Address: Centro Pluridisciplinar de Pesquisas Químicas, Biológicas e Agrícolas
Caixa Postal 6171
CEP: 13081-970 – Campinas/SP – Brazil
Phone: +55 19 3884 7500
Fax: +55 19 3884 7811
Email: cenpesq@cpqba.unicamp.br

Division: Pharmacology and Toxicology
Portuguese only: http://www.cpqba.unicamp.br/divisoes/farmacologia.htm

São Paulo State University 'Júlio de Mesquita Filho' – Campus of Botucatu City

Portuguese only: http://www.unesp.br/index_portal.php
Address: Universidade Estadual Paulista "Júlio de Mesquita Filho"
Rua Quirino de Andrade, 215
CEP: 01049-010 – São Paulo/SP – Brazil
Phone: +55 11 5627 0233

Institute of Biosciences – Botucatu
Portuguese only: http://www.ibb.unesp.br/index.php
Address: Instituto de Biociências
Distrito de Rubião Jr., s/n
CEP: 18618-000 – Botucatu/SP – Brazil
Phone: +55 14 3811 6000

Specialization Course in Toxicology – Center of Toxicological Assistance
Portuguese only: http://www.ibb.unesp.br/unidades%20auxiliares/CEATOX/ceatox.php
Address: Centro de Assistência Toxicológica – CEATOX
Distrito de Rubião Jr, s/n
Caixa Postal 510
CEP: 18618-000 – Botucatu/SP - Brazil
Phone/Fax: +55 14 3815 3048/ 3811 6017/ 3811 6034
Email: ceatox@ibb.unesp.br

Federal University of São Paulo

Portuguese only: http://www.unifesp.br/
Address: Universidade Federal de São Paulo
Rua Botucatu, 740
CEP 04023-900 – São Paulo/SP – Brazil
Phone: +55 11 5576 4000/ 5576-4522

Department of Informatics in Health
Portuguese only: http://www.unifesp.br/dacad.htm
Address: Departamento de Informação em Saúde
Rua Botucatu, 862 térreo – Ed. José Leal Prado
CEP: 04023-062 – São Paulo/SP – Brazil
Phone: +55 11 5574 5234/5576 4521
Fax: +55 11 5572 6601

Specialization Course in Drug Addiction
Portuguese only: http://procdados.epm.br/dpd/proex/index.htm

Department of Psychobiology
Portuguese only: http://www.unifesp.br/dacad.htm
Address: Departamento de Psicobiologia
Rua Napoleão de Barros, 925
CEP: 04024-002 – São Paulo/SP – Brazil
Phone: +55 11 5539 0155

Specialization Course in Cognitive therapies in the treatment of alcohol and drugs addiction
Portuguese only: http://procdados.epm.br/dpd/proex/index.htm

Department of Psychiatry
Portuguese only: http://www.unifesp.br/dacad.htm
Address: Departamento de Psiquiatria
Rua Pedro de Toledo, 650 – 3° andar
CEP: 04039-032 – São Paulo/SP – Brazil
Phone: +55 11 5570 2828

Specialization Course in Drug Addiction
Portuguese only: http://procdados.epm.br/dpd/proex/index.htm

Specialization Course in Prevention in consumption of psychoactive substances
Portuguese only: http://procdados.epm.br/dpd/proex/index.htm

Federal University of Minas Gerais
Portuguese only: http://www.ufmg.br/
Address: Universidade Federal de Minas Gerais
Av. Antônio Carlos, 6627 – Pampulha
CEP 31270-901 – Belo Horizonte/MG – Brazil
Phone: +55 31 3499 5000
Fax: +55 31 3499 4188

Faculty of Pharmacy
Portuguese only: http://www.farmacia.ufmg.br/
Address: Faculdade de Farmácia
Av. Presidente Antônio Carlos, 6627 – Pampulha
CEP: 31270-901 – Belo Horizonte/MG – Brazil
Phone: +55 31 3499 6830

Department of Clinical and Toxicological Analysis
Portuguese only: http://www.farmacia.ufmg.br/ACT/index.htm

Laboratory of Clinical and Toxicological Analysis
Portuguese only: http://www.farmacia.ufmg.br/ACT/index.htm

Laboratory of Occupational Toxicology
Portuguese only: http://www.farmacia.ufmg.br/lato/index.htm
Address: Laboratório de Toxicologia Ocupacional
Av. Presidente Antônio Carlos, 6627 – Pampulha
CEP: 31270-901 – Belo Horizonte/MG – Brazil
Phone: +55 31 3499 6905
Fax: +55 31 3499 6906

Federal University of Paraná

Portuguese only: http://www.ufpr.br/portal/
Address: Universidade Federal do Paraná
Rua XV de Novembro, 1299 – Centro
CEP: 80060-000 – Curitiba/PR – Brazil
Phone: +55 41 3360 5000

Post-graduation in Pharmacology
Portuguese only: http://farmacologia.bio.ufpr.br/posgraduacao/
Address: Pós-Graduação em Farmacologia
Caixa Postal 19031
CEP: 81531-980 – Curitiba/PR – Brazil
Phone: +55 41 3361 1693
Fax: +55 41 3266 2042
Email: pgfarmacologia@ufpr.br

Specialization Course in Pharmacology
Portuguese only: http://farmacologia.bio.ufpr.br/posgraduacao/

Federal University of Santa Maria

Portuguese only: http://www.ufsm.br/
Address: Avenida Roraima, n° 1000, Cidade Universitária
Bairro Camobi, Santa Maria – RS
CEP 97105-900

Post-graduation in Toxicological Biochemistry
Portuguese only: http://www.ufsm.br/ppgbtox/
Address: Pós-Graduação em Bioquímica e Toxicológica
Prédio 18, Sala 2128
CEP: 97105-900 – Santa Maria/RS – Brazil
Phone: +55 55 2155 3220/ 2155 8978/ 2155 8665/ 2155 9462
Fax: +55 55 2155 3220
Email: ppgbtox@mail.ufsm.br

Oswaldo Cruz Faculties

Portuguese only: http://www.oswaldocruz.br/
Address: Faculdade Oswaldo Cruz
Rua Brigadeiro Galvão, 540 – Barra Funda
CEP 01151-000 – São Paulo/SP – Brazil
Phone: +55 11 3824 3660
Fax: +55 11 3824 3660 ramal 102

Faculty of Pharmaceutical and Biochemistry Sciences
Portuguese only: http://www.oswaldocruz.br/escolas.asp?id_escola=8&id_unidade=4

Post-graduation Course in Biochemistry and Toxicological Analysis
Portuguese only: http://www.oswaldocruz.br/cursos/curso.asp?id_curso=86&id_escola=12&id_unidade=

Pontific Catholic University of Rio Grande do Sul

Portuguese only: http://www.pucrs.br/
Address: Pontifícia Universidade Católica do Rio Grande do Sul
Av. Ipiranga, 6681 – Partenon
CEP: 90619-900 – Porto Alegre/RS – Brazil
Phone: +55 51 3320 3500

Institute of Toxicology

Portuguese only: http://www.pucrs.br/toxico/
Address: Instituto de Toxicologia
Av. Ipiranga, 6681 – Prédio 12 D – Sala 140
CEP: 90619-900 – Porto Alegre/RS – Brazil
Phone: +55 51 3320 3677
Fax: +55 51 3320 3868
Email: toxicologia-pg@pucrs.br

Specialization Course in Applied Toxicology
Portuguese only: http://www.pucrs.br/toxico/

Advanced Course in Systematic Toxicological Analysis
Portuguese only: http://www.pucrs.br/toxico/

Course in Forensic Toxicology
Portuguese only: http://www.pucrs.br/toxico/

University of Brasília

English: http://www.unb.br/linguas/english/index.php
Portuguese: http://www.unb.br/
Address: Campus Universitário Darcy Ribeiro
Brasília – DF
CEP 70910-900
Phone: +55 61 3307 2022

Faculty of Health Sciences
Portuguese only: http://www.unb.br/fs/

Post-graduation in Health Sciences
Portuguese only: http://www.unb.br/fs/pgcs/

Professional Societies

Brazilian Society of Toxicology
Portuguese only: http://www.sbtox.org.br/

Brazilian Society of Mutagenesis, Carcinogenesis and Teratogenesis
Portuguese only: http://www.sbmcta.org.br/

Brazilian Society of Chemistry
Portuguese only: http://www.sbq.org.br/

Latin American Association of Toxicologic Pathology
English/Portuguese/Spanish: http://alaptox.org/index.php?option=com_frontpage&Itemid=1

Poison Information/Control Centers

Bahia Center of Anti-Poison Information
Address: Hospital Central Roberto Santos
Estrada Velha do Saboeiro, s/n° – Cabula
CEP: 41150-000 – Salvador/ BA – Brazil
Phone: +55 71 3387 4343
Fax: +55 71 3387 3414
Email: ciave.diret@saude.ba.gov.br

Campinas Poison Control Center
Address: Faculdade de Ciências Médicas Hospital das Clínicas/ UNICAMP
Cidade Universitária Zeferino Vaz s/n° – Barão Geraldo
CEP: 13083-970 – Campinas/ SP – Brazil
Phone: +55 19 3788 7555
Fax: +55 19 3788 7573
Email: cci@fcm.unicamp.br

Campo Grande Poison Control Center
Address: Rua Engenheiro Luthero Lopes, 36 – Bairro Aero Rancho
CEP: 79084-180 – Campo Grande/ MS – Brazil
Phone: +55 67 3386 8655/ 3381 2996
Email: civitoxms@bol.com.br

Center of Assistance and Toxicological Information
Address: SGAN Quadra601 Lotes "O e P"
CEP: 70.830-010 – Brasília/DF
Phone: +55 61 3225-6512
Email: ciatdf@saude.df.gov.br

Center of Toxicological Information of Belém
Address: Hospital Universitário João de Barros Barreto
Rua dos Mundurucus, 448 – Bairro Guamá
CEP: 66073-000 – Belém/ PA – Brazil
Phone: +55 91 3249 6370
Email: cithujbb@ufpa.br

Curitiba Poison Control Center
Address: Hospital de Clínicas
Rua General Carneiro, 181 – Centro
CEP: 80060-900 – Curitiba/ PR – Brazil
Phone: + 55 41 3264 8290/ 3363 7820
Email: cce@sesa.pr.gov.br

Londrina Poison Control Center
Adress: Avenida Robert Koch, 60
Londrina/ PR – Brazil
Phone: +55 43 3371 2244/3371 2669
Fax: +55 43 3371 2422
Email: cci@uel.br

National Reference Center
National Health Surveillance Agency
English: http://www.anvisa.gov.br/eng/index.htm

Portuguese: http://www.anvisa.gov.br/anvisa.htm
Address: SEPN 515 Edifício Omega – bl B – 3° Andar
Brasília/ DF – Brazil
Phone: +55 61 3448-1082/ 3448-1099/ 3448-1451
Fax: +55 61 3448-1076

National System of Toxic-Pharmacological Information
English:http://www.fiocruz.br/sinitox/english/intoxicacoeshumanas/index.htm
Portuguese: http://www.fiocruz.br/sinitox/
Address: Av. Brazil, 4365 – Prédio Haity Moussatché 2° andar – sala 218
CEP: 21040-900 – Rio de Janeiro/RJ – Brazil
Phone: +55 21 3865 3246/ 3865 3247

Niterói Poison Control Center
Address: Hospital Universitário Antônio Pedro – Universidade Federal Fluminense
Av. Marquês do Paraná, 303 – Prédio Anexo do HUAP – 3° Andar - Centro
CEP: 24030-900 – Niterói/ RJ – Brazil
Phone: +55 21 2717 0148/ 2629 9253
Email: analopes@hospital.huap.uff.br or ccin@hospital.huap.uff.br

Ribeirão Preto Poison Control Center
Address: Hospital das Clínicas da Faculdade de Medicina de Ribeirão Preto da USP
Rua Bernardino de Campos, 1000 – Bairro Higienópolis
CEP: 14015-130 – Ribeirão Preto/ SP – Brazil
Phone: +55 16 3602 1290/ +55 16 3602 1000 (Hospital)

Rio de Janeiro Poison Control Center
Address: Hospital Universitário Clementino Fraga Filho
Avenida Brigadeiro Trompvski, s/n° – 8° andar – Sala E-01 – Ilha do Fundão - Cidade Universitária
CEP: 21941-590 – Rio de Janeiro/ RJ – Brazil
Phone: +55 21 2573 3244
Fax: +55 21 2573 7079
Email: robertohbelo@yahoo.com.br

Santa Catarina Poison Control Center
Address: Hospital Universitário – Universidade Federal de Santa Catarina – Bairro Trindade
CEP: 88040-970 – Florinópolis/SC – Brazil
Phone: +55 48 3331 9535/3331 9173
Fax: +55 48 3331 9083
Email: cit@reitoria.ufsc.br

Santos Poison Control Center
Address: Hospital Guilherme Álvaro
Rua Oswaldo Cruz, 197 – sala 134
CEP: 11045-904 – Santos/SP – Brazil
Phone: +55 13 3222 2878
Fax: +55 13 3222 2654
Email: cci.santos@gmail.com

São Jose dos Campos Poison Control Center
Address: Hospital Municipal "Dr. José de Carvalho Florence"
Rua Saigiro Nakamura, 800 – Vila Industrial
CEP: 12220-280 – São José dos Campos/ SP – Brazil
Phone: +55 12 3901 3400 R. 3449

São Paulo Poison Control Center
Address: Hospital Municipal Dr. Artur Ribeiro de Saboya
Av. Francisco de Paula Quintanilha Ribeiro, 860 – 4° Andar – Jabaquara
CEP: 04330-020 – São Paulo/ SP – Brazil
Phone: +55 11 5012 5311 (CIT)
Fax: +55 11 5012 2399
Email: smscci@prefeitura.sp.gov.br

Taubaté Poison Control Center
Address: Fundação Universitária de Saúde de Taubaté – Universidade de Taubaté – Hospital Escola
Av. Granadeiro Guimarães, 270 – Centro
CEP: 12020-130 – Taubaté/SP – Brazil
Phone/fax: +55 12 3632 6565

Toxicological Assistance Center of Botucatu
Portuguese only: http://www.ibb.unesp.br/unidades%20auxiliares/CEATOX/ceatox.php
Address: Instituto de Biociência, UNESP
Distrito Rubião Junior, s/n°
CEP: 18618-000 - Botucatu/ SP – Brazil
Phone: +55 14 3815 3048/ 3811 6017/ 3811 6034

Toxicological Assistance Center of Campina Grande
Address: Hospital Regional de Urgência e Emergência
Avenida Floriano Peixoto, 1045 – São José
CEP: 58110-001 Campina Grande/ PB – Brazil
Phone: +55 83 3310 9238

Toxicological Assistance Center of Clinical Hospital of Medical Faculty – University of São Paulo
Address: Faculdade de Ciências Médicas da Universidade de São Paulo
Avenida Dr. Enéas Carvalho de Aguiar, 647
CEP: 05403-900 – São Paulo/ SP – Brazil
Phone: +55 11 3069 8571
Fax: +55 11 3069 8800
Email: ceatox@icr.hcnet.usp.br

Toxicological Assistance Center of Fortaleza
Address: Instituto Dr. José Frota
Rua Barão do Rio Branco, 1816 – Centro
CEP: 60025-061 – Fortaleza/CE – Brazil
Phone: +55 85 3255 5050/ 3255 5012

Toxicological Assistance Center of Paraíba
Address: Hospital Universitário Lauro Wanderley – Cidade Universitária – Campus I
CEP: 58059-900 – João Pessoa/ PA – Brazil
Phone: +55 83 3224 6688/ 3216 7007

Toxicological Assistance Center of Pernambuco
Address: Avenida Agamenon Magalhães, s/n° – Derby
Recife/ PE – Brazil
Phone: +55 81 3421 5444 ramal 151
Email: americojr@uol.com.br

Toxicological Assistance Center of São José do Rio Pardo
Address: Hospital de Base – Fundação Faculdade Regional de Medicina (FUNFARME)
Av. Brigadeiro Faria Lima, 5544 – Bairro São Pedro
CEP: 15090-000 – São José do Rio Preto/SP – Brazil
Phone: +55 17 3201 5000 R. 1380
Fax: +55 17 3201 5000 R. 1560
Email: ceatox.hbase@famerp.br

Toxicological Attendance Center
Address: Alameda Mary Ubirajara, 205 – Santa Lúcia
Vitória/ES – Brazil
Phone: +55 27 3137 2400/ 3137 2406
Email: toxcen@saude.es.gov.br

Toxicological Information Center
Address: Hospital Governador João Alves Filho
Av. Tancredo Neves, s/n°
CEP: 49000-000 – Sergipe/SE – Brazil
Phone: +55 79 3259 3645
Email: sescit@saude.se.gov.br

Toxicological Information Center of Manaus
Address: Av. Apurinã, 04, Praça 14
CEP: 69020-170 – Manaus/ AM – Brazil
Tel: +55 92 3622 1972/ 3621 6502
Fax: +55 92 3621 6532
Email: citmanaus@ufam.edu.br

Toxicological Information Center of Marília
Address: Hospital das Clínicas de Marília
Rua Aziz Atalah, s/n°
CEP: 17500-000 – Marília/ SP – Brazil
Phone: +55 14 3433 8795/ 3421 1744 R. 1008
Fax: +55 14 3433 1888

Toxicological Information Center of Maringá
Address: Hospital Universitário Regional de Maringá
Av. Mandacaru, 1560
CEP: 87080-000 – Maringá/ PR – Brazil
Phone: +55 44 2101 9127
Fax: +55 44 2101 9431

Toxicological Information Center of Natal
Address: Hospital Giselda Trigueiro
Rua Cônego Monte, 110 – Bairro Quintas
CEP: 59035-000 – Natal/ RN – Brazil
Phone: +55 84 3232-7969
Email: cithgt@rn.gov.br

Toxicological Information Center of Presidente Prudente
Portuguese only: http://www.unoeste.br/ceatox/
Address: Hospital Estadual Odilon Antunes de Siqueira
Av. José Soares Marcondes, 3578 – Jardim Bongiovani
CEP: 19050-230 – Presidente Prudente/ SP – Brazil
Phone: +55 18 3908 3379/ 3908 4422

Toxicological Information Center of Rio Grande do Sul
Portuguese only: http://www.cit.rs.gov.br/
Address: Rua Domingos Crescêncio, 132–8° Andar – Santana
CEP: 90650-090 – Porto Alegre/RS – Brazil
Phone: +55 51 2139 9200
Fax: +55 51 2139 9201

Toxicological Service of Minas Gerais
Address: Avenida Alfredo Balena, 400 – Santa Efigênia
CEP: 301030-100 – Belo Horizonte/ MG – Brazil
Phone: +55 31 3224 4000/ 3239 9224
Email: servitoxmg@hotmail.com; dcampolina@uol.com.br

Toxic-Pharmacological Center of Goiás
Address: Superintendência de Vigilância Sanitária
Av. Anhanguera, 5195 – Setor Coimbra
CEP: 74040-011 – Goiânia/GO – Brazil
Phone: +55 62 3201 4110/ 3201 4111/ 3201 4149
Fax: +55 62 3291 4350

Legislation

Agrochemicals Law
English: http://www.anvisa.gov.br/eng/legis/index.htm
Portuguese: http://www.anvisa.gov.br/toxicologia/legis/index.htm

Cosmetics Law
English: http://www.anvisa.gov.br/eng/legis/index.htm#1
Portuguese: http://www.anvisa.gov.br/cosmeticos/legis/index.htm

Drugs Law
English: http://www.anvisa.gov.br/eng/legis/index.htm
Portuguese: http://www.anvisa.gov.br/medicamentos/legis/especifica.htm

Drugs of Abuse Law
Portuguese only: http://www.imesc.sp.gov.br/infodrogas/legal.htm

Environmental Law
Portuguese only: http://www.ibama.gov.br/cnia/index.php?id_menu=66

Foods and Commodities Law
English: http://www.anvisa.gov.br/eng/legis/index.htm
Portuguese: http://www.anvisa.gov.br/alimentos/legis/especifica/index.htm

Household Products Law
Portuguese only: http://www.anvisa.gov.br/saneantes/legis/index.htm

Labor Law
Portuguese only: http://www.mte.gov.br/legislacao/default.asp

Miscellaneous Resources

BVS ANVISA – Knowledge Portal in Sanitary Vigilance
Portuguese only: http://bvs.anvisa.gov.br/html/pt/home.html

Virtual Library in Health – Toxicology Brazil
Portuguese only: http://tox.anvisa.gov.br/html/pt/home.html

International MEDLARS Center

The National Library of Medicine (NLM) enters into bilateral agreements with public institutions that serve as International MEDLARS Centers. These Centers assist health professionals in accessing databases, offer search training, provide document delivery and perform other functions as bio resource centers.

BIREME/OPAS/OMS
Centro Latino Americano e do Caribe de Informação em Ciências da Saúde
Organização Pan-Americana da Saúde
Organização Mundial da Saúde
Rua Botucatu, 862 – Vila Clementino
Cep:04023-901 – São Paulo/SP – Brazil
Phone: +55 11 5576-9800
Fax: +55 11 5575-8868
Web: http://www.bireme.br

CHAPTER

82

Canada

BARIL MARC, BLAIN JACQUES, AND LAJOIE ALAIN

INTRODUCTION

Canada has a very long history of scientific activity related to toxicology. In the 1960s, Health and Welfare Canada had several laboratories dedicated to this new field of science. In the early 1970s, the Medical Council of Canada (http://www.mcc.ca/english/news/index.html) offered some specific grants to support universities starting initiatives in toxicology. Nearly 40 years later, as it is clearly evident in this chapter, toxicology has literally exploded in Canada. From its origins in pharmacology, toxicology has since influenced many spheres of knowledge. From forensic science to emergency response, environmental science to occupational health and safety, modern techniques such as PBPK (physiological-based pharmacokinetic) modeling, and sophisticated online Internet databases, the science of toxicology is now a firmly established component in the Canadian science arena. For its part, the Society of Toxicology of Canada has been very proactive over the years. Annual congress, grants for graduate student, and newsletters help to keep a network of Canadian toxicologists very active in their specialized fields of interest. The following information resources lists some major books, journals, research articles and other relevant toxicology resources from Canada.

RESOURCES

Original Research Articles in Toxicology

Many Canadian authors routinely submit their original research articles in toxicology to international publications, particularly the official journals of the U.S. Society of Toxicology. In addition, review articles and book chapters frequently appear in books that are edited and published in the United States. Consequently, readers are referred to the detailed descriptions of books and journals that appear in the appropriate section of this text dealing with the United States, because these frequently contain articles of Canadian origin.

In addition, there are some Canadian journals that describe original research in toxicology even if it is not their main topic. For example, there is a pharmacology and toxicology section in the *Canadian Journal of Physiology and Pharmacology*, and articles concerned with environmental toxicology are routinely published in the *Canadian Fisheries Journal*. Other relevant public health articles are published in the *Canadian Journal of Public Health*.

Journals

Canadian Journal of Fisheries and Aquatic Sciences
ISSN: 0706-652X 1205-7533
Web: http://pubs.nrc-cnrc.gc.ca/cgi-bin/rp/rp2_desc_e?cjfas

Published continuously since 1901 (under various titles), this monthly journal is the primary publishing vehicle for the multidisciplinary field of aquatic sciences.

Canadian Journal of Forest Research
ISSN: 0045-5067 1208-6037
Web: http://pubs.nrc-cnrc.gc.ca/cgi-bin/rp/rp2_desc_e?cjfr

Published since 1971, this monthly journal features articles, reviews, notes, and commentaries on all aspects of forest science, contributed by internationally respected scientists. It also publishes special issues dedicated to a topic of current interest.

Canadian Journal of Physiology and Pharmacology
ISSN: 0008-4212 1205-7541
Web: http://pubs.nrc-cnrc.gc.ca/cgi-bin/rp/rp2_desc_e?cjpp

Published since 1929, this monthly journal is affiliated with the Canadian Physiological Society, the Pharmacological Society of Canada, the Canadian Society for Nutritional Sciences, and the Society of Toxicology of Canada. It reports current research in all aspects of physiology, nutrition, pharmacology, and toxicology. It publishes symposium reviews and award lectures, and on occasion dedicates entire issues (or portions thereof) to subjects of special interest to its international.

Canadian Journal of Public Health
ISSN: 0008-4263
Web: http://www.cpha.ca/english/cjph/cjph.htm

The *Canadian Journal of Public Health* is a professional journal which carries a wide variety of in-depth articles on all aspects of public health. The editorial is peer-reviewed, and the editorial board is made up of public health experts from across Canada.

Canadian Journal of Soil Science
ISSN: 0008-4271
Web: http://pubs.nrc-cnrc.gc.ca/aic-journals/cjss.html

Research is published in a number of topic sections: Agrometeorology, Ecology, Biological processes and plant interactions, Composition and chemical processes, Physical processes and interfaces, Genesis, landscape processes and relationships, Contamination and environmental stewardship, Management for agricultural, forestry and urban uses.

Canadian Water Resources Journal
ISSN: 0701-1784

The Canadian Water Resources Association recognizes the need to provide a Canadian-oriented publication in which authors can present their views on a broad range of water resource-related topics. The *Canadian Water Resources Journal* accepts manuscripts in English or French and publishes abstracts in both official languages. In general, preference is given to manuscripts focusing on information and policy aspects of Canadian water management.

Environmental Health

The following publications (Southam Information and Technology Group) deal primarily with environmental health and the impact of toxic substances on the environment. Some also discuss the regulatory aspects of toxic substances. *Ecolog Canadian Pollution Legislation* contains environmental pollution legislation of both the federal and provincial governments. A weekly report on waste management and industrial pollution control is also available.

Environmental Compliance Report is a supplement to *Ecolog Canadian Pollution Legislation.* This monthly publication discusses legislative changes, regulatory amendments, and recent cases.

Environmental Reviews
ISSN: 1208-6053
Web: http://pubs.nrc-cnrc.gc.ca/cgi-bin/rp/rp2_desc_e?er

Published since 1993, this annual journal presents authoritative reviews on a wide range of environmental science and associated environmental studies topics, with emphasis on the effects on and response of both natural and manmade ecosystems to anthropogenic stress.

Occupational Health and Safety

Information which pertains to occupational health and safety with emphasis on hazardous exposures is primarily published by the Southham Magazine and Information Group (1450 Don Mills Rd., ON M3B 2 × 7): *Occupational Health and Safety Canada* (published six times per year) and *Canadian Occupational Health and Safety News* (a weekly report) – evaluates employee exposure and indoor air quality. In addition, *Workplace: Environmental Health and Safety*, published by Templegate Information Services (Toronto), reports on regulations, standards, and guidelines pertaining to occupational health.

Governmental Publications

Health Canada Publications
Web: http://www.hc-sc.gc.ca/ahc-asc/pubs/index_e.html
Ottawa, ON, Canada K1A 0S9

Environment Canada Publications
Hull, QC, Canada K1A 0H3 (http://www.ec.gc.ca/default.asp?lang=En&n=ABE0AD52-1)
Web: http://www.ec.gc.ca/publications/

Proposed Regulatory Decision Documents
Pest Management Regulatory Agency

Ottawa, ON Canada K1A 0C6
Web: http://www.pmra-arla.gc.ca/english/pubs/pubs-e.html

Newsletters

Canadian Occupational Safety and Health News
Web: http://www.businessinformation group.ca/oh&s/cohsn.asp

Canadian Occupational Safety
Web: http://www.cos-mag.com/

CNTC News
Web: http://www.uoguelph.ca/cntc/publicat/publicat.shtml#cntc

EcoLog News
Web: http://www.ecolog.com/default.asp

OHS Canada Magazine
Web: http://www.ohscanada.com/

Safety Compliance Insider
Web: http://www.canadacompliance.com/

STC – Newsletter

S.T.C. News is an official newsletter of the Society of Toxicology of Canada (P.O. Box 517, Beaconsfield, QC H9W 5V1).

Comments: *CNTC News* is produced by the Canadian Network of Toxicology Centres (Bovey Bldg., Gordon St., Guelph, ON N1G 2W1).

Web: http://www.stcweb.ca/newsletter_e.htm

Computerized Information Resources

With the Internet readily available in Canada, the number of publicly accessible databases containing some type of toxicological information has mushroomed in the last decade. The following table gives a broad picture of such digital resources. Information presented below was extracted from the Health Canada inventory database at http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/.

Some of the databases, especially those maintained by governmental organizations, are also accessible by searching for the organization on the web.

Air Data and Management System (ADaMS)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/airdataBC_e.html

Comments: Organization maintaining the database:

Water, Air Monitoring and Reporting Branch BC Ministry of Water, Land and Air Protection

Purpose of database: To store data on hourly average concentrations of major air pollutants in British Columbia, as well as meteorological data.

Air Quality and Meteorological Database (Northwest Territories)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/airqualityNT_e.html

Comments: Organization maintaining the database:

Environmental Protection Service, Dept of Resources, Wildlife and Economic Development, Government of NWT

Purpose of database: To store ambient air quality data and meteorological data for the Northwest Territories.

Air Quality Information System (AQUIS)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/airqualityON_e.html

Comments: Organization maintaining the database:

Water, Air Monitoring and Reporting Branch BC Ministry of Water, Land and Air Protection

Purpose of database: To store data on hourly average concentrations of major air pollutants in British Columbia, as well as meteorological data.

Arctic Contaminants Database (Health Canada)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/arcticdb_e.html

Comments: Organization maintaining the database:

Organizational Unit Toxic Substances Division, Environmental Contaminants Bureau, Safe Environments Programme, HECS Branch, Health Canada

Purpose of database: To monitor tissue (blood, breast milk) levels of environmental contaminants in Arctic populations.

Asbestos Workers Registry (Ontario)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/asbestON_e.html

Comments: Organization maintaining the database:

Occupational Health and Safety Branch Ontario Ministry of Labor

Purpose of database: To collect and store data on hours of Ontario worker exposure to asbestos. Number of data records: 24 000.

Banque de Données Commune (BDC) (Québec)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/communitydb_f.html

Comments: Organization maintaining the database:

Vice-presidence Finances, Direction de la statistique et de l'information de gestion, Service de l'évolution et du fonctionnement des systèmes d'information, CSST

Purpose of database: To house strategic and tactical information for statistical, actuarial, and accounting purposes; as well as client profiles and managerial information related to Quebec workers compensation. There are approximately 515 618 185 records in the database.

Canadian Breast Cancer Screening Database (Health Canada)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/breastcancer_e.html

Comments: Organization maintaining the database:

Health Canada

Purpose of database: Data are collected and analyzed to monitor and evaluate the performance of breast cancer screening in organized programs.

Canadian Childhood Cancer Surveillance and Control Program – Economic Impact Study (Health Canada)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/childhoodcancer_e.html

Comments: Organization maintaining the database:

Health Canada

Purpose of database: Information is gathered to assess the economic impact of childhood cancer.

Canadian Childhood Cancer Surveillance and Control Program – Etiology Surveillance System (Health Canada)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/etiology_e.html

Comments: Organization maintaining the database:

Health Canada

Purpose of database: Data are collected and analyzed to investigate factors, which may increase the risk of children developing cancer, using a case-control design.

Canadian Community Health Survey (CCHS) (Statistics Canada)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/cchs_e.html

Comments: Organization maintaining the database:

Statistics Canada

Purpose of database: To track and monitor legal and illicit drug use among the general Canadian population aged 12 years and older.

Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/chirpp_e.html

Comments: Organization maintaining the database:

There is a network of 15 CHIRPP centers across Canada which contribute data to this national database. The IWK Grace Health Centre is one of these 15 centers.

Purpose of database: For surveillance of childhood injuries across Canada, and specifically within Nova Scotia.

Canadian Pollution Prevention Information Clearinghouse (CPPIC)
Web: http://www.ec.gc.ca/nopp/docs/fact/en/cppic.cfm

Comments: The Canadian Pollution Prevention Information Clearinghouse (CPPIC), an online database and comprehensive resource provides Canadians with the information they need to put pollution prevention (P2) into practice.

Cancer Case Surveillance System (Health Canada)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/cancercase_e.html

Comments: Organization maintaining the database: Health Canada

Purpose of database: The goal of this surveillance program, which collects information from a variety of databases, is to provide timely, reliable cancer statistics for use in publications and to respond to information requests; to monitor national cancer incidence, prevalence and mortality, using temporal geographic and high-risk population information, survival analysis, and projections; and to establish a nationwide and world class population-based cancer surveillance network.

CCOHS. Web Information Services
Web: http://ccinfoweb.ccohs.ca/about.html

Comments: The center Web Information Services provide simple, one-step searching across all OHS database collections.

Central Information System (CIS) (Occupational Health, Newfoundland)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/cis_e.html

Comments: Organization maintaining the database:

Occupational Health and Safety Division, Newfoundland Department of Labor.

Purpose of database: To track all inspections activity of occupational and health safety officers in Newfoundland and Labrador.

Chemical Health Hazard Assessment Tracking System (Health Canada)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/chemicalhazard_e.html

Comments: Organization maintaining the database:

Chemical Health Hazard Assessment Division Bureau of Chemical Safety Food Directorate Health Products and Foods Branch Health Canada

Purpose of database: CHHAD uses internal submission/risk assessment tracking systems to retrieve past assessments and files on specific compounds; Content National and provincial data on food contaminants.

Chronic Respiratory Surveillance System (Health Canada)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/respiratory_e.html

Comments: Organization maintaining the database: Health Canada

Purpose of database: Information gathered, on a one-time basis, facilitates the monitoring, analysis and interpretation of chronic respiratory mortality and hospitalization trends in Canada,

Compensation Assessment and Accident Prevention System (CAAPS) (Northwest Territories)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/caaps_e.html

Comments: Organization maintaining the database:

CGI, Edmonton Office (current outsourcer) David Hiscock, Service Manager, Technical Support 10303 Jasper Ave, Suite 800 Edmonton, Alberta T5J 3N6 Tel: (780)-409-2200 E-mail: david.hiscock@cgi.com

Purpose of database: The database is used to collect and store workers compensation claims data and employer assessment information.

Comprehensive Record and Information System for Pesticides (CRISP) (British Columbia)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/crisp_e.html

Comments: Organization maintaining the database:

British Columbia Ministry of Water, Land & Air Protection

Purpose of database: To track the use of pesticides in British Columbia.

Connaissance et Surveillance de la Qualité de l'Air (CESPA)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/cespa_e.html

Comments: Organization maintaining the database:

Service de l'information sur le milieu atmosphérique (SIMAT), Direction du suivi de l'état de l'environnement (DSÉE), Ministère de l'environnement du Québec (MENV)

Purpose of database: To increase the knowledge on ambient air quality and

to facilitate surveillance in this area, at the national, provincial, and local/municipal levels.

Drinking Water Information Management System (DWIMS) (Ontario)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/dwims_e.html

Comments: Organization maintaining the database:

Drinking Water Surveillance Program, and the Systems Group of the Environmental Monitoring and Reporting Branch, Ontario Ministry of the Environment

Purpose of database: To collect and store drinking water quality data to support standards development in the Drinking Water Surveillance Program (DWSP) and for audit water samples collected when MOE inspects municipal waterworks in Ontario; to define contaminant levels and trends; to assess emerging contaminants; and to monitor the efficiency of water treatment processes.

Drinking Water Quality Database (Nunavut)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/waterqualityNU_e.html

Comments: Organization maintaining the database:

Departmental Systems Coordinator Dept of Health and Social Services Government of Nunavut

Purpose of database: To record and store data on parameters of bacteriological quality of drinking water in Nunavut.

Drinking Water Web System (DWWS) (Ontario)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/dwws_e.html

Comments: Organization maintaining the database:

IMTB/CMD, Ontario Ministry of the Environment. The DWWS is a standalone system which has been managed from a business perspective in the Laboratory Services Branch. Effective June 1, 2003, the DWWS will be part of a much larger database handled by the Ministry's Information Management and Technology Branch (IMTB; contact: Wilson Soon – see above).

Purpose of database: To store data on drinking water sample test results in order to monitor Ontario drinking water quality.

Eco-Log Occupational Health and Safety Legislative Database
Web: http://www.businessinformationgroup.ca/oh&s/oh&sdatabase.asp

Enteric Disease Surveillance System (EDSS) (Health Canada)

Comments: Sponsoring organization: Health Canada

Purpose of database: To collect and disseminates laboratory-based weekly acute surveillance data on enteric foodborne organisms causing human disease, in an effort to identify and reduce risk factors and to enable early intervention.

Environment Integrated System (EnvI) (New Brunswick)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/envi_e.html

Comments: Organization maintaining the database:

Information Management Services (IMS) Branch New Brunswick Dept of Environment & Local Government

Purpose of database: This operational data warehouse stores New Brunswick water quality data for monitoring purposes, as well as industrial certificate-of-approval documents.

Environmental Cancer Risk Surveillance System (Health Canada)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/cancerrisk_e.html

Comments: Organization maintaining the database: Health Canada

Purpose of database: Stores data used to assess the risk of cancer from environment-related factors, and monitors known environmental risk factors.

Environmental Data Management System (EDMS) (Manitoba)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/edms_e.html

Comments: Organization maintaining the database:

Manitoba Conservation (Air Quality Section)

Purpose of database: To compile ambient air quality data from air monitoring stations in Manitoba and to generate summary statistics based on these data.

Environmental Data Store (EDS) (Ontario)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/eds_e.html

Comments: Organization maintaining the database:

Environmental Sciences and Standards Science Division, Environmental Monitoring and Reporting Branch, Ontario Ministry of the Environment

Purpose of database: Serves as a repository for all data on surface water sample analyses done by the Ontario Ministry of the Environment, including surface water monitoring data.

Environmental Monitoring Company (EMC) System Manager Central Data Management System (Manitoba)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/emc_e.html

Comments: Purpose of database: To compile ambient air quality data from air monitoring stations in Manitoba and to generate summary statistics based on these data.

Environmental Monitoring Inventory Database (EMI) (Environment Canada)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/emi_e.html

Comments: Organization maintaining the database: Environment Canada

Purpose of database: The goal is to create an inventory of all the environmental monitoring activities conducted by Environment Canada in order to generally improve the management of toxic substances by the federal government.

Environmental Monitoring System (EMS) (British Columbia)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/ems_e.html

Comments: Purpose of database: To capture data covering physical/chemical and biological analyses performed on water, air, solid waste discharges and ambient monitoring sites throughout the province.

Equipment Registration Database (Newfoundland)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/equipment_e.html

Comments: Organization maintaining the database:

Workplace Health and Safety, Occupational Health and Safety, Newfoundland Department of Labor

Purpose of Database: Serves as an in-house registration and tracking system for radiation equipment.

Fichier des Tumeurs du Québec (J65)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/fichier_e.html

Comments: Organization maintaining the database:

Direction générale de la santé publique, Ministère de la Santé et des Services Sociaux (MSSS)

Purpose of database: The database is a centralized system used to collect data on all new cancer cases reported annually in the province of Québec. The data are used for cancer surveillance, program evaluation, and epidemiologic research.

Global Public Health Intelligence Network (GPHIN) (Health Canada)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/gphin_e.html

Comments: Organization maintaining the database: Health Canada

Purpose of database: Intended to provide 24-hour-per-day, 7-days-a-week monitoring of global infectious disease outbreaks and natural disasters in terms of the details of outbreak events. The goal is to identify potential international health risks and to provide an early warning to programs and public health clients (e.g., the World Health Organization) who assess and manage risk.

Great Lakes Wildlife Toxicology Database
Web: http://www.on.ec.ca/search/metadata.cfm?ID=116&Lang=e

Contains toxicology data for 3000 samples from 11 tissues from 16 species of wildlife collected from 157 sites in the Great Lakes Basin during 1970–1994. Contaminant levels for 5 metals, 26 organochlorine compounds, 7 dioxin congeners, 13 furan congeners, and 42 PCB congeners.

Hedgehog Environmental Systems
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/hedgehog_e.html

Comments: Organization maintaining the database: Health Canada

Purpose of database: The Hedgehog Environmental System provides a single centralized source of integrated data for the critical functions required by public health inspectors and environmental health officers.

International Circumpolar Surveillance (ICS) Database (Health Canada)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/ics_e.html

Comments: Organization maintaining the database: Health Canada

Purpose of database: The aim is to gather data which will lead to a better understanding of the epidemiology of infectious diseases in northern Aboriginal populations in order to improve prevention and control programs. Enables the assessment of the burden of illness and identification of risk factors related to invasive pneumococcal diseases among aboriginal peoples.

Intoxications (Poisonings Database, Québec)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/intoxications_e.html

Comments: Organization maintaining the database:

Direction de la Toxicologie Humaine, Institut National de Santé Publique du Québec

Purpose of database: The database records and stores data on all poisoning-related calls to the Centre Anti-Poison du Québec (CAPQ).

Inventaire des Émissions Atmosphériques (INVSRC) (Inventory of Atmospheric Emissions, Québec)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/invsrc_e.html

Comments: Organization maintaining the database:

Atmospheric Quality Service (Service de la qualité de l'atmosphère), Québec Ministry of the Environment

Purpose of database: To store inventory data on atmospheric emissions of a variety of airborne contaminants.

Leak Test Sampling Database (British Columbia)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/leak_e.html

Comments: Organization maintaining the database:

Radiation Protection Services, British Columbia Centre for Disease Control

Purpose of database: To record certain environmental radiation and Leak Test results for the province of British Columbia. Content Data on soil contaminants, ionizing radiation, and nuclear submarine environmental samples.

Links Database of OHS Division Activities (Saskatchewan)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/links_e.html

Comments: Organization maintaining the database:

Research Officer, Occupational Health and Safety Division, Saskatchewan Labor

Purpose of database: To identify and analyze trends in occupational injuries and illnesses in Saskatchewan to better target activities in the Occupational Health and Safety Division.

Lotus Notes R5 Database (British Columbia)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/lotus_e.html

Comments: Organization maintaining the database:

Health Space Solutions – Hope, British Columbia, Vancouver Island Health Authority, Health Protection and Environmental Services Software Application, Vancouver Island Health Authority (John Harper is the software coordinator and analyst)

Purpose of database: To collect and store data on environmental inspections and permit approvals.

Medico-Environmental Surveillance of Workers' Health, Québec)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/smest_e.html

Comments: Organization maintaining the database:

Direction des technologies de l'information, Direction de la protection de la santé publique, Ministère de la Santé et des Services Sociaux (Québec)

Purpose of database: The database is an occupational health information system which captures data gathered by the occupational health teams of CLSC and the Régies Régionales from the establishments (e.g., industrial) within their respective regions as part of provincial programs or health programs specific to these establishments.

Merged Information System (MIS) (Ontario)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/mis_e.html

Comments: Organization maintaining the database:

Information and Administrative Services Occupational Health and Safety Branch Ontario Ministry of Labor

Purpose of database: The database serves as a repository for occupational health and safety data on projects, organizations, events, field visits conducted, and orders issued. Used for sector planning and evaluation.

Mine Medical X-Ray Database (Yukon)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/mine_e.html

Comments: Organization maintaining the database:

Inspections and Compliance Unit, Yukon Workers' Compensation Health and Safety Board

Purpose of database: The database organizes and houses annual X-ray and medical files of miners exposed to silica in Yukon mines.

Municipal Information Management System (MIMS) (Newfoundland)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/mims_e.html

Comments: Organization maintaining the database:

Information Technology Division, Department of Municipal and Provincial Affairs

Purpose of database: To store drinking water quality data relating to Newfoundland's local/municipal public water supplies.

Municipal Wastewater Database (New Brunswick)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/wastewater_e.html

Comments: Organization maintaining the database:

Environmental Management Division, Stewardship Branch, New Brunswick Dept of the Environment and Local Government

Purpose of database: To collect and store wastewater data for internal records/analysis.

National Contaminants Information System (NCIS)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/ncis_e.html

Comments: Organization maintaining the database: Fisheries and Oceans Canada

Purpose of database: Secures data on waterborne contaminants for Fisheries and Oceans Canada, in support of the Fisheries Act, the Oceans Act and the Canadian Environmental Assessment Agency.

National Dose Registry (Health Canada)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/nds_e.html

Comments: Organization maintaining the database:

There is a network of 15 CHIRPP centers across Canada, which contributes data to this national database. The IWK Grace Health Centre is one of these 15 centers.

Purpose of database: For surveillance of childhood injuries across Canada, and specifically within Nova Scotia. Content Provincial and national data on childhood injuries.

National Enteric Surveillance Program (NESP) (Health Canada)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/nesp_e.html

Comments: Organization maintaining the database: Health Canada

Purpose of database: The collection, collation, and dissemination of laboratory-based surveillance data on enteric pathogens causing human disease provide a timely national view of enteric pathogens in Canada.

National Environmental Monitoring of Radionuclides (Health Canada)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/radionuclides_e.html

Comments: Organization maintaining the database:

National Monitoring Section Environmental Radiation Hazards Division Safe Environments Programme HECS Branch, Health Canada

Purpose of database: To record and maintain data on radionuclide in environmental and food samples from across the country.

National Pollutant Release Inventory (NPRI) (Environment Canada)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/npri_e.html

Comments: Purpose of database: The NPRI database is the only legislated, nationwide, publicly accessible inventory of its kind in Canada. Its main objective is to provide Canadians with access to pollutant release information from facilities located in their communities.

National Population Health Survey (NPHS) Asthma Supplement 1996–97 (Health Canada)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/nphs_e.html

Comments: Organization maintaining the database:

The data are the property of Statistics Canada, but the Centre for Chronic Disease Prevention and Control, Health Canada, maintains a copy.

Purpose of database: Survey data are used to monitor the prevalence of asthma nationwide (all provinces), and to provide information on severity of asthma, associated risk factors, and management and treatment practices.

National Surveillance for Enteric Pathogens from Food and Animals – Guelph Laboratory (Health Canada)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/pathogens_e.html

Comments: Purpose of database: To monitor trends in the sources and characteristics of enteric pathogens (including antimicrobial resistance) isolated from food and animal sources, as an aid in determining risk factors for human illness.

Occupational Exposure Database Management (OEDM) (Ontario)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/oedm_e.html

Comments: Organization maintaining the database:

Information and Administrative Services Occupational Health and Safety Branch Ontario Ministry of Labor

Purpose of database: The sampling results associated with work environment exposure to various airborne hazards in the OEDM database are used in the analysis of work exposure to specific hazards as well as in providing information for regulatory changes.

Occupational Health and Safety Client-Generated Activities Database (Newfoundland)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/client_e.html

Comments: Organization maintaining the database:

Occupational Health and Safety Division, Newfoundland Department of Labor

Purpose of database: To keep records of all client-driven assignments from and initial contact by occupational health and safety officers in Newfoundland and Labrador.

OnAIR Database (Ontario)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/onair_e.html

Comments: Organization maintaining the database:

Environmental Sciences and Standards Science Division, the Database Environmental Monitoring and Reporting Branch, Ontario Ministry of the Environment

Purpose of database: OnAIR is Ontario's industrial, commercial, institutional, and municipal air emissions registry. OnAIR gives the public immediate access to information about what emissions are being released into the air and by whom.

Oracle Research Database of WCB Claims (Oracle WCB) (Saskatchewan)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/oracle_e.html

Comments: Organization maintaining the database:

Performance Management Coordinator of the Occupational Health and Safety Division (OHSD), Saskatchewan Labor

Purpose of database: To identify and analyze trends in occupational injuries and illnesses in Saskatchewan to better target Occupational Health and Safety Division activities.

Pesticide Product Information System (PEPSIS) (Ontario)
Web: http://app.ene.gov.on.ca/pepsis/

Organization maintaining the database:

Ontario Pesticides Advisory Committee (OPAC)

Purpose of database: To provide a listing of pesticides classified for use in Ontario.

Physician Asthma Management Survey (PAMS) (Health Canada)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/pams_e.html

Comments: Organization maintaining the database:

Centre for Chronic Disease Prevention and Control, Health Canada

Purpose of database: To understand physician asthma management practices in Canada.

Prairie Livestock and Environment Database
Web: http://web2.gov.mb.ca/agriculture/pled/

Prevention Services Information System (PSIS) (WCB of the Northwest Territories and Nunavut)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/psis_e.html

Comments: Purpose of the database: To collect and store NWT and Nunavut information on occupational health and safety inspections, investigations and certifications (for inspection purposes).

Product Safety Information System (PSIS)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/productpsis_e.html

Comments: Organization maintaining the database:

National Compliance and Information Systems Division Consumer Product Safety Bureau Product Safety Programme Healthy Environments and Consumer Safety Branch Health Canada

Purpose of database: This national database is a health surveillance system.

Radiation Exposure Report Database (Newfoundland)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/radiation_e.html

Comments: Organization maintaining the database:

Workplace Health and Safety, Occupational Health and Safety, Newfoundland Department of Labor

Purpose of database: The database is a tracking system to monitor individual occupational radiation exposure; and to evaluate trends in radiation exposure, dose history, and dose management.

RATL: A Database of Reptile and Amphibian Toxicology Literature
Pauli BD, Perrault JA, Money SL
National Wildlife Research Centre 2000
Canadian Wildlife Service
Environmental Conservation Branch
Technical Report Series Number 357
Web: http://dsp-psd.communication.gc.ca/Collection/CW69-5-357E.pdf

Rapid Risk Factor Surveillance System (RRFSS) (Ontario)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/rrfss_e.html

Comments: Organization maintaining the database:

A consortium of 20 health units in Ontario forms the RRFSS Working Group.

Purpose of database: The information in the database is used to assist with

program planning and evaluation (i.e., to prioritize health issues, direct operational plans, measure effectiveness of strategies, and monitor progress towards program goals and objectives); and for advocacy or to influence local interests; and to monitor trends over time.

Saskatchewan Environment's Environmental Management System (SEEMS)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/seems_e.html

Comments: Organization maintaining the database:

Environmental Information Section, Environmental Protection Branch, Saskatchewan Environment

Purpose of database: To manage provincial drinking water quality data and information.

Spatial Data Warehouse (SDW) (Health Canada)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/sdw_e.html

Comments: Purpose of database: The Geographic Information System (GIS) infrastructure developed by Health Canada's Centre for Surveillance Coordination (CSC) supports the spatial information needs of CSC projects, epidemiologists, regional surveillance and public health programs, etc.

Special Waste Information System (SWIS) (British Columbia)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/swis_e.html

Comments: Organization maintaining the database:

BC Ministry of Water, Land and Air Protection

Purpose of database: To track the generation & transport of special waste.

Spills Database (Nunavut)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/spills_e.html

Comments: Organization maintaining the database:

Environmental Protection Service, Department of Sustainable Development, Government of Nunavut

Purpose of database: To monitor all spills of hazardous materials in Nunavut and the Northwest Territories.

Sport Fish Contaminant Monitoring Program Database (FISHBASE) (Ontario)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/fishbase_e.html

Comments: Organization maintaining the database:

Biomonitoring Section Sport Fish Contaminant Monitoring Program Environmental Monitoring and Reporting Branch Ontario Ministry of the Environment

Purpose of database: To store data used to develop sport fish consumption advisories, which are published in the Guide to Eating Ontario Sport Fish.

Système de Surveillance Épidémiologique sur les Maladies à Déclarations Obligatoires (MADO) (Epidemiological Surveillance System)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/mado_e.html

Comments: Organization maintaining the database:

Ministère de la Santé et des Services Sociaux (MSSS), Québec

Purpose of database: To store Québec public health network data on diseases subject to mandatory reporting (i.e., notifiable diseases) for the purpose of tracking and documenting the progress of these diseases.

Système Informatisé Eau-Potable (LCH) (Drinking Water Information System, Québec)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/lch_e.html

Comments: Organization maintaining the database:

Direction des ressources informationnelles (Information Resources Directorate), Ministère de l'Environnement du Québec

Purpose of database: To monitor drinking water quality, specifically in distribution networks (Aqueduc) in Québec regions, localities, and municipalities.

Toxin (Toxin Database, Québec)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/toxin_e.html

Comments: Organization maintaining the database:

Québec Anti-Poison Centre (Le centre Anti-poison du Québec (CAPQ),

Institut national de santé publique du Québec (INSPQ)

Purpose of database: To capture data on incidents of poisoning reported to the CAPQ; and to store and provide information on interventions and on health resources (e.g., treatment guides) available in Québec.

Water Quality Database (Newfoundland)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/water_e.html

Comments: Organization maintaining the database:

Water Resources Management Division Newfoundland Department of the Environment

Purpose of database: Collects and stores data that archives provincial (Newfoundland) laboratory testing results.

Watertrax (British Columbia)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/watertrax_e.html

Comments: Organization maintaining the database:

Internet-based service provider is Watertrax Inc. Phone: (604) 691-1744; Email: rong@watertrax.com

Purpose of database: To monitor drinking water quality in British Columbia.

West Nile Virus Database (Health Canada)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/westnile_e.html

Comments: Organization maintaining the database: Health Canada

Purpose of database: To monitor trends in the prevalence and incidence of West Nile virus infections.

Work Injuries and Diseases Database (NWISP) (Association of Workers' Compensation Boards of Canada)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/nwisp_e.html

Comments: Organization maintaining the database:

NWISP Coordinator, Association of Workers' Compensation Boards of Canada

Purpose of database: The database uses information derived from accepted claims from injured workers made to the various Canadian workers compensation boards and commissions. Includes national, provincial, and territorial group-level or aggregate data.

Year 2000 Emission Inventory Update (British Columbia)
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/year2000_e.html

Comments: Organization maintaining the database:

Air Protection Section Water, Air and Climate Change Branch British Columbia Ministry of Water, Land and Air Protection

Purpose of database: To track releases of air pollutants to the British Columbia environment.

Web Links

CCOHS Internet Directory
Web: http://www.ccohs.ca/resources/hshome.html

CNTC Links
Web: http://www.uoguelph.ca/cntc/links/cntc-links.shtml

Environment Canada – Groundwater links
Web: http://www.ec.gc.ca/Water/en/links.cfm?category_id=all&sub_section_id=3

Environment Canada. Environnemental links
Web: http://www.atl.ec.gc.ca/links.html

Inventory of Federal, Provincial and Territorial Environmental and Occupational Health Data Sources and Surveillance Activities
Web: http://www.hc-sc.gc.ca/ewh-semt/pubs/eval/inventory-repertoire/index_e.html

IRSST (useful links)
Web: http://www.irsst.qc.ca/en/_categorieslienwebs_menu.html

Public Health Agency of Canada – Injury Surveillance Data Sources and Surveillance Activities
Web: http://www2.itssti.hc-sc.gc.ca/clf/clfinventory.nsf/Home?OpenForm&lang=E

Society of Toxicology – Sites of Interest
Web: http://www.toxicology.org/ai/si/sites.asp

Legislation and Regulatory Isues

Canadian federal laws, including those which govern the control of toxic substances, are compiled in the *Consolidated Statutes of Canada.* These statutes are updated annually and revised volumes are periodically published in their entirety or as statements of current law called the *Revised Statutes of Canada.* They are also available online through the *Justice Department of Canada.* Proposals for new laws and amendments to existing ones are published in the *Canada Gazette* (Part I), which appears weekly and is available to the public. Once proposals are announced, interested parties have 45 or 60 days to voice their opinions and/or objections before any changes are implemented. Part II of the *Canada Gazette* reports on new statutory regulations and is published biweekly, whereas Part III, published on an ad hoc basis, announces Public Acts of parliament as they are enacted.

The Canadian statutes, which deal specifically with toxic substances, are listed along with their location in the *Statutes of Canada*, the federal department(s) responsible for their enforcement, and a brief description of the law as it pertains to toxicology.

Full text is available on line at www.laws.justice.gc.ca.

Arctic Waters Pollution Prevention Act
Chapter A-12
Northern Affairs

This act provides the legislation to prevent pollution of the Arctic waters, which are adjacent to the mainland and islands of the Canadian Arctic. The act also prohibits the release of substances, which would cause the water to be unsuitable for man, animals, plants, or fish.

Canadian Environmental Protection Act
Chapter C-16
Environment Canada, Health Canada

This act regulates the manufacture and importation of industrial chemicals and other potentially toxic substances not covered by other legislation in order to protect the environment and human life and health. This law sets the minimum standard for assessing substances to which other federal acts regulating toxic substances must adhere. Under this act, the ministers of both departments are jointly responsible for compiling a 'Priority Substances List' which will specify substances to which priority should be given in assessing their toxicity.

Fisheries Act
Chapter F-14
Fisheries and Oceans, Environment Canada

One of the mandates of this law is the protection of fish and their habitats against harm by toxic substances by prohibiting the discharge of any deleterious substance into water frequented by fish.

Food and Drugs Act
Chapter F-27
Health Canada

This act regulates the manufacture, preservation, packaging, and storage of food, drugs, cosmetics, and medical devices. Under this legislation, all these items must be reviewed and found to meet all defined criteria to ensure the safety to human health and life prior to their use in Canada.

Hazardous Products Act
Chapter H-3
Health Canada

This act prohibits the advertising, sale, and importation of hazardous materials. Products designed for human use (household, garden, or personal use) must be shown to pose no danger to the health or safety of the public due to design or contents. Under this legislation the WHMIS was developed to ensure the protection of workers from the adverse effects of hazardous materials.

Migratory Birds Convention Act
Chapter M-7
Environment Canada

This legislation was put in place for the protection of migratory birds and their environment in Canada and the United States. It prohibits the deposition of substances harmful to migratory birds or their habitats.

Pest Control Products Act
Chapter P-9
Pest Management Regulatory Agency (PMRA), Health Canada

This act regulates the manufacture, importation, sale, and use of products to control pests and organic functions of plants and animals with the intent to ensure the safety, merit, and value of the products used in Canada. Manufacturers, importers, exporters, or distributors of a pest control product must comply with restrictions on the formulation, composition, packaging, labeling, product use, and contaminants defined in this act.

Transportation of Dangerous Goods Act
Chapter T-19
Transport Canada

This act regulates the transportation of dangerous goods within Canada. Safety procedures defined in

the law must be adhered to before any shipping of hazardous substances can occur.

THE REGULATION OF CHEMICALS IN CANADA

To ensure the health, safety, and life of humans and the environment, all chemical products must undergo a review process and meet all criteria outlined by the relevant regulatory laws prior to their use in Canada. In some cases, more than one law, requiring the input of several regulatory departments, may cover regulation of a substance. The full text of regulations is available on line at http://laws.justice.gc.ca/en/BrowseRegTitle.

For example, regulation of pesticides occurs primarily under the Pest Control Act, which is enforced by the Pest Management Regulatory Agency of Health Canada. However, establishment of permissible maximum residue limits of pesticides in food is legislated under the Food and Drug Act, whereas the Canadian Environmental Protection Act, the Fisheries Act, and the Migratory Birds Convention Act cover environmental protection against these substances. Therefore, during the course of product registration, experts from Health Canada, Agriculture and Agri-Food Canada, Environment Canada, and Natural Resources Canada may be consulted prior to granting approval. In addition, individual provinces and municipalities may also regulate use of pesticides within their own jurisdiction and may even prohibit the use of a substance, which has been approved by federal authority. They may not, however, use a substance, which has not been approved by federal authority.

The Regulatory Process of Chemical Products

While the process for product approval is similar in many ways among the different regulatory bodies, major differences exist dependent on a product's uses, effects, and human or environmental exposures (be they intentional or not). The following is a brief outline of the regulatory process beginning with the requirements for submission, the review process, and post-marketing surveillance. Where they exist, differences have been delineated.

Product Submission

When submitting a product for review, the petitioner must supply the regulatory body with information which includes product specifications (product recipe with chemical and trade names, the amount of each ingredient contained, and details on packaging), product labeling information, justification of functionality, levels of use, effectiveness, and practicality, and the scientific data required for the evaluation of the product with respect to possible adverse effects on human and environmental health.

Product Review

Experts subject the data submitted by the petitioner to review from the responsible regulatory agency. In some cases, where required, a single submission may undergo review by more than one government bureau. It is imperative that the petitioner supplies any deficiencies in information requested by the reviewer. Once all the data for a submission have been reviewed, it is recommended for either advancement or rejection. In the case of pharmaceutical products, once approval has been granted, the petitioner is notified in a Notice of Compliance. In the case of pesticides, the intent of approval is published in Part I of the Canada Gazette for public scrutiny to which interested parties have 60 days to voice their opinions and/or objections to the proposal. In addition, the PMRA publishes their own 'Proposed Regulatory Decision Documents', which are mailed to the appropriate individuals or interest groups and to which a 60-day reply period applies. Comments received from the public are reviewed and may result in alterations to the submission and subsequent reassessment. Announcement of final approval is published in the Canada Gazette (Part II) and thereafter becomes effective for a period of 5 years, after which time the petitioner must reapply for approval.

Post-Marketing Surveillance

In Canada, physicians are required to report adverse drug effects to Health Canada. Based on this feedback, a product may be monitored and, should potential human health hazards of a product be identified, Health Canada in conjunction with the manufacturer would then take the appropriate action to rectify any problems, which may, if warranted, include the removal of the product from the market. Similarly, for food additives or residues, violation of the Food and Drugs Act for these substances can result in the removal of those affected food products from outlets, the seizure of stocks, and the rejection of imports or prosecution. With pesticides, even once registration has been granted, the PMRA continues to monitor these substances and if precipitated by health and safety concerns, the compound will undergo special review and re-evaluation of all available studies/data on the active ingredient and microcontaminants.

If warranted, registration of a pesticide may be canceled or suspended.

Protection Against Toxic Substances

General Environment

Management of Toxic Substances by the Federal Government

The Federal Toxic Substances Management Policy provides the government with a strategy for handling toxic substances both domestically and internationally. The principal objectives of this policy are (i) to eliminate toxic substances resulting from human activity, which are persistent, and bioaccumulate within the environment and (ii) to manage other toxic substances of concern throughout their entire life cycles in order to prevent or minimize their release into the environment.

Access to Health and Safety Information

Although active ingredients of substances must be disclosed in the labeling information, under the Access to Information Law (Chapter A-1 of the *Canadian Statutes*), any formulary information need not be disclosed because it is considered confidential business information. Therefore, any information supplied to the government for regulatory purposes by a petitioner must be kept confidential if it would result in financial, commercial, or scientific interference to that party. Information resulting from government research regarding environmental or product testing may be released if the testing was carried out by, or on behalf of, the government institution, unless the testing was done as a service to a person, group, or organization for a fee. However, proprietary information may be disclosed in the interest of the health and safety of humans and the environment and if such disclosure outweighs the financial loss, gain, or prejudice of the third party.

Work Environment

Under the auspices of the Hazardous Products Act, WHMIS was developed in 1988 to provide information about hazardous materials in the workplace. This system is overseen by both federal and provincial governments and requires suppliers of hazardous materials to supply adequate labeling information to ensure the safe handling of products and a Material Safety Data Sheet (MSDS) containing information as required by the Controlled Products Regulations and the Ingredient Disclosure List (both issued under the Hazardous Products Act) as a condition of the sale and importation of that product. WHMIS also requires that all workers who work with or near a hazardous substance be informed of its potential hazards and trained to work safely with chemicals.

Provincial legislation also plays a role in regulating worker exposure to toxic substances. For example, in Ontario the Occupational Health and Safety Act allow a toxic substance to be 'designated' and its use in the workplace to be either prohibited or strictly controlled. Designation is reserved for substances known to be particularly hazardous, and currently there are 11 such designated substances. This act also allows exposure to biological and chemical agents in the workplace air to be controlled via the adoption of threshold limit values.

Governmental Organizations

Federal Government

Health Canada

Health Canada has five branches and is represented in five Canadian regions: Atlantic, Quebec, Ontario, Manitoba/Saskatchewan, and Pacific West.

Health Protection Branch

Several activities of the Health Protection Branch are closely linked to toxicology. This branch is responsible for programs that ensure the safety of the food supply, pharmaceuticals and cosmetics, medical or radiation-emitting devices, and the environment. It is also expected to protect Canadians from hazardous consumer products and materials in the workplace and technology. It carries out regulatory and field inspections, has surveillance responsibilities, and investigates disease outbreaks and product hazards. To carry out this large mandate the Health Protection Branch is organized into several directorates.

The role of the Environmental Health Directorate is to assess and manage health risks at work and at home, in the natural and technological environments. This directorate is divided into five bureaus: Chemical Hazard, Product Safety, Medical Device, Radiation Protection, and Tobacco Control.

The Bureau of Chemical Hazard is primarily concerned with the effects of chemicals and biological agents in the environment on human health (e.g., hazard identification and risk quantification relating to chemicals and micro-organisms in air, soil, drinking water, and water for recreational uses). This bureau manages health risks through the introduction of regulations, standards, and guidelines. It is organized into four divisions: Environmental and Occupational

Toxicology, Environmental Substances, Monitoring and Criteria, and Bioregional Health Effects. Its programs currently include five major project areas: air quality, water quality, new chemical substances and biotechnology products, environmental contaminants, and bioregional health effects (e.g., Great Lakes Basins, St. Lawrence River region, and the Arctic). The Canadian Environmental Protection Act, the Canadian Environmental Assessment Act, the Department of Health Act, and agreements such as the Great Lakes Water Quality Agreement, the Canada-Ontario agreement, and the Canada/US Clean Air Act Accord mandate these activities.

Product Safety is concerned with the prevention of injury and death caused by failure of consumer products. It is also responsible for the safety of all consumer and workplace chemical products that do not fall under other legislation. The WHMIS is one of the major programs that product safety administers.

Radiation Protection is concerned with radiation risks to humans, including those from medical and industrial X-ray equipment, lasers, ultraviolet radiation from the sun, microwave ovens, airport noise, and power lines and radon in homes. It also manages the Occupational Dosimetry Service and National Dose Registry.

There are three other directorates within the Health Protection Branch (Food, Drug, and Laboratory and Centre for Disease Control). Some of their activities are also concerned with toxicological research and toxicity testing.

Environment Canada

Environment Canada's objective is to foster a national capacity for sustainable development in co-operation with other governments, departments of government, and private sectors that will result in a safe and healthy environment. The Environmental Protection Service Program is responsible for development of strategies for pollution prevention, controlling pollution from existing sources, and assisting in the remediation of polluted sites.

The National Water Research Institute maintains research facilities at the Canada Centre for Inland Waters (867 Lakeshore Rd., Burlington, ON L7R 4A6), which also houses research laboratories of other organizations and departments that are concerned with environmental research and development of the Great Lakes.

Environment Canada also maintains research laboratories at the Bedford Institute of Oceanography (Department of Fisheries and Oceans, Dartmouth, NS), which conduct chemical, toxicological, and microbiological analyses to support the department's environmental protection programs.

Department of Fisheries and Oceans

This department has research facilities throughout Canada and is organized along disciplinary lines into biological sciences, physical and chemical sciences, and hydrography. The physical and chemical sciences also cover toxicology and contaminants science relating to both marine and freshwater environments.

Pacific Region

Institute of Ocean Sciences
J. C. Davis
9860 West Saanich Rd.
Sidney, BC V8L 4B2

Its chemical oceanographic research is directed toward determining the source, distribution, and trends of concentrations of organochlorine, hydrocarbons, and organometallics in marine and freshwater environments to better understand how these pollutants are cycled within marine and freshwater systems.

Central and Arctic Region

Freshwater Institute (regional headquarters for Ontario, the prairie provinces, and the Northwest Territories)
J. Cooley
501 University Crescent
Winnipeg, MN R3T 2N6

It is the major Canadian center for freshwater and Arctic fisheries research, including marine mammals and fish habitat. Its toxicological research includes acidification, radionuleotides, and heavy metal pollution and toxic chemicals.

The Great Lakes Laboratory for Fisheries and Aquatic Sciences (GLLFAS) at the Bayfield Institute
867 Lakeshore Rd.
Box 5050
Burlington, ON L7A 1A6

It is designated as a center of disciplinary expertise for the study of freshwater fisheries contaminants and toxicology. It is involved in ecotoxicology and 'acid rain' studies as well as studies concerning the impacts of dioxins discharged into the aquatic environment from Canadian pulp mills.

Quebec Region

Maurice Lamontagne Institute
850 Route de la Mer

Box 1000
Mont-Joli, QC G5H 3Z4

It is active in investigating pollution of the St. Lawrence river system.

Scotia-Fundy Region
St. Andrews Biological Station
W. Watson-Wright
Brandy Cove Rd.
St. Andrew, NB, E0G 1X1

One of its three primary functions is to study the impacts of human activities on aquatic ecosystems, including the identification of hazards and the effects of pollutants (including acid rain) on fish species and their environments.

Newfoundland Region

Northwest Atlantic Fisheries Centre
L. W. Coady
P.O. Box 5667
St. John's, NF A1C 5X1

Research is focused on major ground fish, marine mammals, and freshwater and anadromorphous species in the Newfoundland-Labrador area. One aspect of the study is concerned with toxicology/contaminants (hydrocarbons and pesticides).

Federal Government Databases

Agriculture and Agri-Food Canada. Environment

Comments: Environmental stewardship is the foundation for the sector's long term health and vitality. Canada's success in agriculture is based on a foundation of industry innovation, scientific research and public policy that encourages farming to be more productive while keeping the land healthy.

Web: http://www.agr.gc.ca/index_e.php?s1=info&s2=t&page=env

Agriculture and Agrifood Canada – Advancing Canadian Agriculture and Agri-Food (ACAAF) program

Comments: The Advancing Canadian Agriculture and Agri-Food (ACAAF) program is a 5-year, $240 million program aimed at positioning Canada's agriculture and agri-food sector at the leading edge to seize new opportunities.

Web: http://www.agr.gc.ca/acaaf/index_e.html

Canadian Food Inspection Agency

Comments: Dedicated to safeguarding food, animals and plants, which enhances the health and well-being of Canada's people, environment and economy.

Web: http://www.inspection.gc.ca/english/toce.shtml

Clean Energy Portal

Comments: This portal offers unique and extensive access to Canada's burgeoning environmental energy sector and up-to-date details on international climate change initiatives.

Web: http://www.cleanenergy.gc.ca/index_e.asp

Environment Canada – National Pollutant Release Inventory

Comments: The National Pollutant Release Inventory (NPRI) is the only legislated, nationwide, publicly accessible inventory of its type in Canada. It is a database of information on annual releases to air, water, land and disposal or recycling from all sectors – industrial, government, commercial, and others.

Web: http://www.ec.gc.ca/pdb/npri/npri_home_e.cfm

Environment Canada – Canadian Environmental Sciences Network

Comments: The Canadian Environmental Sciences Network is developing as a means for rejuvenating the Canadian environmental sciences community and increasing its cohesion. CESN aims to build on current areas of environmental networking in Canada, using a 'network of networks' approach, to increase communication and develop a sense of collective direction.

Web: http://www.cesn-rcse.ec.gc.ca/

Environment Canada – Canadian Wildlife Service

Comments: The dangers of pesticides and acid rain have become all too familiar to Canadians. Not surprisingly, the threat is no less serious to wildlife. Chemical contamination of wildlife populations provides a useful indication of the overall health of the environment.

Therefore, wildlife biologists monitor the effects of toxic chemicals entering ecosystems through such human activities as agriculture, industry, forestry, and urbanization.

Web: http://www.cws-scf.ec.gc.ca/focus_e.cfm#targ7

Environment Canada – CEPA Environmental Registry

Comments: The CEPA Environmental Registry is a comprehensive source of public information relating to activities under the Canadian Environmental Protection Act, 1999 (CEPA 1999).

Web: http://www.ec.gc.ca/CEPARegistry/

Environment Canada – Clean Air Online

Web: http://www.ec.gc.ca/cleanair-airpur/Home-WS8C3F7D55-1_En.htm

Environment Canada – EcoAction

Comments: Since 1995, Environment Canada's EcoAction Community Funding Program has provided financial support to community groups for projects that have measurable, positive impacts on the environment. Funding support can be requested for projects that have an action focus, a community capacity building focus, or a combination of both objectives.

Web: http://www.ec.gc.ca/ecoaction/index_e.html

Environment Canada – Freshwater website

Web: http://www.ec.gc.ca/water/e_main.html

Environment Canada – Management of Toxic Substances website

Web: http://www.ec.gc.ca/toxics/en/index.cfm

Environment Canada – National Air Pollution Surveillance Network (NAPS)

Comments: The National Air Pollution Surveillance (NAPS) Network was established in 1969 as a joint program of the federal and provincial governments to monitor and assess the quality of the ambient air in Canadian urban centers.

Web: http://www.etc-cte.ec.gc.ca/NAPS/index_e.html

Environment Canada – National Office of Pollution Prevention (NOPP)

Comments: Environment Canada's focal point for the management of toxic substances, implementation of federal pollution prevention policy and legislation, and the development of new concepts and policy instruments that facilitate the transition to pollution prevention in Canada.

Web: http://www.ec.gc.ca/NOPP/EN/index.cfm

Environment Canada – National Pollutant Release Inventory

Comments: The NPRI Communities portal is part of the NPRI website. The community's portal is being created to help the public understand, access, and interpret the information contained in the NPRI and use it to make important decisions related to their health, environment, economy, government, and quality of life.

Web: http://www.ec.gc.ca/npri-inrp-comm/default.asp?lang=en&n=57708B50-1

Environment Canada – State of the Environment (SOE) InfoBase

Comments: The State of the Environment (SOE) InfoBase, administered by the Knowledge Integration Strategies Division, presents Environment Canada's work on state of the environment reporting and environmental indicators-designed to translate science and data into information and knowledge that can be used.

Web: http://www.ec.gc.ca/soer-ree/English/default.cfm

Environment Canada – Toxic Substances Division

Comments: The Toxic Substances Division (TSD) provides scientific and technical expertise in a variety of program areas relating to toxic substances. Areas of expertise include: risk assessment, chemical toxicity evaluations, environmental effects, chemistry, biology, compliance promotion, and laboratory analysis.

Web: http://www.mb.ec.gc.ca/pollution/e00s26.en.html

Environment Canada – The Green Lane

Comments: Environment Canada's Internet resource for weather and environmental information.

Web: http://www.ec.gc.ca/envhome.html

Fisheries and Oceans Canada – Center for Aquaculture and Environmental Research

Comments: The Center for Aquaculture and Environmental Research is a specialized center for aquaculture and coastal research.

Web: http://www-sci.pac.dfo-mpo.gc.ca/sci/facilities/westvan_e.htm

Government of Canada – Chemical Substances – Chemical Management Plan

(An ecoACTION Initiative)

Web: http://www.chemicalsubstanceschimiques.gc.ca/en/index.html

Government of Canada's Chemicals Management Plan will improve the degree of protection against hazardous chemicals exposure among Canadians. A number of new, proactive measures were included under this plan to ensure that chemical substances are managed properly. By taking action now will significantly reduce future costs associated with water treatment, clean-up of contaminated sites, and treating illnesses related to chemical exposure. It will improve Canadians' quality of life, and better protect Canadian environment. This plan will improve the conditions for business in Canada by ensuring a level playing field and a predictable, science-based regulatory regime. This new plan will build on Canada's position as a global leader in the safe management of chemical substances and products. It will marshal new and better science to improve the assessment and mitigation of risks. Further, it will provide Canadian families with better information about the safe use and disposal of a range of everyday products excerpted from (http://www.chemicalsubstanceschimiques.gc.ca/plan/index_e.html).

Health Canada – Consumer Product Safety

Comments: Health Canada helps protect the Canadian public by researching, assessing and collaborating in the management of the health risks and safety hazards associated with the many consumer products, including pest management products, that Canadians use everyday.

Web: http://www.hc-sc.gc.ca/cps-spc/index_e.html

Health Canada – Environmental and Workplace Health

Comments: The environment, including the workplace, has an important impact on a person's health. Health Canada works to protect the health of Canadians from environmental risks.

Web: http://www.hc-sc.gc.ca/ewh-semt/index_e.html

Health Canada – Environmental Contaminants Bureau

Comments: The Environmental Contaminants Bureau collects, generates and analyzes scientific information for assessing the human health risks posed by air pollutants, commercial chemicals and other substances that contaminate the environment.

Web: http://www.hc-sc.gc.ca/ahc-asc/branch-dirgen/hecs-dgsesc/sep-psm/ecb-bce/index_e.html

Health Canada – Environmental Health Assessment Services

Web: http://www.hc-sc.gc.ca/home-accueil/contact/hecs-dgsesc/ehas-sese_e.html

Health Canada – Pest Management Regulatory Agency

Comments: Health Canada's Pest Management Regulatory Agency (PMRA), is the federal agency responsible for the regulation of pest control products in Canada.

Web: http://www.pmra-arla.gc.ca/english/index-e.html

Health Canada – Product Safety Programme

Comments: The Product Safety Programme (PSP) assists in the protection of Canadians by researching, assessing and collaborating in the management of the health risks and safety hazards associated with issues such as: children's products, household products (including household chemical products), cosmetics (including personal care products), new chemical substances, products of biotechnology, workplace chemicals, radiation-emitting devices, noise, ultraviolet (UV) radiation, Globally Harmonized System of Classification (GHS).

Web: http://www.hc-sc.gc.ca/ahc-asc/branch-dirgen/hecs-dgsesc/psp-psp/index_e.html

Health Canada – Toxicology Research Division

Comments: The Divisions uses toxicology research methods to identify and characterize food-based human health hazards.

Web: http://www.hc-sc.gc.ca/ahc-asc/branch-dirgen/hpfb-dgpsa/fd-da/ bcs-bsc/tr-rt/index_e.html

Health Canada – Workplace Hazardous Materials Information System

Web: http://www.hc-sc.gc.ca/ewh-semt/occup-travail/whmis-simdut/index_e.html/msds.htm

Industry Canada – Environment

Comments: The Environment section contains various websites dealing with all aspects of the environment including eco-efficiency, sustainable development, and climate change.

Web: http://www.ic.gc.ca/cmb/welcomeic.nsf/ICPages/SubjectEnvironment

National Research Council Canada – Institute for Chemical Process and Environmental Technology (ICPET)

Comments: With its partners, NRC-ICPET contributes to increasing the competitiveness of Canada's chemistry intensive industries through research into innovative processes and technologies that enable sustainable development.

Web: http://icpet-itpce.nrc-cnrc.gc.ca/research.html

Office of the Auditor General of Canada – Commissioner of the Environment and Sustainable Development

Comments: The Commissioner provides parliamentarians with objective, independent analysis and recommendations on the federal government's efforts to protect the environment and foster sustainable development. Encouraging the government to be more accountable for greening its policies, operations, and programs is a key to the Commissioner's mandate.

Web: http://www.oag-bvg.gc.ca/domino/cesd_cedd.nsf/html/cesd_index_e.html

The Hazardous Materials Information Review Commission (HMIRC)

Comments: The Workplace Hazardous Materials Information System (WHMIS) is Canada's national hazard communication standard. The key elements of the system are cautionary labeling of containers of WHMIS 'controlled products', the provision of material safety data sheets (MSDSs) and worker education and training programs.

Web: http://www.hmirc-ccrmd.gc.ca/english/index.shtml

Provincial Governments

Alberta

Agriculture Alberta – Agri-Food Laboratories Branch

Comments: The primary purpose of the laboratory is to enable the growth of Alberta's agriculture and food industry. The focus is on food safety and the support of Food Safety Division Programs, through applied research, technology development and technology transfer.

Web: http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/afla4271

Alberta Environment

Web: http://environment.gov.ab.ca/default.aspx

Environment Alberta Information Centre

Web: http://www.environment.gov.ab.ca/info/home.asp

Alberta Employment, Immigration and Industry

Web: http://employment.alberta.ca/cps/rde/xchg/hre/hs.xsl/563.html

Alberta Workplace Health and Safety Publications

Web: http://employment.alberta.ca/cps/rde/xchg/hre/hs.xsl/136.html

Work Safe Alberta – Chemical Hazards

Web: http://www.hre.gov.ab.ca/whs/network/hstopics/chemical/index.asp

British Colombia

Ministry of Agriculture and Lands. Pesticide Wise

Comments: Information for ranchers, farmers, growers, crop consultants, pest managers, and horticulturalists about the safe use of pesticides in BC.

Web: http://www.agf.gov.bc.ca/pesticides/index.htm

Ministry of Environment – Environmental Protection Division

Comments: The Environmental Protection Division (EPD) of the Ministry of Environment works to protect human and environmental health. Its main goals are to: improve air quality; reduce greenhouse gas emissions; redevelop a provincial plan for reducing and removing toxins and waste that contaminate the land, air and water – and for responding to high-risk environmental emergencies; and enhance environmental stewardship, shared with other stakeholders.

Web: http://www.env.gov.bc.ca/epdiv/

Manitoba

Contaminated-Impacted Sites Program

Comments: The purpose of the program is to administer The Contaminated Sites Remediation and Consequential Amendments Act (CSRA).

Web: http://www.gov.mb.ca/conservation/envprograms/contams/index.html

Environmental Assessment and Licensing Branch

Comments: To ensure that development maintains sustainable environmental quality and to ensure that water and wastewater facilities are operated by competent and trained operators.

Web: http://www.gov.mb.ca/conservation/envapprovals/contact.html

Manitoba Conservation – Air Quality Section

Web: http://www.gov.mb.ca/conservation/airquality/aq-management/index.html

Manitoba Conservation – Pollution Prevention Branch

Comments: The Pollution Prevention Branch promotes and regulates pollution prevention initiatives, and supports these initiatives through grant-funding programs.

Web: http://www.gov.mb.ca/conservation/pollutionprevention/index.html?

Manitoba Health – Environmental Health Risk Assessment Team

Comments: The Environmental Health Risk Assessment Team provides leadership to identify, assess, and address important and emerging environmental health issues to reduce the threat of environmental public health risks and protect the health of Manitobans.

Web: http://www.gov.mb.ca/health/publichealth/environmentalhealth/risk.html

Manitoba Water Stewardship

Web: http://www.gov.mb.ca/waterstewardship/index.html

Onsite Wastewater Management Systems Program

Comments: The purpose of the program is to administer the Onsite Wastewater Management Systems Regulation pursuant to The Environment Act.

Web: http://www.gov.mb.ca/conservation/envprograms/wastewater/index.html

Ontario

Ministry of the Environment – Industrial Pollution Action Team

Comments: The Industrial Pollution Action Team examines the causes of industrial spills and dangerous air emissions and recommend to the government prevention measures for industry and others.

Web: http://www.ene.gov.on.ca/envision/news/2004/041902mb.htm

Ministry of the Environment

Comments: The Ministry of the Environment (MOE) sets environmental quality standards to protect human and ecosystem

health, prevent damage to the physical environment and minimize offensive odors.

Web: http://www.ene.gov.on.ca/envision/env_reg/er/documents/2000/pa9e0004.htm

Pesticides Advisory Committee

Web: http://www.opac.gov.on.ca/

Quebec

Most of the following database are in French, in some case they are also available in English.

Bureau d'audiences publiques sur l'environnement (BAPE)

Comments: The Bureau d'audiences publiques sur l'environnement (BAPE) is a body dedicated to public information and consultation on projects likely to have a major impact on the environment or any other question related to the quality of the environment. The BAPE is the gateway for citizens to get involved in projects authorization process.

Web: http://www.bape.gouv.qc.ca/

Centre d'expertise en analyse environnementale (CEAEQ)

Comments: The Centre d'expertise en analyse environnementale du Québec (CEAEQ) is an agency of the Ministère du Développement durable, de l'Environnement et des Parcs, which provides specialized services pertaining to various aspects of environmental analysis (laboratory analyses, accreditation, ecotoxicological studies and field surveys).

Web: http://www.ceaeq.gouv.qc.ca/index.htm

Centre d'expertise hydrique (CEHQ)

Comments: The Centre d'expertise hydrique du Québec (CEHQ) is an agency of the Ministère du Développement durable, de l'Environnement et des Parcs created in April 2001. The CEHQ is continuously evolving, to stay at the leading edge of knowledge in the fields of dams, water regime and public water resources.

Web: http://www.cehq.gouv.qc.ca/

Centre de contrôle environnemental

Web: http://www.mddep.gouv.qc.ca/ministere/modernisation/

CSST – Service du répertoire toxicologique (Toxicological Index)

Comments: The mandate of the Service du répertoire toxicologique of the Commission de la santé et de la sécurité du travail (CSST) is to provide information on chemical or biological products used in the workplace.

Web: http://www.reptox.csst.qc.ca/EtPlusEncore.htm

Ministère du développement durable, Environnement et Parcs

Comments: The mission of the Ministère du Développement durable, de l'Environnement et des Parcs is to protect the environment and natural ecosystems for the benefit of current and future generations.

Web: http://www.mddep.gouv.qc.ca/ministere/inter.htm

Québec. Institut national de santé publique (INSPQ)

Comments: The Institut national de santé publique du Québec (INSPQ) is a government organization founded in 1998 to improve the coordination, development and use of expertise in public health.

Web: http://www.inspq.qc.ca/

Recyc-Québec

Web: http://www.recyc-quebec.gouv.qc.ca/client/fr/accueil.asp

Santé et services sociaux

Web: http://www.msss.gouv.qc.ca/sujets/santepub/environnement/index.php?accueil

Source d'inf ormation sur les organismes génétiquement modifiés

Web: http://www.ogm.gouv.qc.ca/index.htm

Scientific Societies

Canadian Association of Poison Control Centers
Secretary Treasurer: P. Gaudreault
Hospital Sainte-Justine
3175 Cote Sainte-Catherine
Montreal, QC H3T 1C5

Canadian Society of Forensic Science
Suite 215
2660 Southvale Crescent
Ottawa, ON K1B 4W5

Society of Toxicology of Canada
Executive Director, G. Krip
P.O. Box 517
Beaconfield, QC H9W 5V1

This is a society of approximately 500 members from academia, government, and industry. It holds its annual meeting and scientific symposium in December, normally in Montreal.

Toxicology Education and Schools

Several Canadian universities offer programs in toxicology at the graduate (MSc and PhD) and/or undergraduate levels. In addition, many schools offer postgraduate diploma programs in toxicology composed of coursework only, whereas others offer programs, which although are not toxicology per se emphasize toxicology in their multidisciplinary programs. These schools, per province, are listed below with the different programs, some explanations regarding especially the aim of the program if available and/or either a contact person or a website to refer to.

Programs in Toxicology

Alberta
University of Calgary
Department of Pharmacology & Therapeutics
Division of toxicology
M.Sc. and Ph.D. in Medical Sciences
University of Calgary, Faculty of Medicine, Department of Pharmacology & Therapeutics,
3330 Hospital Drive NW, Calgary AB T2N 4N1
D. L. Severson
Professor and Head

British Columbia
University of British Columbia
Faculty of Pharmaceutical Sciences
Drug metabolism, Pharmacokinetics and Toxicology
MSc and PhD
2146 East Mall
Vancouver, BC V6T 1Z3
Graduate program Phone: 604-822-2390
Fax: 604-822-3035
Web: www.pharmacy.ubc.ca./research/research_areas_pages_/drug_metabolism.html

The goals of the Drug Metabolism, Pharmacokinetics, and Toxicology group are to pursue research and training in the areas of drug disposition (absorption, distribution, metabolism and excretion) and in clarifying the relationship between pharmacokinetics and drug toxicity.

Simon Fraser University
Environmental Toxicology Program
Department of Biological Sciences
8888 University Drive, Burnaby, B.C. Canada V5A 1S6
Dr. Chris Kennedy, Associate Professor
Aquatic Toxicology
Phone: 604-291-5640
Email: ckennedy@sfu.ca

Master's of Environmental Toxicology Program

Simon Fraser University developed the Master of Environmental Toxicology (MET) program due to the increasing amount of damage that is inflicted on our environment (such as air pollution, mercury levels in fish, etc.). At the inception of the ET program at SFU, there were very few formalized toxicology training programs in Canada. At the present, the Universities of Toronto, Guelph, Saskatchewan, and Montreal offer a Master of Science and/or Doctorate in Toxicology.

A Coop option is available to MET students in which students complete two semesters of Coop during their studies.

Web: www.sfu.ca/biology/dept/resgroup.html

Undergraduate Programs in Toxicology or Diploma in Environmental Toxicology

Sub disciplines: Environmental, biochemical, and ecotoxicology

Dr. F. Law
Environmental Toxicology Program
Department of Biological Sciences
Burnaby, BC V5A 1S6
Phone: 604-291-4285
Fax: 604-291-3496
Email: f_law@sfu.ca

Newfoundland
Memorial University of Newfoundland
MSc in Toxicology
Dr. Chris Parrish, Chair of the program
Environmental Science Program
Dean of Science Office
Memorial University of Newfoundland
St. John's, NL Canada A1B 3X7
Phone: (709) 737-8154
Fax: (709) 737-3316
Email: cparrish@mun.ca
Web: www.mun.ca/sciences/envs/Faculty.php

Nova Scotia
Dalhousie University
MSc in Pharmacology; MSc in Biology; MES in Environmental Toxicology
Sub disciplines: Environmental toxicology, pharmacology, and biology

Dr. R. P. Côté
School for Resource and Environmental Studies
1312 Robie St.
Halifax, NS B3H 3E2
Phone: 902-494-3632
Fax: 902-494-3728
Email: SRES@ac.dal.ca

Ontario
University of Guelph
MSc and PhD in Toxicology
Sub disciplines: Nutritional, chemical, wildlife, environmental, and biomedical toxicology
Dr. N. Bunce
Department of Chemistry and Biochemistry
University of Guelph
Guelph, ON N1G 2W1
Phone: 519-824-4120, ext. 3962
Fax: 519-766-1499
Email: bunce@chembio.uoguelph.ca

The University of Guelph hosts the headquarters of the Canadian Network of Toxicology Centres (http://www.uoguelph.ca/cntc/). CNTC is a nationwide research network in toxicology, funded by the Canadian federal government, and having three 'nodes', at Guelph, Montreal, and Saskatoon.

Web: http://www.uoguelph.ca/graduatestudies/calendar/gradprog/tox-courses.shtml

Undergraduate in Toxicology
BSc (Hons) Toxicology; BSc (Hons) Biomedical Toxicology; BSc (Hons) Environmental Toxicology
Sub disciplines: Nutritional, chemical, wildlife, environmental, and biomedical toxicology
Dr. N. Bunce
Department of Chemistry and Biochemistry
University of Guelph
Guelph, ON NIG 2W1
Phone: 519-824-4120, ext. 3962
Fax: 519-766-1499
E-mail: bunce@chembio.uoguelph.ca
Web: http://www.uoguelph.ca/undergrad_calendar/c10/c10bsc-btox.shtml

Queen's University
MSc and PhD in Pharmacology and Toxicology
Sub discipline: Biomedical toxicology
Dr. Thomas E. Massey
Department of Pharmacology and Toxicology
Kingston, ON K7L 3N6
Phone: 613-545-6115
Fax: 613-545-6412
Email: phardept@queensu.ca
Undergraduate program in Pharmacology and Toxicology
BSc (Hons) Pharmacology and Toxicology
Sub disciplines: Environmental and life sciences
Dr. Thomas E. Massey
Department of Pharmacology and Toxicology
Kingston, ON K7L 3N6.
Phone: 613-545-6115
Fax: 613-545-6412
Email: phardept@qucdn.queensu.ca

University of Toronto
MSc and PhD in Toxicology
Sub disciplines: Biomedical and environmental toxicology

Dr. A. V. Rao, Chair
Collaborative Program in Toxicology
33 Willcocks St. #1016
Toronto, ON M5S 3E8
Phone: 416-978-7077
Fax: 416-978-3884

Undergraduate Studies in Pharmacology & Toxicology
Department of Pharmacology
Faculty of Medicine
Undergraduate Office
Medical Sciences Building
Room 4207
Toronto, Ontario
M5S 1A8
Phone: 416-978-2728
Fax: 416-978-6395

Clinical Pharmacology and Toxicology
Dr. Shinya Ito-Division Head
Email: shinya.ito@sickkids.ca
Telephone: (416) 813-5776
Mailing Address:
The Hospital for Sick Children
Division of Clinical Pharmacology and Toxicology
555 University Avenue
Toronto, Ontario
M5G 1X8

Collaborative Program in Biomedical Toxicology

The Biomedical Toxicology Program is a collaborative degree. Students interested in enrolling in Biomedical Toxicology must meet all of the admission criteria for a collaborative degree. The following participate in the Collaborative Program in Biomedical Toxicology:

University of Western Ontario
MSc and PhD in Pharmacology and Toxicology
BSc (Hons)

Home department	Address	Graduate co-ordinator	Graduate administrator
Laboratory Medicine & Pathobiology	Banting Institute, 100 College St.	Prof. H. Elsholtz 978-8782	Ms M. Michael 978-2550
Medical Science	Room 7213, Medical Sciences Bldg.	Prof. M. Liu 978-5012	Ms J. Chapman 978-8886
Nutritional Sciences*	Room 316 Fitzgerald Bldg.	Prof. V. Tarasuk 978-6071	Ms G. Lim 978-6071
Pharmacology*	Room 4207 Medical Sciences Bldg.	Prof. D. Riddick 978-0813	Ms D. Clark 978-5244
Pharmaceutical Sciences*	Room 413 19 Russell Street	Prof. D. Hampson 978-4494	Ms E. Boddie 978-2179
Zoology	Room 426 Ramsay Wright Bldg.	Prof. Don Jackson 978-3496	Ms J. Valotta 978-3477

*Part-time degree programs are available.

Sub disciplines: Pharmacology, molecular, nutritional, and environmental toxicology
Dr. J. R. Bend
Department of Pharmacology and Toxicology
Medical Sciences Building
Rm 275
London, ON N6A 5C1
Phone: 519-661-3312
Fax: 519-661-4051
Email: jbend@julian.uwo.ca

Trent University
MSc and PhD in Watershed Ecosystems
Sub discipline: Environnemental toxicology
Dr. Chris D. Metcalfe
Environmental and Resource Studies
Peterborough, ON K9J 7B8
Phone: 705-748-1272
Fax: 705-748-1569
Email: cmetcalfe@trentu.ca

Environmental & Resource Science/Studies
Chair of the Program
R. C. Paehlke, Ph.D
Telephone: (705) 748-1011 ext. 1261
Email: ers@trentu.ca
Fax: (705) 748-1569
Web: www.trentu.ca/ers

University of Waterloo
MSc and PhD in Biology
Sub discipline: Environnemental toxicology
Dr. W. D. Taylor
Department of Biology
Waterloo, ON N2L 3G1
Phone: 519-888-4567, ext. 2556
Fax: 519-746-0614
Email: wdtaylor@sciborg.uwaterloo.ca
Jennifer Lehman, Graduate Coordinator

Québec
Université de Montréal

MSc, PhD and Diploma in Toxicology
Sub disciplines: Human health and environmental quality
Chair
Dr. Michel Gérin
2910 Edouard-Montpetit, app. 1
P.O. Box 6128, Succ. Centre-ville
Montréal, QC H3C 3J7
Phone: 514-343-6134
Fax: 514-343-2200

MSc, PhD as per participating departments
Sub disciplines: Industrial, environmental, and ecotoxicology
P.O. Box 6128
Succursale Centre-ville
Montréal, QC H3C 3J7

Participating departments:
Occupational and Environmental Health
Dr. Michel Gérin
Phone: 514-343-6134

Community Health: Environmental Toxicology
Dr. Michel Gérin
Phone: 514-343-6134

Pharmacology
Dr. Mahmoud Sharkawi
Phone: 514-343-6338

Nutrition
Dr. Emile Lévy
Phone: 514-345-4626

Biological Sciences
Dr. Raymond McNeil
Phone: 514-343-6878
Certificate in Eco-Industrial Toxicology

Sub disciplines: Industrial and environmental toxicology
Mrs. Elisabeth Lalague

Faculté de l'éducation permanente
P.O. Box 6128, Succ. Centre-ville
Montréal, QC H3C 3J7
Phone: 514-343-6982

Université Laval
Experimental Medicine program
MSc and PhD in Experimental Medicine
Sub disciplines: Pharmacology and toxicology
Dr. Bao-Linh Dinh
Faculty of Medicine
Sainte-Foy, QC G1K 7P4
Phone: 418-656-5533
Fax: 418-656-2189
Web: http://www.reg.ulaval.ca/admission/Admission2.html (Québec student)
Web: http://www.reg.ulaval.ca/admission/AdmissionExt2.html (student from outside Quebec)

McGill University
MSc and PhD in Pharmacology
Sub disciplines: Reproductive and chemical toxicology
Chairman, Graduate Training Committee
Department of Pharmacology and Therapeutics
McIntyre Medical Sciences Building
3655 Promenade Sir-William-Osler,
Room 1325,
Montréal, Québec,
Canada H3G 1Y6
Office: (514) 398-3623
Fax: (514) 398-6690
Web: www.mcgill.ca

Université du Québec à Montreal
MSc and PhD
TOXEN—Department of Biological Sciences
P.O. Box 8888, Succ. Centre-ville
Montréal, QC H3C 3P8
Phone: 514-987-7026
Fax: 514-987-4647

Chair
Dr Popovic Radovan
Department of chemistry
CB-2320
(514) 987-3000 ext:8467
Fax: (514) 987-4054
Email: Popovic.radovan@uqam.ca

Saskatchewan
University of Saskatchewan
MSc and PhD in Toxicology
Sub disciplines: Pharmacology, environmental, biochemical, clinical, and nutritional toxicology
Dr. C. S. Sisodia
Coordinator, Academic Programs in Toxicology
1301 W.C.V.M., 52 Campus Drive
Saskatoon, SK S7N 5B4
Phone: 306-966-7371
Fax: 306-966-7376

Interdisciplinary Graduate and Undergraduate Program in Toxicology
Department of Veterinary Biomedical Sciences
Western College of Veterinary Medicine
University of Saskatchewan
52 Campus Drive
Saskatoon, Saskatchewan S7N 5B4, Canada

Dr. Barry Blakley
Department Head
Phone: 306-966-7350
Fax: 306-966-7376
Email: barry.blakley@usask.ca

Dr. Gillian Muir
Graduate Chair
Phone: 306-966-7353
Fax: 306-966-7376
Email: gillian.muir@usask.ca

Toxicology Centre
University of Saskatchewan
44 Campus Drive
Saskatoon, Saskatchewan S7N 5B3
Canada
Phone: (306) 966-7441; 966-7442
Fax: (306) 931-1664
Email: tox.centre@usask.ca

Director
Dr. K.L. Liber
Phone: (306) 966-7441
Email: karsten.liber@usask.ca

Graduate coordinator
Dr. B. Blakley
Phone: (306) 966-7350
Email: barry.blakley@usask.ca

Undergraduate contacts
Diane Favreau
Coordinator, Interdisciplinary Programs
College of Arts & Science
Phone: (306) 966-4288
Email: diane.favreau@usask.ca

Dr. M. Wickstrom
Academic Advisor, Toxicology Program
Phone: (306) 966-7446
Email: mark.wickstrom@usask.ca

Undergraduate program
Diploma in Toxicology

Sub disciplines: Analytical, nutritional, environmental, and medical toxicology
Dr. C. S. Sisodia
Coordinator, Academic Programs in Toxicology
1301 W.C.V.M., 52 Campus Dr.
Saskatoon, SK S7N 5B4
Phone: 306-966-7371
Fax: 306-966-7376

Poison Control Centers

The following list represents current contact information for poison control centers across Canada as provided by the Canadian Association of Poison Control Centres web site (December 2006).

Alberta

Poison and Drug Information Service (PADIS)
Foothills Medical Centre North Tower
1403 29th Street, N.W., Room 805
Calgary, Alberta T2N 2T9
Canada
Emergency Phone: (Calgary) (403) 944-1414
Emergency Phone: (Alberta wide toll free) (800) 332-1414
Administrative Phone: (403) 944-6900
Fax: (403) 944-1472
Web: http://www.padis.ca/

British Columbia

B.C. Drug and Poison Information Centre
St. Paul's Hospital
1081 Burrard St.
Vancouver, BC V6Z 1Y6
1-800-567-8911 (toll free B.C.)
(604) 682-5050 (Lower Mainland)
(604) 682-2344 ext. 62126 general inquiries
Fax: (604) 806-8262
Email: daws@dpk.bc.ca

Manitoba

Provincial Poison Information Centre
Children's Hospital Health Sciences Centre
840 Sherbrook St.
Winnipeg, MB R3A 1S1
(204) 787-2591 emergency inquiries
(204) 787-2444 general inquiries
Fax: (204) 787-4807
Email: mtenenbein@hsc.mb.ca

New Brunswick

Poison Control Centre
The Moncton Hospital
135 McBeath Ave.
Moncton, NB E1C 6Z8
(506) 857-5555 emergencies
(506) 857-5353 general inquiries
Fax: (506) 857-5360

Emergency Department, Saint John Regional Hospital
P.O. Box 2100
Saint John, NB E2L 4L2
Phone: (506) 648-6222 (local)
Fax: (506) 648-6901

Newfoundland and Labrador

Provincial Poison Control Centre
The Dr. Charles A. Janeway Child Health Centre
710 Janeway Place
St. John's, NF A1A 1R8
Phone: (709) 722-1110
Fax: (709) 726-0830

Northwest Territories

Emergency Department
Stanton Yellowknife Hospital
550 Byrne Road
Yellowknife, NT X1A 2N1
Phone: (867) 669-4100
Fax: (867) 669-4128
Web: http://www.srhb.org/

Nova Scotia

Poison Control Centre
The Izaak Walton Killam Children's Hospital
5850 University Ave.
Halifax, NS B3J 3G9
Phone: (902) 428-8161(local)
Fax: (902) 428-3213
1-800-565-8161 toll free from P.E.I.

Nunavut

Baffin Regional Hospital
P.O. Bag 200
Iqaluit, NU X0A 0H0
(867) 979-7350 emergencies
(867) 979-4422 ambulance
(867) 979-7300 general inquiries

Cambridge Bay (Ikaluktutiak) Health Centre
X0E 0C0
Phone: (867) 983-2531

Rankin Inlet (Kangiqliniq) Health Centre
X0C 0G0
Phone: (867) 645-2816

Ontario

Ontario Regional Poison Information Centre
Children's Hospital of Eastern Ontario
401 Smyth Road
Ottawa, ON K1H 8L1
1-800-267-1373 English-French, toll-free Ontario
(613) 737-1100 emergency inquiries
(613) 737-2320 general inquiries
Fax: (613) 738-4862

Ontario Regional Poison Information Centre
The Hospital for Sick Children
555 University Ave.
Toronto, ON M5G 1X8
1-800-268-9017 (toll-free Ontario)
(416) 813-5900 local
Fax: (416) 813-7489
Email: margaret.thompson@sickkids.ca
Web: http://www.sickkids.on.ca/poison/

Prince Edward Island

Poison Control Centre
The Izaak Walton Killam Children's Hospital
5850 University Ave.
Halifax, NS B3J 3G9
Phone: 1-800-565-8161 (toll free from P.E.I.)

Québec

Centre antipoison du Québec
Le Centre Hospitalier de l'Université Laval
2705 boul. Laurier
Sainte-Foy, QC G1V 4G2
1-800-463-5060 (Québec only)
(418) 656-8090
Fax: (418) 654-2747
Email: capq@chul.ulaval.ca

Saskatchewan

Emergency Department
Regina General Hospital
1440 14th Ave.
Regina, SK S4P 0W5
1-800-667-4545
(306) 766-4545
Fax: (306) 766-4357

Emergency Department
Royal University Hospital
103 Hospital Drive
Saskatoon, SK S7N 0W8
1-800-363-7474
(306) 655-1362 emergencies
(306) 655-1011 (fax)
(306) 655-1010 general inquiries

Yukon

Emergency Department
Whitehorse General Hospital
5 Hospital Road
Whitehorse, YT Y1A 3H7
Phone: (403) 667-8726
Fax: (403) 667-2471

NGOs

Biocap Canada

Comments: BIOCAP is Capturing Canada's Green Advantage by building research partnerships to encourage productive, competitive and sustainable methods for using our country's biological capital to create clean, sustainable forms of energy, fight climate change and encourage rural economic development.

Web: http://www.biocap.ca/

Board of Canadian Registered Safety Professionals

Web: http://www.acrsp.ca/

Canada's National Certification Body for Environmental Practitioners (CECAB)

Comments: The Canadian Environmental Certification Approvals Board (CECAB) is responsible for the certification of environmental practitioners in Canada.

Web: http://www.cecab.org/

Canada's National Occupational Health and Safety Web Site (CANOSH)

Comments: Enabling Canadians to easily and independently locate occupational health and safety information provided by the federal, provincial and territorial governments of Canada and by the Canadian Centre for Occupational Health and Safety (CCOHS).

Web: http://www.canoshweb.org/

Canadian Association for Research on Work and Health (CARWH)

Web: http://www.workhealth.ca/

Canadian Centre for Occupational Health and Safety (CCOHS)

Comments: CCOHS promotes a safe and healthy working environment by providing information and advice about occupational health and safety.

Web: http://www.ccohs.ca/

Canadian Centre for Pollution Prevention (C2P2)

Comments: To share knowledge, tools and innovative thinking with business, governments, academia, individuals and organizations in order to catalyze behavioral change leading to more sustainable practices, increased competitiveness, and a healthier environment.

Web: http://www.c2p2online.com/index.php3?session =

Canadian Federation of Biological Societies

Comments: The Canadian Federation of Biological Societies is a research consortium representing Canadian Biological and Biomedical professional associations founded in 1957 to promote the acquisition, facilitate the dissemination and encourage the utilization of knowledge in the Biomedical/Life Sciences.

Web: http://www.cfbs.org/

Canadian Institute for Health Information (CIHI)

Comments: The Canadian Institute for Health Information (CIHI) provides timely, accurate and comparable information.

Web: http://secure.cihi.ca/cihiweb/splash.html

Canadian Institutes of Health Research (CIHR)

Comments: Canadian Institutes of Health Research (CIHR) is the major federal agency responsible for funding health research in Canada. It aims to excel in the creation of new health knowledge, and to translate that knowledge from the research setting into real world applications.

Web: http://www.cihr-irsc.gc.ca/e/193.html

Canadian Network of Toxicology Centres

Comments: The Canadian Network of Toxicology Centres (CNTC) was formed in 1988 by the signing of a Memorandum of Understanding by three existing centers: the Centre for Toxicology at the University of Guelph, the Toxicology Research Centre at the University of Saskatchewan, and the Centre interuniversitaire de recherche en toxicologie de l'Université de Montréalet de l'Université du Québec à Montréal. These centres became the 'nodes' of the CNTC.

Web: http://www.uoguelph.ca/cntc/

Canadian Neurotoxicity Information Network

Comments: The Canadian Neurotoxicity Information Network is a non-profit organization dedicated to providing important health information to those suffering from symptoms of the disease.

Web: http://www3.sympatico.ca/cnin/

Canadian Pharmacists Association

Comments: The Canadian Pharmacists Association is the national organization of pharmacists, committed to providing leadership for the profession of pharmacy. CPhA's website is your link to a comprehensive source of drug information, pharmacy practice support material, patient information and news about the world of pharmacists.

Web: http://www.pharmacists.ca/flash.cfm

Canadian Radiation Protection Association

Comments: The Canadian Radiation Protection Association is a professional organization that supports the development and implementation of radiation safety programs in industry, medicine, research and the environment through scientific inquiry, public involvement and interaction with local, provincial, federal, and international authorities.

Web: http://www.crpa-acrp.ca/en/news.php

Canadian Registration Board of Occupational Hygienists

Comments: The CRBOH is a national, not-for-profit organization, which sets standards of

professional competence for occupational hygienists and occupational hygiene technologists in Canada.

Web: http://www.crboh.ca/page.cfm?onumber=1

Canadian Water Network

Comments: The Canadian Water Network/Réseau canadien de l'eau (CWN/RCE) is a federally funded Network of Centres of Excellence.

Web: http://www.cwn-rce.ca/

Clean Air Strategic Alliance

Comments: The Clean Air Strategic Alliance (CASA) was established in March 1994 as a new way to manage air quality issues in Alberta.

Web: http://www.casahome.org/

David Suzuki Foundation

Comments: Since 1990, the David Suzuki Foundation has worked to find ways for society to live in balance with the natural world that sustains us. Focusing on four program areas – oceans and sustainable fishing, climate change and clean energy, sustainability, and the Nature Challenge.

Web: http://www.davidsuzuki.org/

EcoLog

Comments: EcoLog Environmental Resources Group is Canada's leading publisher of print and electronic environmental and OH&S news, legislation and compliance solutions.

Web: http://www.ecolog.com/default.asp

Environmental Health Research Network (RRSE)

Comments: The RRSE, funded by the Fonds de la recherche en santé du Québec (FRSQ), brings together virtually all Québec university researchers working in the environmental health field. The aim of environmental health research, which is preventive in nature, is to characterize the impact of chemical and physical contaminants of the environment as health determinants.

Web: http://www.rrse.ca/

Radiation Safety Institute of Canada

Comments: Founded in 1980, the Radiation Safety Institute of Canada is an independent, national organization dedicated to the promotion of radiation safety in the workplace, in the environment and in homes and schools.

Web: http://www.radiationsafety.ca/

Society of Toxicology of Canada

Comments: The Society of Toxicology of Canada is a non-profit association whose objectives are to: promote the acquisition, facilitate the dissemination, and encourage the utilization of knowledge in the science of toxicology.

Web: http://www.stcweb.ca/

TOXEN

Web: http://www.er.uqam.ca/nobel/toxen/

Toxicology Testing Laboratories

Dozen of laboratories offer their services in the field of toxicology testing in Canada. Before doing any business with a laboratory, it is recommended to verify if the laboratory is certified by a recognized association and has participated in different quality programs.

Environmental Consulting Services

Via the Internet it is now possible to find dozens of specialists in different fields of toxicology. Considering the number of specialists involved and the dynamic of the field, an exhaustive list of either companies or individuals who offer their services can not be presented here.

For a summary list of environmental consultants offering toxicology and risk-assessment-related services in Canada, readers are encouraged to access the following provincial (state level) environmental services association websites.

Alberta
Web: http://www.esaa.org/

British Columbia
Web: http://www.bceia.com/

Manitoba
Web: http://www.meia.mb.ca/

New Brunswick
Web: http://www.nbeia.nb.ca/

Newfoundland and Labrador
Web: http://www.neia.org/

Nova Scotia
Web: http://www.nseia.ns.ca/

Ontario
Web: http://www.oneia.ca/

Quebec
Web: http://www.reseau-environnement.com/RENV/ui/user/index.jsp (in french)

Saskatchewan
Web: http://www.seima.sk.ca/

The ***Canadian Environmental Services Association*** (http://www.ceia-acie.ca/) had already ceased its operation at the time of writing and listing the above resources.

CHAPTER

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Chile

JUAN CARLOS RIOS, JUAN JOSE MIERES, AND ENRIQUE PARIS

INTRODUCTION

In Chile, the teaching of toxicology started shortly after 1900 in the Pharmacy School of the University of Chile when that school was part of the Medicine Faculty, under the direction of Dr. Carlos Ghighliotto. The subjects taught there were compiled under the title 'Toxicology, Legal Pharmacy'. In 1950 Professor Hermann Schmidt Hebbel, pharmacist and professor of bromatology published articles in the journal *The Pharmacist*. These were later compiled in the text *Toxicology Manual: Its Projections Toward Industrial Hygiene and Forensic Chemistry*, which was a required study text for several generations.

RESOURCES

Books

Araya A (1977)
Manual de Seguridad e Higiene Industrial (Manual of Industrial Hygienics and Safety)
Santiago, Chile

Brantes MJ (1990)
Guía consulta: intoxicaciones por plaguicidas (Guide for Poisoning with Pesticides)
Servicio de Salud Metropolitano Occidente

Borgel L et al (2001)
Protocolos para el manejo del paciente intoxicado (Protocols for the Management of the Poisoned Patient)
OPS

Bruning SW, Bruning VW (2002)
Plantas Tóxicas en Pediatria (Toxic Plants in Pediatrics)
Editorial IKU.

A detailed review of Chilean botanical species toxic effects oriented to pediatrics.

Díaz O, García M (2003)
Avances en toxicología de contaminantes químicos en alimentos (Advances in Toxicology of Chemical Contaminants in Food)
Universidad de la Frontera.

Lazo W (2001)
Hongos de Chile (Chilean Fungus)
Salesianos SA
A textbook that lists mushroom species found in Chile.

Ministerio de Salud (1985)
Manual de Toxicologia Ocupacional (Manual of Occupational Toxicology)
Santiago

Paris E, Rios JC (2005)
Intoxicaciones: Epidemiologia, Clínica y Tratamiento (Poisonings: Clinical Features and Management)
Santiago: Ediciones Universidad Católica

Textbook oriented to the clinician. Covers the basic management of the most common poisonings in Chile.

Schmidt-Hebbel H (1986)
Tóxicos químicos en alimentos: avances en su identificación, previsión y desintoxicación (Toxic Chemicals in Food: Advances in their Identification, Prevention and Decontamination)
Fundación Chile

Tapia R (1989)
Toxicologia (Toxicology)
Universidad de Chile

Tapia R, Fernández C (1985)
Toxicología general y aplicada : asignatura de toxicología (General and Applied Toxicology: Toxicology Subject)
Universidad de Chile

Technical Report and Other Documents

Guia clinica para el manejo de mordedura de araña de rincón-Loxosceles laeta (Clinical Guide for the Management of the Loxosceles Laeta Bite)
Web: http://www.cituc.cl/LoxoscelesLaeta.pdf

Prevencion y manejo de intoxicaciones por sustancias químicas en incidentes mayores (Prevention and management of poisonings caused by chemical substances in major incidents) Web: http://epi.minsal.cl/epi/html/public/bioter/aquim/aqpreven.doc

Situacion epidemiologica de las intoxicaciones agudas por plaguicidas chile, 1998 (Epidemiological situation of acute poisonings by pesticidas in Chile)
Web: http://epi.minsal.cl/epi/html/vigilan/revep/intox1998.pdf

Software

Respel 1.0. Reglamento sanitario sobre manejo de residuos peligrosos (Sanitary Regulations for the Management of Hazardous Wastes) (2005)

Allows industrial companies to determine if their wastes are classified as hazardous or not hazardous according to the Chilean legislation.

Journals (General Scientific Journals)

Boletín de la Sociedad Chilena de Química (Journal of the Chilean Chemical Society) (1949–)

Red Nacional de Vigilancia Epidemiológica de Intoxicaciones Agudas por Plaguicidas REVEP (National Network of Epidemiological Vigilance of Acute Poisonings Caused by Pesticides REVEP) (1998–2002)

Revista de Biologia Marina y Oceanografia (Journal of Marine Biology and Oceanography) (1997–)

Revista Chilena De Salud Pública (Chilean Journal of Public Health) (1997–)
Revista Médica de Chile (Chilean Journal of Medicine) (1872–)

Organizations

Governmental Organizations

Comisión Nacional del Medio Ambiente-CONAMA (National Committee of Environment)
Teatinos 254/258, Santiago, Chile

The National Committee of Environment (CONAMA) is the institution of the State that watches over the people's interest specifically the right to live in an environment free of pollution, the protection of the environment, the preservation of nature and the conservation of the national patrimony.

Instituto de Salud Pública (Public Health Institute)
Av. Marathon 1000- Ñuñoa – Santiago

Public institution of a technical and scientific nature that guarantees the quality of goods and services offered to the community in areas related to health. This includes evaluation of the quality of laboratories, vigilance of diseases, control and supervision of drugs, cosmetics and devices for medical use, environmental health, and production and control of vaccines.

Servicio Agrícola y Ganadero: Sub-Departamento de Plaguicidas y Fertilizantes
(Agricultural and Livestock Service, Sub-Department of Pesticides and Fertilizers)
Paseo Bulnes 140, Santiago

Develops and applies institutional politics oriented to improve the efficiency in the evaluation and approbation of agrochemical substances in order to have efficient products with minimal risk to the health of people, animals and the environment, avoiding negative impact on the domestic and foreign trade.

Servicio Médico Legal (Legal Medicine Service)
Avenida La Paz 1012, Independencia, Santiago

Institution commissioned to assist the Justice System and the Public Ministry in matters related to legal medicine through carrying out thanatological, psychiatric, clinical and toxicological investigations.

Non-governmental Organizations

Sociedad Chilena de Medicina Legal, Forense y Criminalistica (Chilean Society of Legal, Forensic and Criminalistic Medicine)
Av. Providencia 365 oficina 22, Providencia, Santiago
Sociedad Chilena de Nutrición, Bromatología y Toxicología (Chilean Society of Nutrition, Bromatology and Toxicology)
Guayaquil 34 , Depto. 3-C, Santiago

Poison Control Centers

CITUC – Centro de Información Toxicologica y de Medicamentos de la Pontificia Universidad Católica de Chile (Poison Information and Drug Information Center)
Marcoleta 367, Santiago
Phone: 562-6353800
Fax: 562-2472112
Email: cituc@med.puc.cl

Centro de Información para Emergencias Químicas de la Pontificia Universidad Católica de Chile (Chemical Emergency Information Center)
Marcoleta 367, Santiago
Phone: 562-2473600
Fax: 562-2472112

Legislation and Regulations

D.F.L. N° 725/67. Código Sanitario Publicado en el Diario Oficial de 31.01.68-Ministerio de Salud (Sanitary Code)

Reglamento del sistema nacional de control de productos farmacéuticos dto. N° 1876, DE 1995 Publicado en el Diario Oficial de 09.09.96 (Regulations for the national system of control of pharmaceuticals)

D.S. N° 404/83 – Reglamento de Estupefacientes (Regulation of Stupefacient Drugs)

D.S. N° 405/83 – Reglamento de Productos Psicotrópicos (Regulation of Psychotropic Products)

El 9 de marzo de 1994 se publicó en el Diario Oficial la Ley N° 19.300, sobre Bases Generales del Medio Ambiente (LBGMA) (General Basis of the Environment)

D.S. N°148 de 2003 Ministerio de Salud Reglamento Sanitario sobre Manejo de Residuos Peligrosos (Sanitary Regulation for the Management of Hazardous Wastes)

D.S. N° 95 de 2001 Ministerio Secretaría General de la Presidencia Reglamento del Sistema de Evaluación de Impacto Ambiental (Regulation of the System of Evaluation of Environmental Impact)

D.S. N° 93 de 1995 Ministerio Secretaría General de la Presidencia Reglamento para la Dictacion de Normas de Calidad Ambiental y de Emisión (Regulation for the Development of Norms about the Environmental Quality and Emissions)

Decreto 88: 2004. Reglamento de notificación obligatoria de las intoxicaciones por plaguicidas (Regulation of Mandatory Notification of Poisonings Caused by Pesticides)

Education/Schools

Few Chilean universities teach toxicology. It is, however, a required subject in the pharmacy programs of several universities of the country. It is optional in the curriculum of some veterinary and nursery schools. Beginning in 2007 the Faculty of Medicine of the Pontificy Catholic University of Chile will offer toxicology for their graduate students in different medical specialities.

Food toxicology is covered in undergraduate courses of Food Engineering and is currently taught at several university departments within the new Food Science and Technology degree programs. Different university faculties and professional societies provide courses of toxicology but there are no graduate programs for specialization in that area.

CHAPTER

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China

ZHIXIONG ZHUANG

INTRODUCTION

Ancient China's knowledge of toxicants dates back over 5000 years. The famous folk legend of *Shennong Tastes all Kinds of Herbs* offers guidance on how to differentiate foods from drugs and poisons in China. *Shennong Bencao Jing* (*Shennong Native Herbs Anthology*) is considered the first Chinese monograph on pharmacology. It itemized 365 medicinal products (including plant, animal, and mineral) and categorized them by broad toxic effect – large, medium, and small. *Zhu Bing Yuan Hou Lun*, written in 610 by Chao Yuan Fang during the Sui Dynasty, identifies snake, bee, and scorpion venom as toxic agents, and offers numerous detailed observations and descriptions of toxic gases, concentration distributions, testing methods, and preventative countermeasures. In *Wai Tai Mi Yao*, written in 752 by Wang Tao during the Tang Dynasty, there are reports of testing animals for effects by exposing them to toxic gases. During the Southern Song Dynasty, Song Ci (in 1247) in *Xi Yuan Ji Lu* records the use of poison for suicide or homicide, and suggests methods of detoxification and poison identification. *Ben Cao Gang Mu*, written in 1590 by Li Shi Zhen during the Ming Dynasty, and which describes numerous poisons and discusses the toxicity of drugs, is often regarded as the first truly comprehensive and seminal pharmacology and toxicology work. Also in the Ming Dynasty, *Tian Gong Kai Wu*, written in 1637 by Song Ying Xing, discusses occupational mercury poisoning and its prevention.

Since the 1920s, parallel with the introduction of Western medicine and science, forensic scientists in China had begun to identify poisons by pathology and chemical analysis. Of special note is Chen Ke Hui, a famous Chinese pharmacologist who, in 1934, discovered an antidote for cyanide poisoning by a ferrihemoglobin forming agent and sodium hyposulfite. Modern toxicology in China could be said to originate with the establishment of the People's Republic of China. At that time, poisoning and treatment was largely the task of occupational health. Chemical toxicity testing and toxicity classification, though, began to emerge. Industrial toxicology developed in the 1950s, and the training of professionals in this area as well as the establishment of acute toxicity testing methods were emphasized. In 1957, the first training class in toxicology was held in China by former Soviet Union experts, who introduced standard toxicity theory and research methods. In 1960, a number of Chinese institutions participated in a training class in military toxicology. Senior pharmacologists and toxicologists also initiated safety evaluation for foods, environmental agents, and drugs. Mutagenesis and teratogenesis research methods were introduced in the 1970s.

Since reforms in China at the end of the 1970s, the national education authority considered the global importance of toxicology and established educational requirements. Toxicology Basic Courses in Schools of Public Health and the Departments of Preventive Medicine, as well as postgraduate education for master's and doctorate degrees were also established. In the 1980s, Health Toxicology branches of the Chinese Society of Preventive Medicine (CSPM), and the Chinese Society of Environmental Mutagens (CSEM) were set up and published the *Journal of Toxicology* (original name: *Journal of Health Toxicology*) and *Carcinogenesis, Teratogenesis, and Mutagenesis*, respectively. In 1993, the

Chinese Society of Toxicology (CST) made its appearance, a milestone for toxicology in China. CST consists of 18 special committees, and jointly with the Chinese Society of Pharmacology (CSP), issues the *Chinese Journal of Pharmacology and Toxicology*.

In the 1980s and 1990s, China sent many toxicologists to the United States, Europe, Japan and other more developed countries for training. They returned with knowledge of state-of-the-art theories and methods which they then communicated to other scientists. At the same time, via scholarly articles and computer communication, developments in Chinese toxicology were relayed throughout the world. This not only promoted Chinese toxicology to a new level, but advanced the foundation of interdisciplinary toxicological research. Technologies in cellular and molecular biology, for example, were introduced into toxicology. This would include detection of TNT hemoglobin adducts, benzene–DNA adducts, DNA–protein adducts, and oncogenes and relevant proteins, the foundation of transgene cell strain and transgene animal models, separation and identification of gene mutations, etc. Significant achievements were also made in reproductive toxicology, immunotoxicology, liver and kidney toxicology, neurotoxicology, and behavioral toxicology, all critical in the public health arena.

Bringing the story up to date, in the 21st century, as the human genome project has evolved, toxicological research in China has utilized genomics, metabonomics, proteomics, gene chip (DNA chip) and other cutting-edge techniques, to carry out research on toxic mechanisms of xenobiotics and polymorphism on environmental response genes (e.g. xenobiotic metabolizing enzyme genes and DNA repair genes).

In the field of regulatory toxicology, there were no hygienic standards for exogenous chemicals in China before the founding of the People's Republic of China. In the 1950s, by referring to the hygienic standard for tolerance limits of the former Soviet Union, China issued corresponding Chinese standards for some chemicals. Afterwards, as the state situation in China evolved, tolerance limits were prepared, until at this point in time, China has standards in place for a great number of chemical compounds.

Beginning in the 1980s, China issued some relevant laws and regulations to protect the environment and public health. These include:

- Law of the People's Republic of China on Prevention and Control of Water Pollution (adopted firstly in 1984, revised in 1996)
- Law of the People's Republic of China on the Prevention and Control of Atmospheric Pollution (adopted firstly in 1987, revised in 1995 and 2000)
- Environmental Protection Law of the People's Republic of China (1989)
- Food Hygiene Law of the People's Republic of China (1995)
- Law of the People's Republic of China on the Administration of Drug (1989)
- Law of the People's Republic of China on the Prevention and Treatment of Occupational Diseases (2002)
- Law of the People's Republic of China on the Quantity and Safety of Agricultural products (2006), etc.

In the meantime, some procedures and standards for safety evaluation of exogenous chemicals were also issued and adopted, for example:

- Procedures and Methods of Safety Evaluation for Cosmetics (GB 7919-1987),
- Procedures for Toxicological Assessment of Food Safety (GB 15193.1-2003),
- Procedures for Toxicological Assessment of Pesticide (1991),
- Toxicological Test methods of Pesticides for Registration (GB/T 15670-1995)
- Guideline for New Drug (Western medicine) Toxicology Research (1993),
- Standard for Drug Non-clinic Research Quality Management (1999),
- Standard for Chemicals Toxicity Identification Management (2000),
- Technical Standard for Testing and Assessment of Health Food (2003),
- Standard for Pesticide Toxicology Security Evaluation Laboratory (2003),
- Technical Standard for Toxicity Testing of Chemicals (2004),
- Standard for Good Laboratory Practices of Pesticide Toxicology Assessment (NY/T718-2003)
- Guidelines for the Testing of Chemicals (HJ/T 153-2004)
- Guidelines for the Hazard Evaluation of New Chemical Substances (HJ/T 154-2004)
- Guidelines for Chemical Testing Good Laboratory Practices (HJ/T 155-2004), etc.

HISTORICAL EVOLUTION ON CHINESE SOCIETY OF TOXICOLOGY (CST)

In the early 1990s, Wu De Chang, Liu Shi Jie and other 24 senior toxicologists proposed establishing the Chinese Society of Toxicology. In April 1993, the preparatory committee of Chinese Society of Toxicology (CST) was established; Prof. Wu De Chang was the director. In May 1993, the China Association for Science

and Technology and The National Science Committee of China formally approved founding of CST.

The Chinese Society of Toxicology (CST) holds a national congress every 4 years, voting Council Member, Standing Council Member and Principal. Past and present officers follow:

The First Council (1993–1997):
President: Professor Dechang WU (Academician)
Vice Presidents: Professor ShuYuan Song, Boqin Lv, Quanguan Jiang, Peizhe Liu, Weige Li, Jiongliang Zhou and Jinxiu Ruan
Secretary General: Professor Changqing Ye;

The Second Council (1997–2001):
President: Professor Dechang WU (Academician)
Vice Presidents: Professor Peizhe Liu, Weige Li, Jiongliang Zhou, Jinxiu Ruan, Zhiji Cai, Junshi Chen, and Youxin Liang
Secretary General: Professor Changqing Ye;

The Third Council (2001–2005):
President: Professor Changqing Ye
Vice Presidents: Professor Junshi Chen (Standing), Kangtai Rong, Jiwang Zheng, Jianren Yao, Wei Meng, Xinru Wang, and Zhixiong Zhuang
Secretary General: Professor Pingkun Zhou;

The Fourth Council (2005–2009):
President: Professor Zhixiong Zhuang
Vice Presidents: Professor Jie Wang, Xinru Wang, Zhicheng Shi, Pingkun Zhou (Standing), Wei Meng, and Mingyang Liao
Secretary General: Professor Pingkun Zhou.

Organization of Chinese Society of Toxicology (CST)

Over 1600 toxicologists from universities and scientific health research institutes, are registered in the CST. CST consists of 19 branch committees: Section of Analytical Toxicology (SAN), Section of Biotoxin Toxicology (SBI),Section of Biochemical and Molecular Toxicology (SBM), Section of Clinical Toxicology (SCL), Section of Drug Dependence Toxicology (SDD), Section of Ecological Toxicology (SEC), Section of Feed Toxicology (SFE), Section of Food Toxicology (SFO), Section of Genetic Toxicology (SGE), Section of Industrial Toxicology (SID), Section of Immunotoxicology (SIM), Section of Military Toxicology (SMI), Section of Radiation Toxicology (SRA), Section of Regulatory Toxicology (SRG), Section of Reproductive Toxicology (SRP), Section of Toxicology History (STH), Section of Veterinary Toxicology (SVE), Section of Drug Toxicology and Security Evaluation, and Section of Poisoning and Treatment (SPT).

CST is affiliated with the Academy of Military Medical Sciences of the Chinese People's Liberation Army, and its official headquarters, led by a secretary general is located at:

CST Office: 27 Taiping Road, Haidian District, Beijing 100850, China
Phone: 86-10-66932387
Fax: 86-10-68183899
Email: chntox@nic.bmi.ac.cn chntox@yahoo.com.cn

In order to strengthen the main business of the Society, CST established four working committees: Academic Committee, Foreign Affairs Committee, Organization Committee, and Youth Committee.

The Relationship between CST and International Academic Organizations

In July 1997, CST successively joined International Union of Toxicology (IUTOX) and the Asian Society of Toxicology (ASIATOX). Professor Junshi Chen, Honorary President and Standing Council Member of CST, Researcher of Chinese Center for Disease Control and Prevention, and Academician of China National Academy of Engineering, was elected as Director of ASIATOX and Council Member of IUTOX; Professor Pingkun Zhou, the Secretary General of CST, was elected as the Secretary General of ASIATOX; and Professor Zhixiong Zhuang, the President of CST, and Professor Xinru Wang and Jie Wang, the Vice President of CST was also elected as the Council Member of ASIATOX.

Academic Communications

Domestic Academic Communications

The Chinese Society of Toxicology pays great attention to academic communications. As of 2007, four National Congresses, two Youthful Scholar Science and Technology Fora and more than 100 symposia have been held by the CST and its branch committees. These have covered a variety of topics. The national congresses, for example, have been held in Beijing, Xi'an, Nanjing, and, most recently, in Shenyang (2005).

Cross-Taiwan Strait Toxicology Seminar

These seminars are held every 2 years and are a collaborative effort between the Chinese Society of Toxicology and the Chinese Taiwan Society of Toxicology, to discuss problems of mutual concern. They have been held in .Nanjing (Oct. 15–16, 2001), Taibei (Dec. 14–20, 2003) and Shenyang (Sep. 18–19, 2005), respectively.

Hosting the International Meetings on Toxicology

Since 2002, Chinese Society of Toxicology has hosted three international meetings on Toxicology. At the thirtieth anniversary of Normalization of Relationship Between China and Japan, Chinese Society of Toxicology and Japanese Society of Toxicology jointly sponsored the China–Japan Joint Congress on Toxicology and Pharmacology , (CJJCTP) on Dec. 1–4, 2002 in Shenzhen, China.

On Nov. 10–13, 2003, Chinese Society of Toxicology (CST) and International Union of Toxicology (IUTOX) jointly sponsored the 5th Congress of Toxicology in Developing Countries (5CTDC) in Guilin, China.

On June 18–21, 2006, Chinese Society of Toxicology (CST) successfully sponsored the 4th International Congress of Asian Society of Toxicology (ASIATOX-IV) in Zhuhai, China.

Academic Periodical

'*Chinese Toxicology Communication*', the interior academic periodical of CST, which is delivered to every council member and branch committees, plays the role of academic communication, information window and link. There are also other academic periodicals, e.g. '*Journal of Drug Dependence*' and '*Chinese Journal of Pharmacology and Toxicology*', sponsored by CST and Chinese Society of Pharmacology (CSP); '*Poisoning Rescue Communication*' and '*Animal Toxicology*' sponsored by some Branch Committees.

Network Construction

In Feb. 2005, the website (www.chntox.org) of CST was established and started operating. CST issues all kinds of relevant information on the web page in this network station, which includes many columns, for example, Brief Introduction of CST, CST Rule, Organization, Academic Activity, Science Forum, Popular Science Education, Special Committee, Chinese Toxicology Communication, Toxicologists Database and News bulletin. It enables the flow of information to be more smooth and the relation between members to be more close.

The website of Medical Professor Net (www.med-professor.com), sponsored by Branch of Industrial Toxicology of CST, has been providing the consultant service for public health and medicine.

The website of Poison & Human Net (www.nwu.edu.cn), jointly sponsored by Section of Toxicology History of CST and College of Life Sciences, Northwest University, has been providing the relevant consultant service for government, society, and the general public.

The website of Toxicology (http://www.toxsmmu.com/index.asp) was jointly sponsored by Section of Genetic Toxicology and Department of Toxicology, The Second Military Medical University.

The other toxicology-relevant websites are as following:

http://www.emss.org.cn/cgi-bin/dw/ (中国急救网; China Emergency Medical Service System)

http://www.eedu.org.cn/Article/es/envir/jiance/200503/4128.html (中国环境生态网; China Eco-environmental Web)

http://www.rcees.ac.cn/index/index.php (中国科学院生态环境研究中心; Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences)

http://www.ioz.ac.cn/index.asp (中国科学院动物研究所; Institute of Zoology, Chinese Academy of Sciences (CAS))

http://www.kiz.ac.cn/ (中国科学院昆明动物研究所; Kuming Institute of Zoology, Chinese Academy of Sciences (CAS))

http://boot.xy568.com/ (中国农业科学院兰州畜牧与兽药研究所; Lanzhou Institute of Animal Science and Veterinary Medicine)

http://fri.caas.net.cn/ (中国农业科学院饲料研究所; Feed Research Institute, Chinese Academy of Agricultural Sciences)

http://sjc.zhb.gov.cn/ (国家环境保护总局; State Environmental Protection Administration of China)

http://www.craes.cn/cn/index.html (中国环境科学研究院; Chinese Research Academy of Environmental Sciences (CRAES))

http://www.crc-sepa.org.cn/ (国家环境保护总局化学品登记中心; Chemical Registration Center of SEPA)

http://www.china-epc.cn/ (中日友好环境保护中心; Sino-Japan Friendship Center for Environmental Protection)

http://www.es.org.cn/default.asp (中国环境标准网; China Environment Standard Web)

http://www.cnemc.cn/index.asp (中国环境监测中心; Environmental Monitoring of China)

http://www.cneac.com/ (国家环境分析测试中心; National Research Center for Environmental Analysis and Measurements)

http://ncswm.sepa.gov.cn/ (国家环境保护总局固体废物管理中心; National Center for Solid Waste Management, SEPA)

http://www.chinacses.org/CN/index.html (中国环境科学; Chinese Society for Environmental Sciences)

http://www.sfda.gov.cn/cmsweb/webportal (国家食品药品管理局; State Food and Drug Administration of China)

http://www.cfs.gov.cn/cmsweb/webportal (国家食品安全网; China Food Safety Web)

RESOURCES

Books and Monographs (after 2000)

Bojun Hunag, Yulin Huang (Eds.) (2004)
Toxicology of Pesticides
Beijing: People's Military Medical Press

Bojun Yuan, Mingyang Liao, Bo Li (Eds) (2007)
Drug Toxicological Method and Technique
Beijing: Chemical Industry Press

Kent Chris, Xiumei Jiang (Eds.) (2001)
Basic Toxicology
Taibei: Gau-lih Book Corp.

Curtis D. Klassen (Ed.) (2002)
Toxicology (English edition)
Beijing: People's Medical Publishing House

Curtis D. Klaassen (Ed.), Jiwu Huang, Zongcan Zhou (Trans) (2005)
Casarett and Doull's Toxicology: The Basic Science of Poisons
People's Medical Publishing House

Curtis D. Klaassen, John B. Watkins (Eds.), Huande Li (Trans) (2006)
Casarett & Doull's Essentials of Toxicology
Chang Sha: HuNan Science & Technology Press

Richard C. Dart (Ed.), Jingshen Yang (Trans) (2001)
The 5 Minute Toxicology Consults
Beijing: China Medicine Science & Technology Press

Guangzhao Huang (Ed.) (2004)
Forensic Toxicology, 3rd Edition
Beijing: People's Medical Publishing House

Guolian Liu (Ed.) (2002)
Cellular Toxicology
Beijing: Military Medical Science Press

Jianhua Xu, Fengming Wang, Tianliang Zhang (Eds.) (2005)
Toxicology Evaluation and Experimental Methods of Chemicals
Beijing: Ocean Press

Jianzheng Li (Ed.) (2006)
Environmental Toxicology
Beijing: Chemical Industry Press

Jianzhong Shen (Ed.) (2002)
Toxicology of Animals
Beijing: China Agriculture Press

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Journals

Biomedical and Environmental Sciences
ISSN 0893-3985
C. M. Chen (Ed.)
Published under the auspices of Chinese Center for Disease Control and Prevention (China CDC), 27 Nan Wei Road, Beijing, 100050.

Biomedical and Environmental Sciences, an international journal with special emphasis on scientific findings in China, publishes articles dealing with the biologic and toxic effects of environmental pollutants on man and other forms of life. The effects may be measured with pharmacological, biochemical, pathological, and immunological techniques. The journal also publishes reports dealing with the entry, transport, and fate of natural and anthropogenic chemicals in the biosphere and their impact on human health and well-being.

Chinese Journal of Industrial Hygiene and Occupational Diseases (1983–)
ISSN 1001-9391
Domestic Periodical Register CN-12-1094/R
S. Wang (Ed.)
Sponsored by the Chinese Preventive Medical Association. Edited and published by Tianjin Center for Disease Control and Prevention.

This journal is intended for personnel responsible for labor hygiene and occupational health. It frequently publishes articles and reviews concerned with toxicological issues of chemical substances.

Chinese Journal of Industrial Medicine (1988–, bimonthly)
ISSN 1002-2214
CN-21-1267/R
F. S. He and Z. D. Zhao (Eds.)
Sponsored by Labour Hygiene & Occupational Diseases Society, Chinese Preventive Medical Association. Published by Shen Yang Institute of Labour Hygiene & Occupational Diseases, Editorial Board of the Chinese Journal of Industrial Medicine, 18 South 11 W.Road, Tie Xi District, Shen Yang, 110024.

This journal is for professionals in occupational medicine and labor safety and for managers in charge of labor hygiene and occupational diseases.

Chinese Journal of Pharmacology and Toxicology (1986–, quarterly)
ISSN 1000-3002
CN-11-1155/R
Y. X. Zhang (Ed.)
Sponsored by the Chinese Pharmacological Society. Undertaken by Academy of Military Medical Sciences, 27 Taiping Road, Beijing, 100850. Edited and published by Editorial Office of Chinese Pharmacology and Toxicology, 27 Taiping Road, Beijing, 100850.

This journal is intended mainly for pharmacologists, toxicologists, hygienists, and occupational doctors. Series of this journal contain reviews, articles, and press and new briefs concerning toxicology and pharmacology.

Chinese Journal of Preventive Medicine (1953–, bimonthly)
ISSN 0253-9624
CN-11-2816
Y. D. Chen (Ed.)
Chinese Medical Association, 42 Dongsi Xidajie, Beijing, 100710.

This periodical is one of the important Chinese medical series published by the Chinese Medical Association. This journal is intended for preventive medical professionals. It contains the most extensive presentations on preventive medicine, and toxicology is one of the topics of this journal. Every major article has an English abstract.

Industrial Health and Occupational Diseases (1973–, bimonthly)
ISSN 1000-7164
CN-21-1147/R
M. R. Xu (Ed.)
An Shan Institute of Industrial Health, 29 129-Park, An Shan, Liaoning, 114001. Sponsored by An Shan Institute of Industrial Health, An Shan Iron & Steel Corp. at An Shan, Liaoning. Edited by Editorial Board of Industrial Health and Occupational Diseases.

This is a professional periodical for persons interested in occupational health and labor safety; it also is intended for managers in business and industry. Toxicological issues are one of the topics covered in this journal.

Journal of Environment and Health (1984–, bimonthly)
ISSN 1001-5914
CN-12-1095
S. X. Dong (Ed.)
Published by the Editorial Board of the Journal of Environmental & Health, 76 Tian Shan She Street, Hedong District, Tianjin, 300011.

This is a professional periodical for persons responsible for and interested in environmental health and environmental protection as well as teachers at medical universities. The topics include review, survey, and research; technology and methods; special information; short reports; training courses; and press reviews.

Journal of Health Toxicology (1987–, quarterly)
ISSN 1002-3127
CN-2413/G2
X. Gao (Ed.)
Sponsored by the Chinese Preventive Medical Association, edited by the editorial board, and published by the editorial department (Beijing Center for Disease Control and Prevention). Chaowai, Dong de Qiao Bei, Beijing, 100020.

This journal is an important periodical of toxicology in China. It belongs to the series published by the Chinese Preventive Medicine Association. The topics of this journal include industrial toxicology, environmental toxicology, health criteria of chemical substances risk assessment for chemicals, and toxicological test methods. This journal is intended mainly for toxicologists, hygienists, and occupational doctors. It is also a useful reference for teaching and training. The language of the journal is Chinese with abstracts in English.

Journal of Hygiene Research (bimonthly)
ISSN 1000-8020
CN 11-2816
J. S. Chen (Ed.)
Published under the auspices of the Institute for Nutrition and Food Safety, Chinese Center for Disease Control and Prevention, 29 Nan Wei Road, Beijing, 100050.

The major topics of this journal include reviews and articles on labor hygiene, environmental health and monitoring, occupational medicine, nutrition and food hygiene, and health statistics. Toxicology is one aspect of this journal. This journal is intended for medical professionals of sanitary anti-epidemic stations, teachers and students of medical universities, and researchers of hygienic institutes. Some articles have English abstracts.

Journal of Preventive Medicine of Chinese People's Liberation Army (1983–, bimonthly)
ISSN 1001-5248
CN-12-1198/R
Z. F. Gu (Ed.)
Sponsored and published by the Preventive Medicine Center, People's Liberation Army. Edited by the editorial board of Journal of Preventive Medicine PLA, The Preventive Medicine Center, PLA, 1 Da Li Road, Tian Jin, 300050.

This is a special journal for military preventive medicine. Topics cover health criteria research and review, experimental technology, and survey and experiment in field preventive medicine for military purposes. It includes some toxicological issues.

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Government Agencies

Chinese Center for Disease Control and Prevention (China CDC)

The Chinese Center for Disease Control and Prevention (China CDC) is a non-profit institution working in the fields of disease control and prevention, public health management, and provision of service. China CDC is committed to strengthening research on strategies and measures for disease control and prevention; organizes and implements control and prevention plans for different kinds of diseases; carries out public health management for food safety, occupational health, health-related product safety, radiation health, environmental health, healthcare for women and children, among others; conducts applied scientific research; provides technical guidance, staff training and quality control for disease control and prevention and public health services throughout the country; acts as national working group for diseases prevention, emergency relief, and construction of public health information systems.

Affiliated Organizations

Institute for Communicable Disease Control and Prevention

Institute for Viral Disease Control and Prevention

National Institute of Parasitic Disease

National Center for AIDS/STD Control and Prevention

National Center for Tuberculosis Control and Prevention

Institute for Nutrition and Food Safety

Institute for Occupational Health and Poison Control

Institute for Environment Hygiene and Health Related Product Safety

Institute for Radiological Protection and Nuclear Safety

Institute for Health Education

National Center for Maternal and Child Health Care

National Center for Rural Water Supply Technical and Guidance

Office for Research in Public Health Policy

Center for Public Health Surveillance and Information Service

National Immunization Programme

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天津市疾病预防控制中心 (Tianjin Center for Disease Control and Prevention)
Web: http://cdctj.com.cn

河北省疾病预防控制中心 (Hebei Center for Disease Control and Prevention)
Web: http://www.hebeicdc.com

山西省疾病预防控制中心 (Shanxi Center for Disease Control and Prevention)
Web: http://www.sxcdc.org

内蒙古疾病预防控制中心 (Inner Mongolia Center for Disease Control and Prevention)
Web: http://www.chinacdc.net.cn

辽宁省疾病预防控制中心辽宁 (Liaoning Center for Disease Control and Prevention)
Web: http://www.lncdc.com

大连市疾病预防控制中心 (Dalian Center for Disease Control and Prevention)
Web: http://www.dlcdc.com.cn

吉林省疾病预防控制中心 (Jilin Center for Disease Control and Prevention)
Web: http://www.jlcdc.com.cn

黑龙江疾病预防控制中心 (Heilongjiang Center for Disease Control and Prevention)
Web: http://www.hljcdc.org

上海市疾病预防控制中心 (Shanghai Center for Disease Control and Prevention)
Web: http://www.scdc.sh.cn

江苏省疾病预防控制中心 (Jiangsu Center for Disease Control and Prevention)
Web: http://www.jshealth.com

浙江省疾病预防控制中心 (Center for Disease Control and Prevention)
Web: http://www.cdc.zj.cn

宁波市疾病预防控制中心 (Ningbo Center for Disease Control and Prevention)
Web: http://www.nbcdc.org.cn

山东省疾病预防控制中心 (Shandong Center for Disease Control and Prevention)
Web: http://www.sdcdc.cn

青岛市疾病预防控制中心 (Qingdao Center for Disease Control and Prevention)
Web: http://www.qdcdc.org

安徽省疾病预防控制中心 (Anhui Center for Disease Control and Prevention)
Web: http://www.ahcdc.com.cn

江西省疾病预防控制中心 (Jiangxi Center for Disease Control and Prevention)
Web: http://www.jxcdc.cn

福建省疾病预防控制中心 (Fujian Center for Disease Control and Prevention)
Web: http://www.fjcdc.com.cn

厦门市疾病预防控制中心 (Xiamen Center for Disease Control and Prevention)
Web: http://www.xmcdc.com

河南省疾病预防控制中心 (Center for Disease Control and Prevention)
Web: http://www.hncdc.com.cn

湖北省疾病预防控制中心 (Center for Disease Control and Prevention)
Web: http://www.hbcdc.cn

湖南省疾病预防控制中心 (Henan Center for Disease Control and Prevention)
Web: http://www.hncdc.com

广东省疾病预防控制中心 (Guangdong Center for Disease Control and Prevention)
Web: http://www.cdcp.org.cn

深圳市疾病预防控制中心 (Shenzhen Center for Disease Control and Prevention)
Web: http://www.szcdc.net

广西僮族自治区疾病预防控制中心 (Guangxi Center for Disease Control and Prevention)
Web: http://www.gxcdc.com

海南省疾病预防控制中心 (Hainan Center for Disease Control and Prevention)
Web: http://www.hncdc.cn

重庆市疾病预防控制中心 (Chongqing Center for Disease Control and Prevention)
Web: http://www.cqcdc.org

贵州省疾病预防控制中心 (Guizhou Center for Disease Control and Prevention)
Web: http://www.gzcdc.gov.cn

云南省疾病预防控制中心 (Yunnan Center for Disease Control and Prevention)
Web: http://www.yncdc.cn

陕西省疾病预防控制中心 (Shanxi Center for Disease Control and Prevention)
Web: http://www.sxcdc.com/htdocs/index.asp

新疆维吾尔自治区疾病预防控制中心 (Xinjiang Center for Disease Control and Prevention)
Web: http://www.xjcdc.com

宁夏疾病预防控制中心 (Ningxia Center for Disease Control and Prevention)
Web: http://www.nxcdc.com.cn/

甘肃省疾病预防控制中心 (Gansu Center for Disease Control and Prevention)
Web: http://www.gscdc.gov.cn/

State Food and Drug Administration

The State Food and Drug Administration is directly under the State Council, which is in charge of comprehensive supervision on the safety management of food, health food and cosmetics and is the competent authority of drug regulation. The main responsibilities are:

- To organize relevant authorities to draft laws and regulations on the safety management of food, health foods and cosmetics; organize relevant authorities to formulate comprehensive supervision policy, work plan, and supervise its implementation.
- To exercise comprehensive supervision on the safety management of food, health foods and cosmetics in accordance with laws; organize and coordinate supervision work on safety of food, health food and cosmetics carried out by relevant authorities.
- To organize and carry out investigation and impose punishment on serious safety accidents of food, health foods and cosmetics; delegated by the State Council, organize, coordinate and conduct specific law-enforcement campaigns over safety of food, health foods and cosmetics nationwide; organize, coordinate and collaborate with relevant authorities in carrying out emergency rescue work on serious safety accidents of food, health food and cosmetics.
- To comprehensively coordinate the testing and evaluation for the safety of food, health food and cosmetics; formulate provisions on releasing of supervision information for safety of food, health food and cosmetics in conjunction with relevant authorities and monitor their implementation; sum up safety information of food, health food and cosmetics from relevant authorities and release it to the public regularly.
- To draft law and administrative regulations on drug administration and supervise their enforcement; carry out protection system for certain traditional Chinese medicinal preparations and administrative protection system for pharmaceuticals in accordance with law or regulations.
- To draft law and regulations on administration of medical devices and supervise their enforcement; take charge of registration and regulation of medical devices; draft relevant national standards, draw up and revise professional standards of medical devices, manufacturing practice and supervise their implementation.
- To be in charge of drug registration, draw up, revise and promulgate national standard of drugs; draw up criteria for marketing authorization of health foods; review and approve health foods; set up classification system for prescription drugs and OTC drugs; establish and improve ADR monitoring system; be responsible for drug reevaluation, review drugs to be withdrawn and formulate national essential medicines list.
- To draft and revise good practices for drug research, manufacturing, distribution and use, and supervise their implementation.
- To control the quality of drugs and medical devices in manufacturers, distributors and medical institutions; release national quality bulletin on drugs and medical devices on a regular basis; investigate and punish illegal activities of producing and selling counterfeit and inferior drugs and medical devices in accordance with law.

Address: A38, Beilishi Road, Beijing 100810, P.R. China
Fax: 86-010-68310909
Email: inquires@sda.gov.cn
Web: http://www.sfda.gov.cn/

Affiliated Organizations

National Institute for the Control of Pharmaceutical and Biological Products
Address: 2 Tiantan Xi Li, Beijing 100050, P. R. China
Phone: 86-010-67095114
Fax: 86-010-67018094
Email: nicpbp@nicpbp.org.cn

Pharmacopoeia Commission of People's Republic of China
Address: Building 11, Fahua Nanli, Gymnasium Road, Beijing 100061, P. R. China
Phone: 86-010-67154488
Fax: 86-010-67152766
Email: chpc@chp.org.cn

Center for Drug Evaluation, SFDA
Address: Jia-1, Fuxing Road, Haidian District, Beijing 100038, P. R. China
Phone: 86-010-68585566

Fax: 86-010-68584181; 86-010-68584193
Email: cde@cde.org.cn

Drug Certification Center of SFDA
Address: 3/F, No.11 Building, Fahuananli Chongwen District, Beijing 100061, P. R. China
Phone: 86-010-67102284
Fax: 86-010-67152467
Email: ccd@ccd.org.cn

Center for Drug Reevaluation, SFDA (National Center for ADR Monitoring)
Address: Building 6, No.3 Yard, No.1 district of Sanlihe, Xicheng District, Beijing 100045, P. R. China
Phone : 86-010-68586296
Fax : 86-010-68586295
Email: webmaster@cdr.gov.cn

National Committee on the Assessment of the Protected Traditional Chinese Medicinal Products (Center for Health Food Evaluation, SFDA)
Address: Building 15, No. 11 Yard, No.188 south 4th ring road, Beijing 100070, P. R. China
Phone: 86-010-63703355
Fax: 86-010-63703550
Email: zybh@zybh.gov.cn

Center of Medical Device Evaluation, SFDA
Address: Room 812, Instrimpex Building, No.6 Xizhimenwai Street, Beijing 100044, P. R. China
Phone : 86-010-68338857
Fax: 86-010-68330377
Email:cmde@cmde.org.cn

Information Center of SFDA
Address: A38, Beilishi Road, Beijing 100810, P. R. China
Phone : 86-010-88363205
Fax : 86-010-88363205
Email: info_center@sda.gov.cn

Training Center of SFDA
Address: 16 Xi Zhan Nan Lu, Beijing 100073, P. R. China
Phone : 86-010-63365012
Fax : 86-010-63263390
Email: sdatc@sdatc.com

Center for Qualification of Licensed Pharmacist, SFDA
Address : A38, Beilishi Road, Beijing 100810, P. R. China
Phone : 86-010- 68001448
Fax : 86-010- 68001446
Email: cqlpsda@263.net

China Pharmaceutical News
Address: Haidian Wenhuiyuan Nanlu A2, Beijing 100088, P. R. China
Phone : 86-010-62212356
Fax: 86-010-62213699
Email: yyb@263.net.cn

China Medico-Pharmaceutical Science & Technology Publishing House
Address: A-22, Northern WenHuiYuan Road, Haidian District, Beijing 100088, P. R. China
Phone : 86-010-62217308
Fax : 86-010-62217308
Email: weiwang@mpsky.com.cn

China Center for Pharmaceutical International Exchange
Address: Room 5301–5312, Building B, No. 6, South Street, Xizhimen, Beijing 100035, P. R. China
Phone : 86-010-66152975/66155603
Fax : 86-010-66161160
Email: ChinaPharm@263.net

SFDA Southern Medicine Economic Institute
Address: Tianyu building 6F, Dongfeng East Road 753#, Guangzhou 510080, P. R. China
Tel : 86-020-37886800
Fax : 86-020-37886805
Email: meinet_wj@163.net

State Environmental Protection Administration (SEPA)

The State Environmental Protection Administration (SEPA) follows the principle of taking natural ecological conservation and environmental pollution prevention as its main tasks; strengthening supervision on nuclear safety and enhancing environmental enforcement; improving supervision and administration; focusing on people-oriented principles; safeguarding the environmental rights and interests of the public, and promoting the sustainable development of society, economy and environment.

Address: 115 Xizhimennei Nanxiaojie, Beijing 100035, China
Phone: 010-66556006/07
Fax: 010-6556010
Email: mailbox@sepa.gov.cn
Website: http://www.sepa.gov.cn/

Main Affiliated Organizations

Chinese Research Academy of Environmental Sciences

The China Research Academy of Environmental Sciences focuses on researches of environmental sciences and technologies, engineering design, environmental pollution prevention, and development of environmental engineering technologies; and undertakes major national projects of environmental

researches. It conducts researches on key cross-region and cross-sector environmental issues, and provides scientific evidence and technical support to the decision-making of environmental management in SEPA.

Address: No. 8 Dayangfang, Andingmenwai, Beijing 100012, P. R. China
Phone: 010-84915193
Fax: 010-84915194
Web: http://www.craes.cn/index.jsp

China National Environmental Monitoring Center

As the center of network, technology, information, and training for national environmental monitoring, the China National Environmental Center is responsible for managing and guiding the work of the national environmental monitoring system, and providing technical support to SEPA in carrying out environmental supervision and management.

Address: No. 1, Yuhuinanlu, Chaoyang District, Beijing 100029, P. R. China
Phone: 010-84637722-2526
Web: http://www.cnemc.cn

Nuclear Safety Center of SEPA

The Nuclear Safety Center is mainly engaged in the technical assessment, verification, monitoring, science researches, and science and technology information of nuclear safety concerning nuclear power plants, reactors, recycling facilities of nuclear fuels, application of nuclear technologies, uranium mines and safety associated with radiation, and to provide technical support and safeguard for the safety of civil nuclear facilities and supervision management of radiation safety in the country.

Address: No. 54 Honglian Nancun, Haidian District, Beijing 100088, P. R. China
Phone: 010-62257804
Fax: 010-62257804

National Center of Environmental Analysis and Testing

National Center of Environmental Analysis and Testing is a center for the methodologies of analysis and testing and technology researches of environmental sciences. The work includes: analysis and testing of the key national research programs of sciences and technologies, and major engineering projects; and to undertake the analysis and arbitration of environmental disputes; to provide services of analysis and testing; and to organize academic and technical exchanges of environmental analysis and testing.

Address: No. 1 Yuhuinanlu, Chaoyang District, Beijing 100029, P. R. China
Phone: 010-84637722
Fax: 010-84634275
Web: http://www.cneac.com

Chinese Academy of Sciences (CAS)

CAS was founded in Beijing on 1st November 1949 on the basis of the former Academia Sinica (Central Academy of Sciences) and Peiping Academy of Sciences. CAS is a leading academic institution and comprehensive research and development center in natural science, technological science, and high-tech innovation in China. The mission of CAS is: to conduct research in basic and technological sciences; to undertake nationwide integrated surveys on natural resources and ecological environment; to provide the country with scientific data and advice for governmental decision-making, and to undertake government-assigned projects with regard to key S&T problems in the process of social and economic development; to initiate personnel training; and to promote China's high-tech enterprises by its active involvement in these areas.

Address: 52 Sanlihe Rd., Beijing 100864, P. R. China
Phone: 86-10-68597289
Fax: 86-10-68512458
Email: bulletin@mail.casipm.ac.cn
Web: http://www.cas.cn/

Chinese Academy of Engineering (CAE)

The Chinese Academy of Engineering was established in 1994. As the most prestigious and informative advisory institution in China's engineering science and technology, the academy boasts a group of academics with outstanding contributions to engineering and technological sciences. The Academy is a national and independent organization composed of elected members with the highest honor in the community of engineering and technological sciences of the nation. Its missions are to initiate and conduct strategic studies, provide consultancy services for decision-making of nation's key issues in engineering and technological sciences and promote the development of the undertaking of engineering and technological sciences in China and devote itself to the benefit and welfare of the society.

Address: 2 BingJiaoKou HuTong, Beijing 100088, P. R. China
Beijing Post Box 8068
Phone: 8610-59300264
Fax: 8610-59300140
Email: CAEChn@cae.cn
Web: http://www.cae.cn/index.html

Institute of Materia Medica, Chinese Academy of Medical Sciences and Peking Union Medical College

The main task of the institute is searching for new drugs for treatment of commonly occurring diseases that seriously threaten people's health. These include cancer, cardio- and cerebral vascular diseases, inflammatory and immunological disease, hepatitis and other viral diseases, disorders of nervous system and retrogression of old age, etc. At the same time, emphasis is put on the application and development of modern medical theory and high technology.

Address: 1 Xian Nong Tan, Beijing 100050, P. R. China
Phone: 86-10-63037394
Fax: 86-10-63017757
Email: webmaster@imm.ac.cn
Web: http://www.imm.ac.cn/

Non-government Organizations (NGOs)/Societies

The China Association for Science and Technology (CAST)
Address: 3 Fuxing Road, Beijing 100863, P. R. China
Phone: 8610-68571898
Fax: 8610-68571897
Email: castint@cast.org.cn
Web: http://www.cast.org.cn/

Chinese Environmental Mutagen Society (CEMS)
Address: 38, College Road, Haidian District, Beijing 100083, P. R. China
Phone: 10-62335754
Fax: 10-62335754
Email: iaems_cn@163.com; a38@cast.org.cn
Web: http://www.cems.org.cn/html/us.htm

Chinese Medical Association (CMA)
Address: 42, Western Dongsi Avenue, Beijing 100710, P. R. China
Phone: 010-85158515
Web: http://www.cma.org.cn/

Chinese Pharmaceutical Association (CPA)
Address: 18/F Tower 9, Jianwai SOHO, No. 4 Jianwai Street, Chaoyang District, Beijing 100022, P. R. China
Phone: 0086-10-58699271
Fax: 0086-10-58699272
Email: Beijing2007@cpa.org.cn
Web: http://www.cpa.org.cn/en/english.htm

Chinese Pharmacological Society
Address: 1 Xian Nong Tan, Beijing 100050, P. R. China
Phone: 010-63165211
E-mail: cnphars@cnphars.org;
Web: http://www.cnphars.org/default.htm

Chinese Preventive Medicine Association (CPMA)
Address: 154, Western Gulou Avenue, Western District, Beijing, 100009, P. R. China
Phone: (010)64014326
Email: cpma@mail.cpma.org.cn
Web: http://www.cpma.org.cn/

Chinese Society for Environmental Sciences
Address: 54, Hongliannancun, Beijing 100082, P. R. China
Phone: 010-82211021
Email: mailto:LYJLP@sina.com
Web: http://www.chinacses.org/CN/index.html

CHAPTER

85

Czech Republic

M. HORNYCHOVA AND J. VESEAL

HISTORY OF TOXICOLOGY IN THE CZECH REPUBLIC

It was not until 1987 that toxicology was recognized by the Czechoslovak Academy of Sciences (ČSAV) as being a scientific discipline, and was classified as an independent combined medical discipline.

At the same time the Chair of Toxicology at the Institute of Postgraduate Medical and Pharmaceutical Studies (ILF, presently Institute for Postgraduate Medical Education – IPVZ) in Prague was established.

Although not initially recognized as a scientific discipline, toxicology began to make its presence felt in all areas – health care, education, the chemical and food industries, and later in relation to the environment – after the establishment of Czechoslovakia in 1918.

Health Care

The Minister of Health, Vavro Šrobár, had originally been engaged in the planning of a national public health institute which, with a donation from the Rockefeller Foundation was opened on November 5, 1925 as the NIPH.

During the time of the First Republic, the NIPH became an eminent scientific institution. Its activities included the manufacture of sera and vaccines, wide-ranging scientific activities, and participation in bacteriological and pharmaceutical research. Another important part of the institute was a public health department concerned with nutritional hygiene, occupational health, living conditions, etc. In 1942, a veterinary department was set up containing laboratories for the analysis of meat and milk.

In 1952, an edict by the Ministry of Health included the establishment of the Institute of Epidemiology and Microbiology, the Institute of Hygiene, and the National Institute for Research and Control of Drugs. A fourth institute was added in 1962, the Institute of Industrial Hygiene and Occupational Diseases.

On January 1, 1953, the Department of Veterinary Hygiene was established within the Ministry of Agriculture (National Institute of Public Health 2007).

One of the most prominent people in Czech toxicology was MUDr. Jaroslav Teisinger, DrSc. (1902–1985), founder of the Czech occupational medicine school, who also founded the first advisory bureau for occupational diseases in 1932. In 1942, with his participation, the First Congress of Occupational Medicine was convened and made the motion to consider, in the program of the Second Congress (1947), the problem of solvents in the working environment.

In 1947, at the Charles University Faculty of Medicine there was established the Clinic of Occupational Diseases. Prof. Teisinger became its first Head Physician. The Clinic served as an undergraduate and postgraduate training facility. The scope of the Teisinger school was on the one hand problems of occupational pulmonary diseases (silicosis, asbestosis, allergic pulmonary diseases), and on the other, problems of toxicology. In 1952, Prof. Teisinger founded the Institute of Occupational Hygiene and Occupational Diseases, which is now incorporated in the National Institute of Public Health as the Center of Occupational Medicine. There, in the early 1950s, workplace limits for toxic substances were recommended and established, with Prof. Teisinger presiding over that activity. In 1962, a Toxicology

Information Center was established at the Clinic. It was one of the first not only in Europe but in the whole world, its head being MUDr. Jarmila Filipová. It was a unique facility that provided information on the diagnosis and treatment of acute intoxications, for the needs of professionals and the lay public in the Czech Republic and abroad. On the initiative of Prof. Teisinger, in 1968, the file of the Toxicology Information Center was officially recognized by the University Hospital directorate as a department of the Clinic, and retained the name, Toxicology Information Center (Apatykar.info 2007).

The Specialised Group for Toxicological Chemistry of the Czechoslovak Chemical Society commenced its activities in 1964. Its members were recruited from the ranks of chemists, physicians, pharmacists, veterinarians, the military, and other professions. Its founder and first committee chairman was Prof. MUDr. Ing, Dr. Karel Kácl, DrSc. (1900–1986), chairman of the Chair of Medical Chemistry I at the Charles University Faculty of Medicine in Prague in the years 1945–1970. In the pre-World War II period he had founded the Department for Chemical Poisons. In 1953, he established a laboratory, the name of which was changed to the Institute for Toxicology and Forensic Chemistry – up to 1990 together with the 1st Institute for Medical and Forensic Chemistry forming a common Chair. In 1990 that Chair was divided into the First Institute of Medical Chemistry and Biochemistry and the Institute for Toxicology and Forensic Chemistry, the latter existing independently from 1990–1998, and now integrated into the Institute of Forensic Medicine and Toxicology of the First Faculty of Medicine and the Faculty General Hospital.

Military Toxicology

The Chair of Military Toxicology was formed in September 1, 1951, and dedicated to problems of chemical weapons and the prevention of their effects. In the early 1950s, the activities were purely educational. Later, research focused mostly on yperite (mustard gas), cyanide and nerve-paralyzing substances, was initiated. However, results were classified and there were only very few publications. A practical output was research, development, and introduction of the re-activator pralidoxime (2-PAM). In 1965, a lay syringe (LIS) containing atropine was introduced in Czechoslovakia. At the close of the 1960s, as a result of research, maximum admissible doses for nerve-paralyzing agents and yperite were recommended. In the early 1970s, research was focused on protection against nerve-paralyzing agents. In the early 1980s, very potent antidotes against nerve-paralyzing substances were developed, some of which the army is equipped with to date. The 1990s have witnessed intensive research, namely in the area of non-cholinergic effects of nerve-paralyzing agents, improved treatment of poisonings with soman and tabun, and the study of the effects of inhalation exposure to low concentrations of sarine (Institute of Analytical and Food Chemistry 2007).

The Field of Chemistry

The development of toxicology in the Czech Republic was influenced greatly by the appearance of the chemical industry and the production of novel chemicals, especially after World War II. As an example, we present the development of the discipline of toxicology at one faculty. Following the formation of an independent Czechoslovakia in 1918, the Czech Technical University arose from the Imperial and Royal Czech Polytechnic Institute in Prague, becoming the Czech Technical University (ČVUT) in 1920. This included the Chemical and Technological Engineering University (VŠCHTI). Established therein was the Institute of Analytical and Food Chemistry, concerned with general analytical chemistry and the analysis and testing of foodstuffs, and host lectures on Toxicology and Forensic Chemistry and Microscopy. In the academic year 1938/39, Professor Hanuš held lectures in Analysis of Foodstuffs and practicals in Chemical Analysis of Foodstuffs and Spices and the subject The Testing of Foodstuffs. Professor Hanuš (1872–1955) can be considered to be the true founder of the chemistry and analysis of foodstuffs in our country; he was one of the eminent analytical chemists of that period. In 1939, part of the curriculum in the field of food chemistry was transferred to and became a component of the curriculum of the Institute of Chemical Technology of Foodstuffs and Food Science, founded in 1925, at the VŠCHTI. The development of food chemistry and analysis in the period between the two World Wars has been underscored by the introduction of modern instruction by experts in food quality control through postgraduate studies. Much of the training was designed for state food testing institutions and the ministries. In 1952, an independent University of Chemical Technology (VŠCHT) was formed and within its framework the Faculty of Food Technology (FPT). In 1959, the Analysis of Foodstuffs was first included in the curricula of all FPT disciplines. In the academic year 1969/70 the Faculty was renamed Faculty of Food and Biochemical Technology (FPBT). In 1990, the Faculty returned to its former name (Faculty of Military Health Sciences of the University of Defence 2007).

References

Apatykar.info (2007) (homepage on the Internet) Clinic of Occupational Diseases and Toxicology Information Center, Faculty General Hospital in Prague and 1st Faculty of Medicine, Charles University; c2002–2007 (cited 2007 Mar 5). Available from: http://lekarnici.apatykar.cz/index.php?id=13.

Faculty of Military Health Sciences of the University of Defence (2007) (homepage on the Internet) Hradec Králové: Chair of Toxicology – History (cited 2007 Mar 5). Available from: http://www.pmfhk.cz/Katedry/ktox_historie.htm.

Institute of Analytical and Food Chemistry FPBT, University of Chemical Technology (2007) (homepage on the Internet) Prague: History of Institute of Analytical and Food Chemistry (cited 2007 Mar 5). Available from: http://www.vscht.cz/zkp/ustav/historie.htm.

National Institute of Public Health (2007) (homepage on the Internet) Prague: The Establishment of the NIPH; c2003 (cited 2007 Mar 5). Available from: http://www.szu.cz/English/niph1/history.htm.

RESOURCES

Books

Balíková M (2004)
Forensic and Clinical Toxicology
Prague: Galén
ISBN 80-7262-284-6

This book is designed foremost for students of medicine, natural sciences and pharmacology, as well as for specialists within the framework of continuing professional education in health care, criminalistics and judiciary. It provides orientation in complex toxicological problems, in areas such as pharmacokinetics; biotransformation, general approaches to the treatment of acute intoxications, laboratory diagnostics of intoxications and the developmental trends in analytical toxicology, and presents individual noxae causing acute poisonings. It presents legislation concerning addictive substances. There is also practical information regarding acute poisonings.

Bencko V, Cikrt M, Lener J (1995)
Toxic Heavy Metals in the General and Occupational Environment
Prague: Grada
ISBN 80-7169-150-X

This publication is intended for professionals who are involved in the problems of protecting the environment. Its aim is to contribute to the practical application of knowledge in the field of toxicology with regard to metals, their genotoxic and carcinogenic effects and immunotoxicity in the effort to improve the environment by way of industrial operations, and to contribute to the gradual reduction of toxic metals in the food chain.

Hrdina V (2004)
Natural Toxins & Poisons
Prague: Galén
ISBN 80-7262-256-0

This publication acquaints the professional and public with problems concerning natural toxins of bacterial, plant, and animal origin. It reviews toxicokinetics, and presents the characteristics and organotropic properties of poisons and toxins, as well as the principles of treating acute intoxications caused by natural toxins.

Marhold J (1980)
Survey of Industrial Toxicology: Inorganic Substances
Prague: Avicenum

This book represents a fundamental work in industrial toxicology. It presents a list of inorganic substances and a detailed description of them including their toxicological parameters.

Marhold J (1986)
Survey of Industrial Toxicology: Organic Substances
Prague: Avicenum

The book is a companion to the one above. It presents a list of organic substances and a detailed description of them, including their toxicological parameters.

National Institute of Public Health in Fortuna (1997)
Manual of Prevention in Medical Practice. Part 5. Prevention of Unfavourable Occupational Factors and Processes
Prague: National Institute of Public Health in Fortuna
ISBN 80-7071-060-8

Belonging to a series of methodological publications this handbook is intended not only for general practitioners but for students of the disciplines of preventive medicine. It describes in detail the individual factors in the working environment from the point of view of their characteristics and effects on humans. It further looks into workplace accidents, occupational diseases, and occupational health care at the enterprise.

National Institute of Public Health in Fortuna (2000)
Manual of Prevention in Medical Practice. Part 8. The Foundations of Health Risk Evaluation
Prague: National Institute of Public Health in Fortuna
ISBN 80-7071-161-2

This manual contains important information for all professionals dealing with the general and working environments. It focuses namely on the management of health risks due to exposure to chemical substances.

Occupational Safety Research Institute (2005)
Identification and Evaluation of Risk
Prague: Occupational Safety Research Institute
ISBN 80-903604-2-4

A revised edition of this book deals with approaches to and methods of risk assessment in two thematic units: Risk and Its Assessment; Methods and Identification in Risk Assessment. The objective of this publication is to assure that the limiting of risks becomes an essential component in the responsible management of every enterprise.

Pelclová D (2000)
The Most Frequent Types of Poisoning and Associated Therapy
Prague: Galén
ISBN 80-7262-074-6

This publication intends to orientate physicians in the treatment of acute poisonings. It presents various types of intoxications selected according to their frequency and seriousness. Each therapeutic approach has been updated on the basis of collaboration with the European Association of Poisons Centres and Clinical Toxicologists (EAPCCT).

Prokeš J, et al (2005)
The Foundations of Toxicology: General Toxicology and Ecotoxicology
Prague: Galén
ISBN 80-7262-301-X

A textbook for students of medicine summarizing basic pieces of knowledge in toxicology. It reflects present-day topics of interest such as drug addiction, conditions for testing various substances in laboratory animals, environmental protection and the negative effects of chemical noxae not only in industry and agriculture, but also in households, and the abuse of chemical weapons by extremist and terrorist groupings, etc.

Ševela K, Ševčík P, Kraus R (2002)
Acute Intoxication in Medicine
Prague: Grada
ISBN 80-7169-843-1

This publication, besides summing up the major clinical symptoms, laboratory findings, as well as listing antidotes for each toxic substance, presents reviews of differential diagnostic procedures. Further options are presented for the treatment of acute addictive drug intoxications in pre-hospital and post-hospitalization care.

Vondráček V, Riedl O (1980)
Clinical Toxicology: Pharmaceuticals, Foods, Poisonous Flora & Fauna
Prague: Avicenum

This publication presents a list of toxic substances and their effects on human health. It briefly characterizes each toxin and describes and analyzes the symptoms of poisonings. It also takes up the course and treatment of intoxications.

Reports

Environmental Health Monitoring System in the Czech Republic. Summary Reports 1998–2005
Prague: National Institute of Public Health
Web: http://www.szu.cz/chzpa/sumrep.htm (English)
Web: http://www.szu.cz/chzp/reporty.htm (Czech)

These reports present results of the monitoring and assessment of trends in pollution, exposure, impacts on health and health risks, that are the output of the Environmental Health Monitoring System (an integrated system of data collection, processing, and evaluation of information on the state of components of the environment and their influence on the health of the Czech population, with the aim of following up and evaluating temporal series of selected quality indicators of components of the environment and population health, assessing the magnitude of exposure of the population to noxae, and the consequent health impacts and risks).

Journals

In the Czech Republic there are no special journals focused on toxicology. However, relevant articles may be found in the following:

Air Protection
Prague: Civic Association for Protecting Ambient Air Quality
ISSN 1211-0337
Web: http://ochrana-ovzdusi.cz (Czech only)

The journal *Air Protection* publishes information on the pollution and quality of the ambient air in Prague and other regions of the Czech Republic. It popularizes results in science and research in the field of environmental protection, namely ambient air protection. On a long-term basis it is directed at workers in industry, the national administration and self-government bodies, inspection and public health services, as well as the general public.

Central European Journal of Public Health
Prague: National Institute of Public Health
ISSN 1210-7778

Web: http://www.szu.cz/svi/cejph/cejpheng.htm (English)
Web: http://www.szu.cz/svi/cejph/cejph.htm (Czech)

This journal is published in English and takes up the tradition of the international *Journal of Hygiene, Epidemiology, Microbiology and Immunology*. It is a platform for the publication of research in all spheres of public health.

Chemical Papers
Prague: Association of Czech Chemical Societies
ISSN 1213-7103
Web: http://chemicke-listy.vscht.cz/en/index.html (English)
Web: http://chemicke-listy.vscht.cz/cz/index.html (Czech)

This journal publishes papers in chemistry and related fields (biochemistry, environmental science, material science, pharmaceutics, food science, information science), and original papers on laboratory technique and methods.

Cosmos
Prague: Cosmos Ltd.
ISSN 1214-4029
Web: http://www.vesmir.cz (Czech only)

Cosmos is a popular science journal that publishes articles covering the whole vast field of natural sciences. It thereby records the present state as well as trends in each discipline. It is mainly addressed to naturalists and teachers.

Czech and Slovak Pharmacy
Prague: Czech Medical Association/J.E. Purkyně
ISSN 1210-7816
Web: http://www.clsjep.cz/en/nts/casop/farmacie/farmacie.asp (English)
Web: http://www.clsjep.cz/nts/casop/farmacie/farmacie.asp (Czech)

This journal publishes papers in the field of pharmacy and allied disciplines. It also provides information on research dealing with synthetic and natural drugs, pharmacokinetics, technology of new drug forms, cultivation of medicinal plants, pharmaceutical care, dispensing, etc. The journal is an important source of information for all pharmaceutists, healthcare personnel and specialists from areas connected with pharmacy and various aspects of therapeutic drugs.

Czech Occupational Medicine
Prague: Tigis
ISSN 1212-6721
Web: http://www.tigis.cz/prac/Index.htm (Czech only)

This journal publishes original papers and information from practice in occupational health care, studies in occupational diseases, industrial hygiene, ergonomics, technology, and environment.

Homeostasis
Prague: Collegium Internationale Activitatis Nervosae Superioris
ISSN 0960-7560
Web: http://www.szu.cz/chpnp/index.php?page=journals (English only)

This journal is devoted to studies of integrative brain functions in homeostasis, their adaptation to environmental and psychosocial conditions, and underlying mechanisms ranging from molecular to systemic processes and behavior. Particularly encouraged are the following topics: central nervous and endocrine control of autonomic functions, ingestive behavior, neurocirculatory regulation, effects of stress and pertinent coping and intervention procedures, including drug effects, modification of lifestyle- and work-related risk factors which disturb homeostasis and may cause disease.

Occupational Medicine
Prague: Czech Medical Association/J.E. Purkyně
ISSN 0032-6291
Web: http://www.clsjep.cz/en/nts/casop/prac_lekar/prac_lekar.asp (English)
Web: http://www.clsjep.cz/nts/casop/prac_lekar/prac_lekar.asp (Czech)

This journal is focused on occupational hygiene, physiology and psychology, preventive care at worksites, and occupational diseases. The journal publishes papers from the clinical, epidemiological, experimental, and laboratory sphere, case-histories, diagnostic and differential diagnostic criteria, therapeutic procedures, rating criteria, and preventive provisions in occupational diseases and ancillary disciplines (orthopaedics, neurology, ENT, dermatology).

Databases

An ABC list of hazardous substances
Eurochem

A vast list of 300 000 substances with references to toxicological properties, R-, S-, labels, safety certificates, safety symbols, producers of chemical compounds.

Web: http://www.eurochem.cz/cindex

AISLP information system on pharmaceuticals
Zentiva

AISLP is an information system covering human, homeopathic, and veterinary therapeutic products registered in the Czech Republic and in Slovakia.

Web: https://www.zdravcentra.cz/cps/rde/xchg/zc/xsl/aislp.html?init=y

Biotox CZ

Poisons, narcotics, drugs; a complex of a number of interlinked projects dealing with natural substances and their effects on the human organism.

Web: http://www.biotox.cz/projekty.php

Database Eurochem
Eurochem

EuroChem is the B2B portal for chemical searching and chemical databases, offering chemicals exchange and trading. Chemical database EuroChem contains over 127 000 chemical compounds and over 250 000 properties including references to their sources.

Web: http://www.eurochem.cz/?LA=EN

Database of Medicinal Products
State Institute for Drug Control

The items in the database include homeotherapeuticals, over-the-counter remedies, and exclusive therapeuticals with insert information and synoptic data on each product.

Web: http://www.sukl.cz/cs02leciva/index.php

Food Safety Strategy
National Institute of Public Health

Information on harmful substances in foodstuffs – biological hazards, chemical hazards, radiation treatment of foodstuffs.

Web: http://www.chpr.szu.cz

Hazardous Substances Database Dance 2005
The Ministry of Industry and Trade of the Czech Republic

A database covering hazardous chemical substances that are listed in the Register of Chemical Substances Classified Obligatorily as Hazardous in decree No. 369/2005 Coll. (following the act on chemical substances and chemical products; classification, packaging and labeling hazardous chemical substances and chemical products).

Web: http://www.mpo.cz/cz/prumysl-a-stavebnictvi/dance/vyhledani-latek.html

Integrated Pollution Registry
The Ministry of Environment of the Czech Republic

At present, the Integrated Pollution Registry covers information on emissions (including accidental) into the ambient air, water, soil and on the transfer of 72 substances under mandatory notification. It is operated by CENIA, the Czech Environmental Information Agency. The Registry is a component of the Unified Environmental Information System.

Web: http://www.irz.cz

Lists of chemical substances: EINECS, ELINCS, and NPL
The Ministry of Environment of the Czech Republic

The lists of chemical substances EINECS, ELINCS, and NPL are published by the Ministry of Environment following Act No. 356/2003 Coll., on chemical substances and chemical agents, and amendments of certain laws. They describe and classify each substance and are thus a source of information for the safeguarding of health and the environment against their undesirable effects.

Web: http://chem-latky.env.cz

Official Czech Catalog of Pesticides

The list of registered products is a database of plant protection agents in which it has been demonstrated that the risk following their application is acceptable from the point of view of present-day knowledge as regards the health of humans, animals, and environmental protection. By decision of the State Phytosanitary Administration they have been approved for introduction on the market and exploitation in agriculture in the Czech Republic. The list describes the agents, their properties, use and mode of application.

Web: http://www.srs.cz/portaldoc/pripravky_na_ochranu_rostlin/registrace/registrace_pripravku/registr_pripravku06.zip

Transportation information system DOK
Ministry of Transport of the Czech Republic

The information system collects data about hazardous substances that may be the object of transport; it is available to administrative organs, rescue and emergency services, and those included in crisis management readiness at the traffic department. It serves as a source of information for the establishing of suitable conditions for the transport of such substances, and for the liquidation of the consequences in cases of an accident.

Web: http://cep.mdcr.cz/dok2/DokPub/dok.asp

Organizations

Government

Academy of Sciences of the Czech Republic

The Academy is a public non-university scientific institution of the Czech Republic encompassing a complex of research institutes engaged primarily in basic research. AS CR formulates and pursues a conceptual policy of science and research, participates in national and international research programs, promotes cooperation with the application sphere, and fosters the development of education, scholarship and culture.

Address: Národní 3, 117 20 Prague 1, Czech Republic
Phone: +420 221 403 111
Fax: +420 224 240 512
Email: info@cas.cz
Web: http://www.cas.cz/en (English)
Web: http://www.cas.cz (Czech)

Institute of Biophysics, Academy of Sciences of the Czech Republic

The Institute is involved in (a) research dealing with the physical and chemical characteristics of the structure and interactions of bio-macromolecules, (b) research in the biophysical properties of live organisms, including the action of environmental factors, and (c) theoretical investigations in those fields.

Address: Královopolská 135, 612 65 Brno, Czech Republic
Phone: +420 541 517 111
Fax: +420 541 211 293
Email: ibp@ibp.cz
Web: http://www.ibp.cz/index.php (English)
Web: http://www.ibp.cz (Czech)

Institute of Chemical Process Fundamentals, Academy of Sciences of the Czech Republic

The Institute of Chemical Process Fundamentals (ICPF) is one of the six institutes constituting the Section of Chemical Sciences of the Academy of Sciences of the Czech Republic. The Institute functions as a center for advanced research in chemical, biochemical, catalytic, and environmental engineering and it acts as a graduate school for PhD studies in the fields of chemical engineering, physical chemistry, industrial chemistry, and biotechnology.

Address: Rozvojova 2, 165 02 Prague 6, Czech Republic
Phone: +420 220 390 111
Fax: +420 220 920 661
Email: icecas@icpf.cas.cz
Web: http://www.icpf.cas.cz/Default.aspx?lang=EN (English)
Web: http://www.icpf.cas.cz (Czech)

Institute of Experimental Medicine, Academy of Sciences of the Czech Republic

The Institute of Experimental Medicine of the Academy of Sciences of the Czech Republic is the leading institution in the Czech Republic for biomedical research, particularly in cell biology and pathology, neurobiology, neurophysiology, neuropathology, developmental toxicology and teratology, molecular pharmacology, immunopharmacology, molecular embryology, stem cells and nervous tissue regeneration. The Institute is an internationally recognized center in these fields, and as such it was selected as an EU Center of Excellence (MEDIPRA).

Address: Vídeňská 1083, 142 20 Prague 4, Czech Republic
Phone: +420 241 061 111
Fax: +420 241 062 782
Email: uemavcr@biomed.cas.cz
Web: http://uemweb.biomed.cas.cz (English only)

Institute of Macromolecular Chemistry, Academy of Sciences of the Czech Republic

The task of the Institute of Macromolecular Chemistry, Academy of Sciences of the Czech Republic, is to pursue basic, target-oriented, and applied research in the chemistry and physics of polymers. The research comprises the three main areas: Biomacromolecular systéme, Dynamics and self-assembling of molecular and supramolecular polymer structures, Preparation, characterization and use of new polymeric systems with controlled structure and properties.

Address: Heyrovského nám. 2, 162 06 Prague 6, Czech Republic
Phone: +420 296 809 111
Fax: +420 296 809 410
Email: office@imc.cas.cz
Web: http://www.imc.cas.cz/en/index.html (English)
Web: http://www.imc.cas.cz/czisol2/index.html (Czech)

Institute of Organic Chemistry and Biochemistry, Academy of Sciences of the Czech Republic

The Institute performs fundamental research in organic chemistry, biochemistry and related disciplines oriented mostly to medicinal and environmental applications. The Institute is involved in university level of education and supervises diploma and PhD studies.

Address: Flemingovo nám. 2., 166 10 Prague 6, Czech Republic
Phone: +420 220 183 333
Fax: +420 220 183 578
Email: uochb@uochb.cas.cz
Web: http://www.uochb.cas.cz/Welcome_en.html (English)
Web: http://www.uochb.cas.cz/Welcome_cz.html (Czech)

CENIA (Czech Environmental Information Agency)

The Czech Environmental Institute (CEI) was established in 1992. The Czech Environment Information Agency (CENIA) was founded on the grounds of the Czech Environment Institute on 1 April, 2005. The objectives of the organization are: (a) to operate and develop a unified environmental information system including primary data validation and information syntheses; (b) to formulate possibilities of active environmental influencing in compliance with the strategy of sustainable development; (c) to develop and validate methods of land-development and landscape regeneration procedures; (d) to develop and validate methods of identification and assessment of environmental risks; (e) to monitor the development and efficiency of the legislation and other tools of environmental policy and propose measures in this area; (f) to research environmental technologies; (g) to keep an integrated pollution register; (h) to prepare forecasts, alternative scenarios and to propose measures within the business objective to be used as data for the decision-making process of the Ministry.

Address: Kodaňská 10, 100 10 Prague 10, Czech Republic
Phone: +420 267 225 232
Fax: +420 271 742 306
Email: info@cenia.cz
Web: http://www.cenia.cz/__C1257257003305C2.nsf/index.html (English)
Web: http://www.cenia.cz/__C12571B20041F1F4.nsf/index.html (Czech)

Czech Agriculture and Food Inspection Authority

CAFIA is a state administration body subordinate to the Ministry of Agriculture. It is a state authority responsible for supervision of the safety, quality, and labeling of foodstuffs.

Address: Květná 15, 603 00 Brno, Czech Republic
Phone: +420-543 540 111
Fax: +420-543 540 202
Email: epodatelna@szpi.gov.cz
Web: http://www.szpi.gov.cz/eng/default.asp (English)
Web: http://www.szpi.gov.cz/cze/default.asp (Czech)

Czech Environmental Inspectorate

The Czech Environmental Inspectorate is a professional body of the state administration, which is charged with supervising the rules of law in regard to the environment. This body also has oversight for binding decisions of administrative authorities in the environmental realm. The Czech Environmental Inspectorate was established by the Act No. 282/1991 of the Czech National Council in 1991 and it is an independent budgetary organization subordinate to the Ministry of the Environment of the Czech Republic.

Address: Na Břehu 267, 190 00 Prague 9, Czech Republic
Phone: +420 283 891 564
Fax: +420 283 892 662
Email: Public@cizp.cz
Web: http://www.cizp.cz/(yyfizf55hc2anvnwxoot0i45)/default.aspx?l=2 (English)
Web: http://www.cizp.cz/(yyfizf55hc2anvnwxoot0i45)/default.aspx?l=1 (Czech)

Czech Statistical Office

Address: Na padesátém 3268/81, 100 00 Prague 10, Czech Republic
Phone: +420 274 051 111
Fax: +420 233 551 068
Email: infoservis@czso.cz
Web: http://www.czso.cz/eng/redakce.nsf/i/home (English)
Web: http://www.czso.cz/csu/redakce.nsf/i/home (Czech)

Czech Trade Inspection

The Czech Trade Inspection is a state administration body subordinated to the Ministry of Industry and Trade. Its major objective and activities relate to checking up on the observance of regulations in the realm of the domestic market and consumer protection.

Address: Štěpánská 15, 120 00 Prague 2, Czech Republic
Phone: +420 296 366 111
Fax: +420 296 366 236
Email: info@coi.cz
Web: http://www.coi.cz/internet/(i4qolp55m3nwip55h210sdar)/default.aspx (English)
Web: http://www.coi.cz/internet/(rugpot45u0ged2ficzhfq445)/default.aspx (Czech)

Institute of Health Information and Statistics of the Czech Republic

This is a government organization founded by the Ministry of Health. The main task and object of activity of the Institute is the management and co-ordination of the National Health Information System (NHIS), including its further development and improvement. The functions of NHIS include the collection and processing of information concerning health and health care, management of national health registries, provision of information in the extent determined by law and other regulations respecting protection of personal data, and exploitation of this information in health research. The tasks of IHIS CR and of NHIS are defined by Act No. 20/1966 Coll., on National Health Care.

Address: Palackého nám. 4, P.O. Box 60, 128 01 Prague 2, Czech Republic
Phone: +420 224 972 712, +420 224 972 243
Fax: +420 224 915 982
Email: uzis@uzis.cz
Web: http://www.uzis.cz/news.php?mnu_id=1000&lng=en (English)
Web: http://www.uzis.cz/news.php?mnu_id=1000&lng=cz (Czech)

Institute for Occupational Safety Education

The Institute of Occupational Safety Education was established in Brno in 1974. It is devoted to the training and education of employees of the state supervision and the professional public in safety at work.

Address: Cejl 10, 658 38 Brno, Czech Republic
Phone: +420 545 423 951
Fax: +420 545 423 953
Email: ivbp@ivbp.cz
Web: http://www.ivbp.cz (Czech only)

Institute for State Control of Veterinary Biologicals and Medicaments

The Institute has been established as a bureau of the administration by Act No. 79/1997 Coll., on pharmaceuticals. Namely, it issues decisions on the registration of therapeutical agents and approvals for the production of such, including medicated feeds and veterinary autogenous vaccines.

Address: Hudcova 56a, 621 00 Brno, Czech Republic
Phone: +420 541 518 211
Fax: +420 541 210 026
Email: uskvbl@uskvbl.cz
Web: http://www.uskvbl.cz (Czech only)

Ministry of Agriculture of the Czech Republic

The Ministry of Agriculture is a central authority of the state administration for agriculture excepting preservation of agricultural land fund, for water management excepting preservation of natural water accumulation, preservation of water sources and preservation of water quality, and for the food industry. It is also a central state authority administering forests, hunting and gamekeeping and fisheries outside the territory of national parks. Further in the matter of veterinary and plant care, of protection of animals against cruelty, and of protection of rights to new plant varieties and to new breeds of animals. The Ministry of Agriculture administrates the Czech Agricultural and Food Inspection, the State Veterinary Administration of the Czech Republic, the State Board of Plant-Care, the Central Institute for Supervising and Testing in Agriculture, the Czech Breeding Inspectorate, and the Czech Inspection for Improvement and Breeding of Farming Animals.

Address: Těšnov 17, 117 05 Prague 1, Czech Republic
Phone: +420 221 811 111
Fax: +420 224 810 478
Email: info@mze.cz
Web: http://www.mze.cz/en (English)
Web: http://www.mze.cz (Czech)

Ministry of the Environment of the Czech Republic

The Ministry of the Environment (MoE) was set up under Act of the Czech National Council No. 173/1989 Coll., effective as of 1 January 1990, as a central state administration authority and the supreme supervisory body in environmental affairs. The Ministry of the Environment is the central state administration authority for: (a) the protection of the natural accumulation of water, (b) the protection of water resources and the protection of ground and surface water quality, (c) air protection, (d) the conservation of nature and the landscape, (e) the protection of agricultural land resources, (f) the performance of the state geological survey, (g) the protection of the geological environment, including the protection of mineral resources and ground water, (h) geological works and environmental supervision of mining, (i) waste management, (j) impact assessments of activities and their environmental consequences, including those extended beyond state borders, (k) hunting, fishing, and forestry in national parks, (l) state environmental policy. To safeguard the inspecting activities of the Czech Government, the Ministry of the Environment coordinates the procedure of all ministries and other central state administration authorities of the Czech Republic in environmental matters.

Address: Vršovická 65, 100 10 Prague 10, Czech Republic
Phone: +420 267 121 111
Fax: +420 267 310 308
Email: posta@env.cz
Web: http://www.env.cz/__C1257131004B200D.nsf/index.html (English)
Web: http://www.env.cz (Czech)

Ministry of Health

The Ministry of Health of the Czech Republic is a central organ of the state administration covering health care and public health protection.

Address: Palackého nám. 4, 128 01 Prague 2, Czech Republic
Phone: +420 224 971 111
Fax: +420 224 972 111
Email: mzcr@mzcr.cz
Web: http://www.mzcr.cz/ (Czech only)

Ministry of Industry and Trade of the Czech Republic

The Ministry of Industry and Trade is the central body of the government administration involved in: (a) the national industry policy, trade policy, foreign economic policy, integrated raw materials policy, the use of mineral resources, energy, gas and heat production, mining, crude oil, natural gas, solid fuels, nuclear materials, ores and non-ores treatment and conversion, (b) metallurgy, machinery, electrical engineering and electronics, the chemical industry, crude oil processing, the rubber and plastic materials industry, the glass and ceramics industry, the textile and clothing industry, the leather and print industry, the paper, cellulose and woodworking industry, building materials production, building industry production, medical production, junk and metal waste, (c) domestic trade and the protection of consumers interests, foreign trade and supporting exports, (d) small and medium-sized companies matters with the exception of regional business support and trading matters.

Address: Na Františku 32, 110 15 Prague 1, Czech Republic
Phone: +420 224 851 111
Fax: +420 224 811 089
Email: posta@mpo.cz
Web: http://www.mpo.cz/default_en.html (English)
Web: http://www.mpo.cz (Czech)

Ministry of Labour and Social Affairs of the Czech Republic

The Ministry of Labour and Social Affairs (MoLSA) was established in 1990. It is responsible for social policy (e.g. people with disabilities, social services, social benefits, family policy), social security (e.g. pensions, sickness insurance), employment (e.g. labor market, employment support, employment of foreigners), labor legislation, occupational safety and health, equal opportunities for women and men, migration and integration of foreigners, European Social Fund and other social or labor-related issues.

Address: Na Poříčním právu 1/376, 128 01 Prague 2, Czech Republic
Phone: +420 221 921 111
Fax: +420 224 918 391
Email: posta@mpsv.cz
Web: http://www.mpsv.cz/en/ (English)
Web: http://www.mpsv.cz/cs/ (Czech)

National Institute for Nuclear, Chemical and Biological Protection

The Institute is a non-profit organization established on the basis of a decision made by the chairman of the State Office for Nuclear Safety Prague on Jan. 1, 2000. The Institute was founded in order to: (a) conduct measuring and collect data to be used for the evaluation of impacts of nuclear, chemical, and biological substances on humans and the environment; (b) measure and evaluate the level of protection against the aforementioned substances provided by both individual and collective protective equipment; (c) conduct research and development in that area; (d) participate in monitoring activities conducted by the SÚJB in the area of nuclear protection and verification of compliance with regulations prohibiting the use of chemical, bacteriological (biological) and toxin weapons; (e) conduct training and educational activities; (f) provide services in the area of personal dosimetry and monitoring.

Address: 262 31 Milín-Kamenná 71, Czech Republic
Phone: +420 318 600 200
Fax: +420 318 626 055
Email: sujchbo@sujchbo.cz
Web: http://www.sujchbo.cz/dokument.php?cislo=2&jazyk=en (English)
Web: http://www.sujchbo.cz/dokument.php?cislo=2&jazyk=cs (Czech)

National Institute of Public Health

The National Institute of Public Health (NIPH) is a healthcare establishment for basic preventive disciplines: hygiene, epidemiology, microbiology, and occupational medicine. Its main tasks are health promotion and protection, disease prevention, and follow-up of the environmental impact on population health.

Address: Šrobárova 48, 100 42 Prague 10, Czech Republic
Phone: +420 267 081 111

Fax: +420 272 744 354
Email: zdravust@szu.cz
Web: http://www.szu.cz/English/english.htm (English)
Web: http://www.szu.cz (Czech)

National Radiation Protection Institute

The National Radiation Protection Institute (NRPI) is a non-profit organization established by the decision of the chairman of the State Office for Nuclear Safety (SONS) on May 26, 1995, which became effective on July 1, 1995. The Institute was based mainly on the former Centre for Radiation Hygiene of the National Institute of Public Health in Prague transferred under the authority of SONS, and it continues its tradition of many years.

Address: Bartoškova 28, 140 00 Praha 4, Czech Republic
Phone: +420 241 410 214
Fax: +420 241 410 215
Email: suro@suro.cz
Web: http://www.suro.cz/en/index.html (English)
Web: http://www.suro.cz (Czech)

Occupational Safety Research Institute

The mission and goal of OSRI is research in and development of means to reduce the risks involved in work activities and increase production efficiency, work culture and work satisfaction. It achieves its mission by: (a) monitoring and foreseeing trends in workplace safety and health protection, (b) a comprehensive and systematic approach, (c) the quality of our services and products.

Address: Jeruzalémská 9, 116 52 Prague 1, Czech Republic
Phone: +420 221 015 811
Fax: +420 224 238 550
Email: krizkova@vubp-praha.cz
Web: http://www.vubp.cz/strankyaj.php (English)
Web: http://www.vubp.cz/index.php (English)

Radioactive Waste Repository Authority

The Radioactive Waste Repository Authority (RAWRA) was established on 1st June 1997 as the result of Decision of the Minister of Industry and Trade No. 107/1997 issued in pursuance of Article 26 of Act No. 18/1997 Coll., on the peaceful utilization of nuclear energy and ionizing radiation (the Atomic Act), as a state organization responsible for the management of activities related to the disposal of radioactive waste.

Address: Dlážděná 1004/6, 110 00 Prague 1, Czech Republic
Phone: +420 221 421 511
Fax: +420 221 421 544
Email: info@rawra.cz
Web: http://www.proe.cz/surao2/index.php?Lang=EN&p= (English)
Web: http://www.surao.cz (Czech)

Research Institute of Food Industry

Research Institute of Food Industry was founded in 1958 by an act of the then existing Ministry of Food Industry and Purchase. Since then it has played an important role in the scientific and technological research in this country and abroad. It has become an institution dealing with fundamental and applied research, with developments in food chemistry, biochemistry, and engineering.

Address: Radiová 7, 102 31 Prague 10, Czech Republic
Phone: +420 296 792 111
Fax: +420 272 701 983
Email: vupp@vupp.cz
Web: http://www.vupp.cz/ (English)
Web: http://www.vupp.cz/czvupp/index.htm (Czech)

State Environmental Fund of Czech Republic

The State Environmental Fund of the Czech Republic was founded on 4th Oct., 1991, by the Act on the State Environmental Fund of the Czech Republic (No. 338/1991 Coll.). The Fund is the essential economic instrument used to: (a) fulfill the obligations arising from international conventions on environmental protection; (b) fulfill the bonds of EU membership; (c) implement the National Environmental Policy.

Address: Kaplanova 1931/1, 148 00 Prague 11-Chodov, Czech Republic
Phone: +420 267 994 300
Fax: +420 272 936 597
Email: lnovak@sfzp.cz
Web: http://www.sfzp.cz/en (English)
Web: http://www.sfzp.cz/cs (Czech)

State Institute for Drug Control

The State Institute for Drug Control is an administration body established by the Act No. 79/1997 Coll. It falls under direct control of the Ministry of Health and is financed from the state budget. In the interest of public health protection, the Institute's mission is (a) to ensure that all human pharmaceuticals available on the Czech market meet appropriate standards of quality, safety and efficacy, and (b) to take care in ensuring that only safe and functional medical devices are used in the Czech Republic.

Address: Šrobárova 48, 100 41 Prague 10, Czech Republic

Phone: +420 272 185 111,+420 255 726 111
Fax: +420 271 732 377
Email: sukl@sukl.cz
Web: http://www.sukl.cz/enindex.htm (English)
Web: http://www.sukl.cz (Czech)

State Labour Inspection Office

The bureau and inspectorates check up on: (a) the fulfilling of obligations following from legal regulations in the area of occupational safety and health protection, (b) rights and duties in labor relations, (c) compliance with collective labor agreements in the section dealing with the legal rights of employees following from the labor code.

Address: Horní náměstí 103/2, 746 01 Opava, Czech Republic
Phone: +420 553 696 154
Fax: +420 553 626 672
Email: opava@suip.cz
Web: http://www.suip.cz/cubp_ddw/drvisapi.dll?MIval (Czech only)

State Office for Nuclear Safety

The Office is a regulatory body responsible for governmental administration and supervision in the fields of uses of nuclear energy and radiation and of radiation protection. The authority and responsibilities of the Office, as stipulated by Act No. 18/1997 Coll. on Peaceful Utilisation of Nuclear Energy and Ionising Radiation (Atomic Act).

Address: Senovážné náměstí 1585/9, 110 00 Prague 1, Czech Republic
Phone: +420 221 624 111
Fax: +420 221 624 837
Email: podatelna@sujb.cz
Web: http://www.sujb.cz/?r_id=26 (English)
Web: http://www.sujb.cz (Czech)

State Phytosanitary Administration

Activities of the State Phytosanitary Administration are mandated by Act No. 326/2004 Coll., on phytosanitary care and amendments to certain related laws. The main activities are concerning: protection of the territory of the Czech Republic and of the other EU member states against the introduction of harmful organisms from abroad through: (a) systematic phytosanitary inspection of propagating material, (b) diagnostics of diseases and pests of plants and plant products, (c) registration of pesticides and other plant protection products, their testing and testing methods of plant protection, supervision of pesticide testing in the Czech Republic, (d) testing of plant protection machinery and checking of its use.

Address: Těšnov 17, 117 05 Prague 1, Czech Republic
Phone:+420 221 813 004
Fax:+420 221 812 804
Email: sekretariat@srs.cz
Web: http://www.srs.cz/portal/page?_pageid=75,1&_dad=portal&_schema=PORTAL (English)
Web: http://www.srs.cz/portal/page?_pageid=74,1&_dad=portal&_schema=PORTAL (Czech)

State Veterinary Administration

The State Veterinary Administration of the Czech Republic is a public administration body under the Ministry of Agriculture of the Czech Republic and it was established according to the Veterinary Act No. 166/1999. Main tasks: (a) protection of consumers from products of animal origin likely to be harmful to human health, (b) monitoring of animal health situation and maintaining it favorable, (c) veterinary protection of the state territory of the Czech Republic, (d) animal welfare and animal protection.

Address: Slezská 7, 120 00 Prague 2, Czech Republic
Phone: +420 227 010 111
Fax: +420 227 010 191
Email: e.podatelna@svscr.cz
Web: http://www.svscr.cz/?lng=en&cat=0 (English)
Web: http://www.svscr.cz/?lng=cs&cat=0 (Czech)

T. G. Masaryk Water Research Institute

The Water Research Institute was among the first scientific institutes established in the independent republic of the Czechs and the Slovaks. This priority was the logical consequence of high attention that water management and use have had in the Czech lands for centuries.

Address: Podbabská 30, 160 62 Prague 6, Czech Republic
Phone: +420 220 197 111
Fax: +420 224 310 450
Email: info@vuv.cz
Web: http://www.vuv.cz/index.eng.php (English)
Web: http://www.vuv.cz (Czech)

Veterinary Research Institute

At present, the VRI is a funded institution and directly controlled by the Ministry of Agriculture of the Czech Republic. By the end of 2004, VRI had 230 employees. The Institute cooperates with numerous Czech and international research institutions and state executive organs. The VRI is the only specialized research institute in the Czech Republic aimed at investigation in the area of veterinary medicine including practical application of the research.

Address: Hudcova 70, 621 00 Brno, Czech Republic
Phone: +420 533 331 111
Fax: +420 541 211 229
Email: vri@vri.cz
Web: http://www.vri.cz/default.asp (English)
Web: http://www.vri.cz/default_cz.asp?page=first_cz.asp (Czech)

Non-Government

BioTest Ltd.

BioTest is a contract research laboratory offering comprehensive services in the safety assessment and environmental risk assessment of human and veterinary pharmaceuticals, industrial chemicals, food additives, agrochemical preparations, and other related fields.

Address: Pod Zámkem 279, 281 25 Konárovice, Czech Republic
Phone: +420 321 766 074, +420 321 766 075
Fax: +420 321 766 066
Email: zabsky@biotest.cz
Web: http://www.biotest.cz/index.htm (English)
Web: http://www.biotest.cz/cz/uvod-cz.htm (Czech)

Biopharm – Research Institute of Biopharmacy and Veterinary Drugs

Biopharm provides complex research and development of veterinary products for customers, and provides pharmaceutical services, conducts numerous specialized studies and tests for veterinary and human pharmacy as well as other branches.

Address: Pohori – Chotoun 90, 254 49 Jílové u Prahy, Czech Republic
Phone: +420 241 950 383
Fax: +420 241 950 503
Email: biopharm@bri.cz
Web: http://www.bri.cz/anglictina/home.htm (English)
Web: http://www.bri.cz/nove/home.htm (Czech)

EMPLA Ltd. – Environment Protection

EMPLA is involved in the research, development, and materialization of technologies designed for the protection of the environment and health. It provides complex services in environmental protection.

Address: Za Škodovkou 305, 503 11 Hradec Králové, Czech Republic
Phone: +420 495 218 875, +420 495 211 579
Fax: +420 495 217 499
Email: empla@empla.cz
Web: http://www.empla.cz/english.php (English)
Web: http://www.empla.cz/index.php (Czech)

Environmental Law Service – Legal Protection of Environment and Human Rights

The Environmental Law Service (ELS) is a non-governmental, non-profit, and non-political public interest organization of lawyers who use law to further the public interest.

Address: Na Rybníčku 16, 120 00 Prague 2, Czech Republic
Phone: +420 222 312 390
Fax: +420 224 941 092
Email: praha@eps.cz
Web: http://www.eps.cz/php/index-en.php (English)
Web: http://www.eps.cz/php/index.php (Czech)

MEDISTYL Ltd.

MEDISTYL provides information services, searches in the literature, patent information, a database of hazardous substances and services in the field of occupational therapy and occupational hygiene.

Address: Sezimova 13, 140 00 Prague 4, Czech Republic
Phone: +420 241 492 651
Fax: +420 241 492 692
Email: jaroslav.horky@medistyl.cz
Web: http://www.medistyl.cz/english.htm (English)
Web: http://www.medistyl.cz (Czech)

VUOS – Research Institute of Organic Synthese

One of the largest Czech firms dealing with research and development in the field of organic chemistry and toxicology. VUOS can offer a wide range of services based on personal, technical and legislative grounds, it is capable of covering all requirements in the field of industrial product testing.

Address: Rybitvi 296, 532 18 Pardubice, Czech Republic
Phone: +420 466 822 545
Fax: +420 466 823 900
Email: vuos@vuos.com
Web: http://www.vuos.com/vuos/index.php?lang=eng (English)
Web: http://www.vuos.com (Czech)

Universities

Problems of toxicology, chemical safety, and environmental health are a component of study programs and research activities of the institutes and departments at the following universities and higher education facilities.

First Faculty of Medicine, Charles University
Institute of Pharmacology

Institute of Hygiene and Epidemiology
Institute of Forensic Medicine and Toxicology
Address: Kateřinská 32, 121 08 Prague 2, Czech Republic
Phone: +420 224 961 111
Fax: +420 224 915 413
Email: office@lf1.cuni.cz
Web: http://www.lf1.cuni.cz/default.asp?nLanguageID=2 (English)
Web: http://www.lf1.cuni.cz (Czech)

Second Faculty of Medicine, Charles University
Department of Pharmacology
Department of Clinical Biochemistry and Pathobiochemistry
Department of Medical Chemistry and Biochemistry
Department of Public Health and Preventive Medicine
Department of Forensic Medicine
Address: V Úvalu 84, 150 06 Prague 5, Czech Republic
Phone: +420 224 431 111
Fax: +420 224 435 820
Email: helena.ulovcova@lfmotol.cuni.cz
Web: http://www.lf2.cuni.cz/homepage.htm (English)
Web: http://www.lf2.cuni.cz/index.htm (Czech)

Third Faculty of Medicine, Charles University
Department of Pharmacology
Centre of Preventive Medicine
Department of Forensic Medicine
Address: Ruská 87, 100 00 Prague 10, Czech Republic
Phone: +420 267 102 111
Fax: +420 267 311 812
Email: ilka.ouzka@lf3.cuni.cz
Web: http://www.lf3.cuni.cz/english/index.html (English)
Web: http://www.lf3.cuni.cz (Czech)

Faculty of Medicine in Hradec Kralové, Charles University
Department of Hygiene and Preventive Medicine
Department of Pharmacology
Department of Medical Biochemistry
Department of Forensic Medicine
Address: Šimkova 870, P.O.BOX 38, 500 38 Hradec Králové, Czech Republic
Phone: +420 495 816 111, +420 495 816 242, +420 495 816 243
Fax: +420 495 513 597
Email: dekanats@lfhk.cuni.cz
Web: http://www.lfhk.cuni.cz/start.asp?nLanguageID=2 (English)
Web: http://www.lfhk.cuni.cz/start.asp?nLanguageID=1 (Czech)

Faculty of Medicine in Plzeň, Charles University
Institute of Pharmacology and Toxicology
Institute of Medical Chemistry and Biochemistry
Institute of Hygiene
Department of Forensic Medicine
Address: Husova 3, 306 05 Plzeň, Czech Republic
Phone: +420 377 593 400
Fax: +420 377 593 449
Email: info@lfp.cuni.cz
Web: http://www.lfp.cuni.cz/Default.aspx (English)
Web: http://www.lfp.cuni.cz/contact_address.aspx (Czech)

Faculty of Pharmacy in Hradec Králové, Charles University
Department of Pharmacology and Toxicology
Department of Pharmaceutical Botany and Ecology
Address: Heyrovského 1203, 500 05 Hradec Králové, Czech Republic
Phone: +420 495 067 111
Fax: +420 495 518 002
Email: krieglerova@faf.cuni.cz
Web: http://www.faf.cuni.cz/en/Pages/default.aspx (English)
Web: http://www.faf.cuni.cz/org/dept/fkol/ (Czech)

Faculty of Science, Charles University
Department of Ecology
Institute for Environmental Studies
Section of Chemistry
Address: Albertov 6, 128 43 Prague 2, Czech Republic
Phone: +420 221 951 111
Fax: +420 221 951 127
Email: tajemnik@natur.cuni.cz
Web: http://www.natur.cuni.cz/www/en/index.php (English)
Web: http://www.natur.cuni.cz (Czech)

Faculty of Environmental Technology, Institute of Chemical Technology in Prague
Department of Environmental Chemistry
Address: Technická 3, 166 28 Prague 6, Czech Republic
Phone: +420 220 443 276
Fax: +420 233 335 216
Email: jaroslava.vitkova@vscht.cz
Web: http://www.vscht.cz/main/soucasti/fakulty/ftop/english/welcome/index.html (English)
Web: http://www.vscht.cz/main/soucasti/fakulty/ftop/index.html (Czech)

Faculty of Environment, J. E. Purkyně University in Ústí nad Labem
Department of Technical Science
Address: Králova výšina 3132/7, 400 96 Ústí nad Labem, Czech Republic
Phone: +420 475 284 111
Fax: +420 475 284 158
Email: blazkova@fzp.ujep.cz
Web: http://fzp.ujep.cz/en/index.php (English)
Web: http://fzp.ujep.cz/index.php (Czech)

Faculty of Science, J. E. Purkyně University in Ústí nad Labem
Department of Chemistry
Address: České mládeže 8, 400 96 Ústí nad Labem, Czech Republic
Phone: +420 475 283 223
Fax: +420 475 283 563
Email: info@sci.ujep.cz
Web: http://sci.ujep.cz/ (English)
Web: http://sci.ujep.cz/ (Czech)

Faculty of Medicine, Masaryk University in Brno
Department of Pharmacology
Department of Preventive Medicine
Address: Komenského nám. 2, 662 43 Brno, Czech Republic
Phone: +420 549 491 111, +420 549 496 266
Fax: +420 542 213 996
Email: mpaulik@med.muni.cz
Web: http://www.muni.cz/to.en/med/?lang=en (English)
Web: http://www.muni.cz/to.en/med/?lang=cs (Czech)

Faculty of Science, Masaryk University in Brno
Research Centre for Environmental Chemistry and Ecotoxicology
Department of Chemistry
Address: Kotlářská 2, 611 37 Brno, Czech Republic
Phone: +420 549 491 411, +420 549 496 360
Fax: +420 541 211 214
Email: pakosto@sci.muni.cz
Web: http://www.muni.cz/sci?lang=en (English)
Web: http://www.muni.cz/sci (Czech)

Faculty of Medicine, Palacký University in Olomouc
Institute of Medical Chemistry and Biochemistry
Institute of Pharmacology
Institute of Preventive Medicine
Institute of Forensic Medicine and Medical Law
Address: Tř. Svobody 8, 771 26 Olomouc, Czech Republic
Phone: +420 585 632 015
Fax: +420 585 632 015
Email: jitka.melcrova@upol.cz
Web: http://www.upol.cz/en/faculties/faculty-of-medicine-and-dentistry/faculty/ (English)
Web: http://www.upol.cz/fakulty/lf/aktuality-lf (Czech)

Faculty of Science, Palacký University in Olomouc
Department of Biochemistry
Department of Organic Chemistry
Department of Ecology and Environment
Address: Třída Svobody 26, 771 46 Olomouc, Czech Republic
Phone: +420 585 634 009
Fax: +420 585 225 737
Email: secret@prfnw.upol.cz
Web: http://www.upol.cz/en/faculties/faculty-of-science/faculty-of-science/ (English)
Web: http://www.upol.cz/fakulty/prf/ (Czech)

Faculty of Military Medicine, University of Defence
Department of Toxicology
Address: Kounicova 65, 612 00 Brno, Czech Republic
Phone: +420 973 253 101
Fax: +420 973 442 160
Email: sekretariat@pmfhk.cz
Web: http://www.unob.cz/en/struktura_fvz.aspx (English)
Web: http://www.unob.cz/struktura_fvz.aspx (Czech)

Medico-social Faculty, University of Ostrava
Institute of Clinical Pharmacology
Department of Hygiene and Epidemiology
Address: Syllabova 19, 703 00 Ostrava – Zábřeh, Czech Republic
Email: jaroslav.slany@osu.cz
Web: http://zsf.osu.eu/ (English)
Web: http://zsf.osu.cz/ (Czech)

Faculty of Chemical Technology, University of Pardubice
Institute of Environment Protection
Address: nám. Čs. legií 565, 532 10 Pardubice, Czech Republic
Phone: +420 466 037 294
Fax: +420 466 037 068
Email: dekanat.fcht@upce.cz
Web: http://genesis.upce.cz/english/english-faculties/en-fcht/ (English)
Web: http://www.upce.cz/fakulty/fcht/ (Czech)

Faculty of Health and Social Studies, University of South Bohemia in České Budějovice
Department of Radiology and Toxicology
Department of Ecology and Hydrobiology
Address: Jírovcova 24/1347, 370 04 České Budějovice, Czech Republic
Phone: +420 387 315 181
Fax: +420 387 438 389
Email: zsf@zsf.jcu.cz
Web: http://www.zsf.jcu.cz/faculty-of-health-and-social-studies/view?set_language=en (English)
Web: http://www.zsf.jcu.cz (Czech)

Research Institute of Fish Culture and Hydrobiology, University of South Bohemia in České Budějovice
Department of Aquatic Toxicology and Fish Diseases
Address: Zátiší 728/II, 389 25 Vodňany, Czech Republic
Phone: +420 383 382 402
Fax: +420 383 382 396
Email: vurh@vurh.jcu.cz

Web: http://www.vurh.jcu.cz/index_a.html (English)
Web: http://www.vurh.jcu.cz (Czech)

Faculty of Veterinary Medicine, University of Veterinary and Pharmaceutical Sciences in Brno
Institute of Pharmacology
Address: Palackého 1/3, 612 42 Brno, Czech Republic
Phone: +420 541 562 441
Fax: +420 549 248 841
Email: fvl@vfu.cz
Web: http://fvl.vfu.cz/index.html?lang=en (English)
Web: http://fvl.vfu.cz/index.html (Czech)

Faculty of Veterinary Hygiene and Ecology, University of Veterinary and Pharmaceutical Sciences in Brno
Institute of Veterinary Ecology and Environmental Protection
Institute of Public Veterinary Medicine and Pharmacology
Address: Palackého 1/3, 612 42 Brno, Czech Republic
Phone: +420 541 562 796
Fax: +420 549 243 020
Email: fvhe@vfu.cz
Web: http://fvhe.vfu.cz/index.html?lang=en (English)
Web: http://fvhe.vfu.cz/index.html (Czech)

Faculty of Pharmacy, University of Veterinary and Pharmaceutical Sciences in Brno
Institute of Human Pharmacology and Toxicology
Address: Palackého 1/3, 612 42 Brno, Czech Republic
Phone: +420 541 561 111
Fax: +420 541 219 751
Email: dekanfaf@vfu.cz
Web: http://faf.vfu.cz/english/index.htm (English)
Web: http://faf.vfu.cz (Czech)

Faculty of Mining and Geology, VŠB Technical University of Ostrava
Institute of Environmental Engineering
Address: Třída 17. listopadu 15, 708 33 Ostrava – Poruba, Czech Republic
Phone: +420 597 326 752, +420 597 325 456
Fax: +420 596 918 589
Email: sekretariat.hgf@vsb.cz
Web: http://en.vsb.cz/information-about/faculties/ (English)
Web: http://www.hgf.vsb.cz/oblasti/instituty-a-pracoviste/instituty/546 (Czech)

Professional Societies

Association of Chemical Industry of the Czech Republic

The Association is the most important organization for supporting the chemical industry in the Czech Republic. It was founded in 1992 as a voluntary association of manufacturing, commercial, designing, research and advisory organizations with relations to chemical, pharmaceutical, petrochemical, and rubber and plastics industries.

Address: Dělnická 12, 170 00 Prague 7, Czech Republic
Phone: +420 266 793 580
Fax: +420 266 793 578
Email: mail@schp.cz
Web: http://www.schp.cz/html/index.php?&lng=2 (English)
Web: http://www.schp.cz (Czech)

Czech Chemical Society

CCS is a member of the Association of the Czech Chemical Societies, Czech Union of Science and Technology Societies and the Federation of European Chemical Societies and EUCemSoc consortium.

Address: Novotného lávka 5, 116 68 Prague 1, Czech Republic
Phone: +420 221 082 383
Fax: +420 222 220 184
Email: csch@csch.cz
Web: http://www.csch.cz (Czech/English)

Czech Committee of Food Science and Technology

CCFoST represents the interests of the Czech Republic in the International Union of Food Science and Technology (IUFoST) as an Adhering Body.

Address: Technicka 5, 166 28 Prague 6, Czech Republic
Phone: +420 224 353 109
Email: pavel.kadlec@vscht.cz
Web: http://www.vupp.cz/ckpvt/english.htm (English)
Web: http://www.vupp.cz/ckpvt/index.htm (Czech)

Czech Pharmaceutical Society of the Czech Medical Association of J. E. Purkyně

This is a professional and scientific association with its seat in Hradec Králové and active on the territory of the Czech Republic. The Society is an independent, voluntary, non-governmental organization open to pharmacists and other specialists in health care and all related fields of activity.

Address: Faculty of Pharmacy Charles University, Heyrovského 1203, 500 05 Hradec Králové, Czech Republic
Phone: +420 495 067 403
Fax: +420 495 512 482
Email: jahodar@faf.cuni.cz
Web: http://en.cfs-cls.cz (English)
Web: http://www.cfs-cls.cz (Czech)

Czech Society for Experimental and Clinical Pharmacology and Toxicology of the Czech Medical Association of J. E. Purkyně

The society associates workers in experimental and clinical pharmacology and toxicology, and supports the universal development of those disciplines in the Czech Republic. It is a member of the International Union of Pharmacology (IUPHAR) and the European Union of Pharmacology (EPHAR), and expands relations with analogous organizations abroad.

Address: Department of Pharmacology, Faculty of Medicine, Simkova 870, 500 38 Hradec Králové, Czech Republic
Email: gersl@lfhk.cuni.cz
Web: http://farmspol.cls.cz/pharmacology.htm (English)
Web: http://farmspol.cls.cz/cile.htm (Czech)

Czech Society of Forensic Medicine and Forensic Toxicology of the Czech Medical Association of J. E. Purkyně

The fundamental function of the society is to guarantee the expertise and quality of forensic medical practice.

Address: Institute of Postgraduate Medical Studies, Chair of Forensic Medicine, FN Na Bulovce, Budínova 2, 180 81 Prague 8, Czech Republic
Phone: +420 266 083 437
Email: premysl.klir@email.cz
Web: http://www.cls.cz/spolecnosti/cls44.htm (Czech only)

Society of Occupational Medicine of the Czech Medical Association of J. E. Purkyně

The Society of Occupational Medicine gathers specialists in the field of occupational medicine. This discipline studies the impact of work and working conditions on the health of workers. It deals with the prevention, diagnostics, treatment, and medicolegal aspects of diseases caused or exacerbated by working conditions.

Address: Na Bojišti 1, 120 00 Prague 2, Czech Republic
Phone: +420 724 240 743, +420 606 334 732
Email: tucek.m@post.cz
Web: http://www.pracovni-lekarstvi.cz/aboutus.php (English)
Web: http://www.pracovni-lekarstvi.cz/onas.php (Czech)

Poison Control Center

Toxicological Information Centre
Address: Na Bojišti 1, 120 00 Prague 2, Czech Republic
Phone: +420 224 919 293
Email: tis@cesnet.cz
Web: http://whois.cuni.cz/cgi-bin/newho/.en.windows-1250?lan=en&db=uk&ask=!UK.5598&back= (English)
Web: http://whois.cuni.cz/cgi-bin/newho/.cs?db=uk&back=&ask=!UK.5598 (Czech)

Legislation

Act No. 262/2006 Coll., Labour Code
Web: www.mpsv.cz/files/clanky/3221/labour_code.pdf (English)
Web: Czech --- http://www.sbcr.info/cgi-bin/khm.cgi?typ=1&page=khm:PPSBA6/SBA6262A.HTM (Czech)

Collection of Laws
Web: http://www.mvcr.cz/sbirka (Czech only)

Portal of Public Administration
In full text of existing legislation from Coll. of Laws CR, as subsequently amended.
Web: http://portal.gov.cz/wps/portal/_s.155/699 or http://www.zakonynawebu.cz (Czech only)

Health Regulations

Act No. 258/2000 Coll., on Public Health Protection and on Amendment of Certain Acts, as Amended
Web: http://www.sbcr.info/cgi-bin/khm.cgi?typ=1&page=khm:PPSBA0/SBA0258A.HTM (Czech only)

Act No. 79/1997 Coll., on pharmaceuticals and amendments to some related acts
Web: http://www.sbcr.info/cgi-bin/khm.cgi?typ=1&page=khm:SSBC97/SBC97026.HTM;ca079_1997_00 (Czech only)

Act No. 110/1997 Coll., on foodstuffs and tobacco products and amending and supplementing some related laws
Web: http://www.sbcr.info/cgi-bin/khm.cgi?typ=1&page=khm:PPSB97/SB97110A.HTM (Czech only)

Act No. 167/1998 Coll., on dependency producing substances and on amendment of some other acts; regulation
Web: http://www.sbcr.info/cgi-bin/khm.cgi?typ=1&page=khm:PPSB98/SB98167A.HTM (Czech only)

Legislation Concerning Chemicals and Chemical Preparations

Act No. 356/2003 Coll., on chemical substances and chemical preparations and amendments to certain legislation
Web: http://www.env.cz/ris/vis-legcz-en.nsf/ (English)
Web: http://www.env.cz/__c1256e7000424ac6.nsf/Categories?OpenView&Start=1&Count=30&Expand=10.2#10.2 (Czech)

Act No. 120/2002 Coll., on conditions for introducing biocides and active substances on the market and amendments to certain associated directives
Web: http://portal.gov.cz/wps/portal/_s.155/701?number1=120/2002+&number2=&name=&text= (Czech only)

Legislation Concerning Environment

Air-quality protection

Act No. 86/2002 Coll., on Clean Air Protection and Amendment of Some Other Acts
Web: http://www.env.cz/ris/vis-legcz.nsf/0/BBF11620AAD725D5C1256CCA0038DBA4/$file/Z%C3%A1kon_o_%20ochr_ovzd_angl_862002.pdf (English)
Web: http://www.sbcr.info/cgi-bin/khm.cgi?typ=1&page=khm:PPSBA2/SBA2086A.HTM (Czech)

Waste-disposal management

Act No. 185/2001 Coll., on waste and amending some other laws; (Zákon č. 185/2001 Sb., o odpadech a o změně některých dalších zákonů;)
Web: http://www.env.cz/ris/vis-legcz-en.nsf/ (English)
Web: http://www.sbcr.info/cgi-bin/khm.cgi?typ=1&page=khm:PPSBA1/SBA1185A.HTM (Czech)

Water-quality management

Act No. 254/2001 Coll. on water and amendments to some acts (The Water Act)
Web: http://www.env.cz/AIS/web-pub.nsf/$pid/MZPICF6Y54JW/$FILE/Water_Act_%202542001_EN.pdf (English)
Web: http://www.sbcr.info/cgi-bin/khm.cgi?typ=1&page=khm:PPSBA1/SBA1254A.HTM (Czech)

Phytosanitary care

Act No. 326/2004 Coll., on phytosanitary care and amendments to certain associated laws
Web: http://www.sbcr.info/cgi-bin/khm.cgi?typ=1&page=khm:PPSBA4/SBA4326A.HTM (Czech only)

Miscellaneous Resources

ChemInfo

ChemInfo is the product of the SciChem company that provides consultation services in the field of chemistry. Besides the database of companies, it contains information about chemical workplaces, schools and information sources. It also offers mediation in transactions in chemical equipment and articles.

Web: http://www.cheminfo.cz/

EcoMonitor environmental news database

EcoMonitor is a database accessible cost-free, that includes full texts of articles on the environment from selected journals, the press disclosures of the Ministry of Environment and non-governmental organizations from the electronic conference apc.ecn.press. It is updated according to need regularly. Its operation is guaranteed by the 'Brontosaurus' ecological center 'Zelený klub' (The Green Club).

Web: http://www.ecomonitor.cz/

CHAPTER

86

Denmark

HILDE BALLING

INTRODUCTION

In the following pages a short introduction to the history of toxicology in Denmark is given in the form of thematic sections followed by a brief description of regulation and legislation in the area of chemicals today. Ongoing research and education are described in the section on organizations, including research institutions and regulatory bodies, but not including the pharmaceutical industry.

Pharmacology and Forensic Medicine

Pharmacology has been taught at the University of Copenhagen (founded in 1479) since 1660. During the first couple of hundred years the teaching focused on pharmacotherapy. The physicians to a great extent had to be personally knowledgeable about the drugs, which were administered largely on an empirical basis.

The Royal Danish School of Pharmacy, later the Danish University of Pharmaceutical Sciences and, as of January 2007, the Faculty of Pharmaceutical Sciences at the University of Copenhagen, was founded in 1892. Until then there was no education in pharmaceutics. If one wanted to become a pharmacist one had to practice at a pharmacy, follow lectures at the University of Copenhagen and at the College of Advanced Technology (founded in 1829), and pass an examination before a commission consisting of five professors from the University of Copenhagen, and a pharmacist.

Experimental research in pharmacology was initiated by Professor Hans Chr. Gram (1891–1900) and further developed by his successor Professor Johannes Boeck (1900–1938). In 1898 the first Danish institute of pharmacology was established in Copenhagen.

Lectures in forensic medicine were given as early as 1740. In 1819 forensic medicine was accepted as a specific discipline under the professorship in pharmacology and in 1905 a professorship in forensic medicine was established at the University of Copenhagen. For many years forensic toxicology was a part of forensic medicine. In connection with the construction of a new institute in the 1960s forensic toxicology became a separate department unde r the Institute of Forensic Medicine.

According to the Act of 30 April 1909 the Institute of Pharmacology or other laboratories were obligated to perform forensic toxicology investigations upon request from the Medico Legal Council. The development of forensic toxicology became one of the main interests of the Institute of Pharmacology and a Department of Forensic Toxicology was established in 1943. In 1973 this department was transferred to the Institute of Forensic Medicine and a smaller unit of toxicology was established at the Institute of Pharmacology under the leadership of Professor Jens S. Schou.

At the University of Aarhus, founded in 1928, the Institute of Forensic Medicine was established in 1959. The first toxicological investigations were performed at the beginning of the 1960s and in 1968 the Department of Forensic Toxicology was established.

At the University of Odense, founded in 1966, now University of Southern Denmark, the Institute of Forensic Medicine was established in 1971. A unit of forensic toxicology was established in 1980 and became the Department of Toxicology in 2004.

From Hygiene to Environmental Medicine

Hygiene as an independent science was established at the medical faculty at the University of Copenhagen as early as 1840 but it was not until 1913 that the first professorship in hygiene was established. Bacteriology and technical and veterinary hygiene were separate disciplines so when a professorship in hygiene was established it came to include nutritional and occupational hygiene, and public health. The Institute of Hygiene, established in 1931 at the University of Copenhagen (later the Institute of Hygiene and Social Medicine), carried out investigations in relation to nutritional and occupational hygiene. Later, when the analyses became more extensive, the laboratories became part of the new National Food Institute and the new Institute of Occupational Health (see below). In 1969, an independent institute of social medicine was established at the University of Copenhagen and in 1990 the Institute of Hygiene was abolished. The toxicological resources were transferred to the Institute of Pharmacology (later the Department of Pharmacology).

From the start in 1840 and up to the middle of the twentieth century hygiene focused on sanitary conditions and acute and chronic infections but soon the picture began to change, with a focus on the broad spectrum of environmental factors that humans can be exposed to. As in other countries, the expression 'environmental medicine' was chosen to characterize the tasks. Environmental medicine is multidisciplinary and involves occupational medicine, epidemiology, and toxicology. The word 'hygiene,' on the other hand, in everyday language had come to mean personal hygiene and cleaning.

In the beginning of the 1990s a research program in toxicology/environmental medicine was initiated at the Department of Pharmacology at the University of Copenhagen. A professorship in medical toxicology was filled from 1993 to 1996 (Henrik E. Poulsen). A professorship in environmental medicine was established in 1998 (Steffen Loft) and transferred to the Institute of Public Health, which had been established at the University of Copenhagen in 1997, including the Department of Occupational and Environmental Health. Up until the present, research and teaching in toxicology at the University of Copenhagen have been integral parts of the Department of Pharmacology (now Department of Neuroscience and Pharmacology) and the Department of Occupational and Environmental Health, but recently a professorship in toxicology of 5 years duration (Elisabeth E. Knudsen) has been established at the Department of Occupational and Environmental Health.

At the University of Aarhus a professorship in hygiene was established in 1938, and the Institute of Hygiene, including the science of toxicology, was established in 1943. Later, in 1987, the name of the institute was changed to the Institute of Environmental and Occupational Medicine with Herman Autrup as professor in environmental medicine. The Institute of Public Health was established in 2005, including the Institute of Environmental and Occupational Medicine, now the Department of Environmental and Occupational Medicine.

At the University of Odense, now the University of Southern Denmark, a professorship in hygiene was established in 1972 at the Institute of Hygiene, later the Institute of Hygiene and Social Medicine. In 1980 the name was changed to the Institute of Public Health, Department of Hygiene, and in 1982 further changed to the Institute of Public Health, Department of Environmental Medicine, with Philippe Grandjean as professor in environmental medicine.

The Working Environment

Denmark has had worker protection regulations since 1873 when the Danish Working Environment Authority (WEA) was set up to supervise compliance with the Act. From the start chemists were employed, and in 1978, occupational physicians and occupational toxicologists as well.

A working environment laboratory was established in 1946. In 1955 this laboratory became the Institute of Occupational Hygiene, the tasks of which from 1977 included research and education. In 1988, the Institute was established as a governmental research institute, The National Institute of Occupational Health (now The National Research Centre for the Working Environment) which was separated from the Danish Working Environment Authority in 1997.

Beginning in 1958 medical students were taught occupational medicine and in 1995 the first Danish professorship (Finn Gyntelberg) was established at the University of Copenhagen. Two more professorships were established at the University of Aarhus in 2002 (Jens Peter Bonde) and in 2004 (Torben Sigsgaard).

Poison Treatment

The Poison Treatment Centre at Bispebjerg Hospital in Copenhagen opened in 1949 and gained international respect for improvements in the treatment of poisoned patients, especially barbiturate poisonings, during the 1950s and 1960s. Along with providing actual treatment, the Centre advised physicians on treatment of drug poisonings.

The Danish Poison Information Centre started advisory activities on poisoning with chemical products and other non-drug substances in 1972 at the Clinic of Occupational Medicine, Rigshospitalet, later Bispebjerg Hospital.

In 2002 the information activities in the two centres were joined in a collaboration between three departments at Bispebjerg Hospital, the Danish Poison Control Centre, and in 2006 this centre was opened for inquiries from the public.

Veterinary Toxicology

A veterinary school was founded in Copenhagen in 1773 by the first Danish veterinary Peter Abildgaard and in 1958 the Royal Veterinary and Agricultural University was founded in Copenhagen.

A professorship in pharmacology was established in 1901 (Carl H. Hansen) and in 1950 toxicology as a discipline was included when the Institute of Pharmacology and Toxicology and a professorship in pharmacology and toxicology (Svend Dalgaard-Mikkelsen) were established. In 1994 the Institute was divided into two areas and a professorship in toxicology was established (Christian Friis). As of January 2007 the Royal Veterinary and Agricultural University merged with the University of Copenhagen and became the Faculty of Life Sciences.

Food Toxicology and the Institute of Toxicology

The National Food Institute, later the National Food Agency, was established in 1968 and consisted of the Institute of Toxicology and the Central Laboratory (later the Institute for Food Research and Nutrition). In 1969 the National Vitamin Laboratory and the National Pesticide Laboratory were incorporated in the National Food Institute.

In 1968 the main activities of the Institute of Toxicology were toxicological investigations and risk assessments of food additives, pesticide residues, and contaminants of foods. Beginning in 1978 the activities included toxicological studies and risk assessments of pesticides, household chemicals, and cosmetics and in 1986 human safety aspects of genetically engineered plants, animals, and micro-organisms and their products were included. In 1994 risk assessments of foodborne micro-organisms and micro-organisms used in the production of foods were included, and in 1996 the name of the institute was changed to the Institute of Food Safety and Toxicology.

In 1997 the National Food Agency and the Veterinary Directorate merged and became the Danish Veterinary and Food Administration. In 2002 the Institute for Food Research and Nutrition and the Institute for Food Safety and Toxicology merged and became the Institute for Food Safety and Nutrition which in 2004 became a part of the Danish Institute for Food and Veterinary Research. As of January 2007 the Institute for Food and Veterinary Research merged with the Technical University of Denmark and has been divided into two institutes: the National Food Institute and the National Veterinary Institute. The Danish Veterinary and Food Administration, now under the Ministry of Food, Agriculture and Fisheries, by contract is secured continued direct toxicological assistance by the Department of Toxicology and Risk Assessment at the National Food Institute.

Ecotoxicology

Ecotoxicology as defined by the French professor Réné Truhaut is concerned with the toxic effects of chemical and physical agents on living organisms, especially on populations and communities within defined ecosystems, and includes the transfer pathways of those agents and their integration with the environment.

In Denmark, scientific and experimental ecotoxicology was initiated in the late 1970s at the independent, international consulting and research organization the Water Quality Institute (later DHI Water Environment Health) in Hørsholm where testing in the aquatic environment became highly developed. In 1977 a new Laboratory for Environmental Sciences and Ecology was established at the Technical University of Denmark (founded in 1829) under the leadership of Professor Finn Bro Rasmussen. During the 1980s the Institute organized several international conferences (e.g. the 1st European Conference on Ecotoxicology of SECOTOX (1989)). In 1991 the Institute merged with the Institute of Environment & Resources (later becoming the Department of Environmental Engineering) at the Technical University of Denmark.

A professorship in environmental toxicology was established in 1977 at the Department of Biology at the University of Odense, now the University of Southern Denmark, with Professor Ole Karlog (1977–1985) as head. Aquatic ecotoxicology was established with the employment of Professor Michael H. Depledge (1987–1994), and later, under the leadership of Professor Poul Bjerregaard, research on endocrine disruption was developed.

In 1990 the Danish National Environmental Research Institute established the Department of Terrestrial Ecology in Silkeborg, focusing on terrestrial

ecotoxicology with Dr Hans Løkke as head. In 2004 a professorship of 5 years duration in terrestrial ecology/ecotoxicology (Martin Holmstrup) was established as a collaboration between the Department of Terrestrial Ecology and Department of Biological Sciences at the University of Aarhus. The Danish National Environmental Research Institute was a part of the Ministry of the Environment until January 2007 when it merged with the University of Aarhus.

The departmental structure at Roskilde University, founded in 1972, has been undergoing major changes. As of September 2006 six new departments have been established. Two of the departments, the Department of Science, Systems and Models and the Department of Environmental, Social and Spatial Change carry out some research in ecotoxicology and environmental toxicology and started courses in ecotoxicology in 2003.

The Danish Environmental Research Programme 1992–2004 (http://info.au.dk/smp/smp_uk/Hjem/hjem.htm) has had a great impact on the development of Danish ecotoxicology. The research carried out in the Danish Centre for Ecotoxicological Research (1992–1997) resulted in a range of new tools that increased understanding of and enabled assessment of the risks posed by environmentally hazardous substances. New tools were developed, particularly in connection with the aquatic environment and for cleaning up contaminated soil. In the Danish Centre for Environmental Oestrogen Research (1996–2000) methods of testing that can reveal estrogen-like effects of chemicals were developed and effects of selected chemicals were studied on levels of biological organization ranging from the molecular level through cellular and organ level to studies of individuals and populations.

Regulatory Toxicology

As far back as in 1701, a Danish decree directed the police director not to allow the selling of tainted or unhealthy foods and drinks. In 1818, a regulation instructed medical officers to observe especially the putrefaction of corn and unhealthy drinking water and in 1829 medical practitioners were ordered to report diseases, the symptoms of which indicated food poisoning, and further provide material for chemical analyses by the health police. In 1836 the Police Commissioner in Copenhagen published a list made by the medical officer indicating the colorings which could be used by producers of confectionery and toys and in 1843 the list, consisting of 39 compounds, applied to all of Denmark.

The first real food act was passed in 1903 and supplemented by statutory orders on analyses of foods (1911), on addition of colorings and preservatives (1913), and on investigations of materials coming into contact with foods (1913).

Until 1945 the Danish legislation on food primarily focused on the bacteriological control of foods and to a much lesser degree on food additives. After World War II a new food act taking into account new aspects and thoughts was prepared. The Food Act of 1950 was an emergency powers act which authorized the authorities to issue orders regulating food additives which were increasingly used in the food industry.

Developments in the food industry and the growth of food export resulted in an increasing awareness of toxicological aspects in Denmark and in the other Scandinavian countries and in 1955 an initiative was taken to suggest to WHO the idea of setting up an expert committee on food additives. In 1956 the first meeting of experts was convened by the WHO and since then annual meetings have taken place in what came to be known as the FAO/WHO Joint Expert Committee on Food Additives.

In 1968 the National Food Institute, including the Institute of Toxicology, was established under the Ministry of the Interior. From the start, the Institute of Toxicology provided toxicological assistance to the Ministry of the Interior and also advised the National Board on Health on toxicological matters.

The Ministry of the Environment was founded in 1971 and in 1972 the Danish Environmental Protection Agency was established. Agencies for nature protection etc. were established and in 1973 the National Food Institute, including the Institute of Toxicology, was transferred to the Ministry of the Environment. In 1987, when the National Food Institute was transferred to the new Ministry of Health, the Ministry of the Environment by contract was secured continued direct toxicological assistance provided by the Institute of Toxicology.

The National Institute of Occupational Health (now the National Research Centre for the Working Environment) was separated from the Danish Working Environment Authority in 1997 but stayed as a part of the Ministry of Employment. The Institute provides toxicological assistance to the Danish Working Environment Authority in connection with the regulation of chemical substances in the working environment.

Regulation and Legislation of Chemicals Today

The area of environmental chemicals is regulated by three authorities in Denmark – the Ministry of the Environment, the Ministry of Food, Agriculture and Fisheries, and the Ministry of Employment, and their agencies the Danish Environmental Protection Agency,

the Danish Veterinary and Food Administration, and the Danish Working Environment Authority.

The activities in the Danish Environmental Protection Agency concentrate on preventing and combating water, soil, and air pollution. Furthermore, the overall responsibility for the regulation of chemical substances and products lies within the agency.

Knowledge on chemical substances is used to lay down quality criteria as a basis for the setting of limit values for the maximum permissible concentration of chemical substances in the environment and in emissions (quality criterion: the highest non-harmful dose for humans or for the environment). Likewise, the evaluation of chemical substances is the basis for the classification of chemical products.

The activities in the Danish Working Environment Authority concentrate on health and safety in the working environment, including substances and materials. The Danish Working Environment Authority also sets administrative standards for air pollution at the workplace in the form of limit values for a number of substances and materials that have been documented to be injurious to health.

The Product Register (http://www.at.dk/sw12537.asp) was established at the Danish Working Environment Authority in 1979 as a joint register for the Working Environment Authority and the Danish Environmental Protection Agency. The register holds information on approximately 38 000 notified products and provides a useful means of obtaining an overall picture of the distribution of chemical products. All of the information is stored in a database and is used to assess the risks presented to the environment and to the working environment by chemical substances and products.

The activities in the Danish Veterinary and Food Administration concentrate on securing 'safety, health and quality in foods from farm to table.' The agency is responsible for the setting of national limit values for the use of food additives and for the maximum permissible concentrations of residues of pesticides and certain chemical pollutants in foods.

The monitoring program for foods was established in 1983 and results are reported for periods of 5 or 6 years. The fourth period report 1998–2003 consists of four sub-reports: Chemical contaminants, Pesticides, Food additives, and Microbial contaminants. The objectives of the monitoring program is 'to monitor, by means of analyses, the contents of desirable and undesirable substances/micro-organisms in foods, to investigate the dietary habits of the Danish population, and to carry out intake estimates by combining contents in foods and data on diet.' Subsequently, a nutritional and/or toxicological assessment can be made.

The program has been temporarily terminated due to lack of resources. Meanwhile, plans for a modernized program are being discussed.

The Danish Medicines Agency under the Ministry of Health and Prevention concentrates on securing that medicinal products are of satisfactory quality, are safe to use, and have the desired effect.

Legislation

Most of the Danish legislation concerning chemicals is based on regulation set by the European Union and then adopted in the Danish legislation. For some areas the Danish legislation is more extensive than the regulation in the European Union prescribes. Furthermore, Danish legislation also exists for areas not covered by the regulation in the European Union.

In Denmark regulation of environmental chemicals is based on the Environmental Protection Act and the Chemical Substances and Products Act and supplemented by the Working Environment Act and by the Food Act.

The Environmental Protection Act covers releases into the air, water, soil, and subsoil of chemical substances that can be dangerous to the health or to the environment. The Act is based on two main principles: polluting chemicals should not be released in the landscape and 'the polluter pays the bill.'

The Chemical Substances and Products Act regulates all chemical substances and products manufactured, imported, or sold in Denmark, including regulations on the distribution, consumption, and disposal of chemical substances. The purpose of the Act is to prevent damage to the health and to the environment and to promote the use of cleaner technologies. It is based on the principle that assessments of chemical substances should be life cycle assessments.

The Chemical Substances and Products Act is currently supplemented by orders, e.g. Statutory Order No 1065 of 30 November 2000 on classification, packaging, labeling, sale, and marketing of chemical substances and products.

The Danish Environmental Protection Agency publishes a series of factsheets presenting the orders applying to chemical substances and products in Denmark, addressing consumers, retail traders, wholesalers, importers, and manufacturers.

The Danish Working Environment Act lays down the general objectives and requirements in relation to the working environment, including substances and materials, and is currently supplemented by executive orders. WEA Guidelines are based on acts and executive orders and explain how these are to be interpreted. An example is WEA Guideline C.0.13, May

2004, dealing with the notification of substances and materials for industrial use, that is 'produced or imported substances or materials to be used in work or work processes of an industrial character, or is for re-sale in Denmark, export, or use in the producer's or importer's own business.'

The Food Act lays down the general objectives and requirements in relation to foods, including regulation of food additives and of chemical contaminants in foods, and currently is supplemented by statutory orders, e.g. Statutory Order No 22 of 11 January 2005 on Food Additives (in Danish). Positivlisten (the Positive List) describes the additives which are accepted for use in different foods and in which amounts they can be used.

The Danish Medicines Act lays down general objectives and requirements in relation to medicinal products, including authorization and control of medicinal products, reporting of adverse drug reactions, and medicinal product trials on humans. The law is currently supplemented by executive orders, e.g. Executive Order No 1211 of 7 December 2005 on the quality of medicinal products (in Danish). The Danish Medicines Agency publishes guidelines as well, e.g. on authorization of medicinal products.

The background narrative is based on relevant Danish texts and websites.

Chief physician Peter Jacobsen, Clinic of Occupational and Environmental Medicine, Bispebjerg Hospital, Copenhagen, kindly provided data for the section on the Danish Poison Control Centre.

Director of Research Department Hans Løkke, National Environmental Research Institute, kindly provided data for the section on ecotoxicogy.

RESOURCES

Books

The list of books is based on searches at http://bibliotek.dk/ and on lists provided by some of the institutions described in the section 'Organizations.' The list covers the period 1990–2006. Only a few books in Danish are included, mostly textbooks.

Arlien-Søborg P (1992)
Solvent Neurotoxicity
CRC Press

The ATV Committee on the Setting of Limit Values for Chemicals, Danish Academy of Technical Sciences (1996)
Ecotoxicological assessments and the setting of limit values for chemicals in the environment
Proceedings from the ATV Conference, January 1996. The ATV Committee on the Setting of Limit Values for Chemicals, Danish Academy of Technical Sciences
ISBN: 87-7836-030-7

Autrup H, Bonde JP, Rasmussen K, Sigsgaard T (Eds.) (2003)
Miljø- og arbejdsmedicin, 2.udgave (Environmental and Occupational Medicine, 2nd Edition (textbook))
FADLs Forlag København: Aarhus, Odense

Forbes VE, Forbes TL (1994)
Ecotoxicology in Theory and Practice
Chapman and Hall.
ISBN: 0-412-43530-6

Forbes VE (Ed.) (1999)
Genetics and Ecotoxicology
Taylor & Francis
ISBN: 1560327154

Grandjean P (1990)
Skin Penetration: Hazardous Chemicals at Work
Taylor & Francis
ISBN: 0850668344

Jensen AA, Slorach SA (1991)
Chemical Contaminants in Human Milk
CRC Press Inc.: Boca Raton, FL
ISBN: 0849366070

Jørgensen SE (1990)
Modelling in Ecotoxicology
Elsevier
ISBN: 0444886990

Jørgensen SE, Halling-Sørensen B, Mahler H (1998)
Handbook of Estimation Methods in Ecotoxicology and Environmental Chemistry
Lewis Publishers
ISBN: 1566702119

Jørgensen SE, Nielsen SN, Jørgensen LA (1991)
Handbook of Ecological Parameters and Ecotoxicology
Elsevier

Krüger D, Louhevaara V, Nielsen J, Schneider T, Krüger D (Eds.) (1997)
Risk Assessment and Preventive Strategies in Cleaning Work
Bremerhaven: Wirtschaftsverlag NW

Løkke H, van Gestel CAM (Eds.) (1998)
Handbook of Soil Invertebrate Toxicity Tests
Wiley
ISBN: 0471971030

Midtgård U, Simonsen L, Knudsen LE (Eds.) (1999)
Toksikologi i arbejdsmiljøet, Bind 1–2 (Toxicology in the Working Environment, volumes 1–2)

Arbejdsmiljøinstituttet, København; National Institute of Occupational Research, Denmark

Nielsen SN, Halling-Sørensen B, Jørgensen SE (1995)
Handbook of Environmental and Ecological Modelling
Lewis Publishers
ISBN: 156670202x

Poulsen PB, Jensen AA (Eds.) (2004)
Working Environment in Life-Cycle Assessment
Pensacola: SETAC Press

Selzer Rasmussen E (1995)
Prospects for Use of in vitro Methods for Assessment of Human Safety
National Food Agency of Denmark
ISBN: 87-601-4754-7

Sheppard SC, Bembridge JD, Holmstrup M, Posthuma L (1998)
Advances in Earthworm Ecotoxicology
SETAC Press, Pensacola, FL

Simonsen J (1999)
Retsmedicin og medicinallovgivning (Forensic Medicine and Medical Legislation (textbook))
København: FADLs Forlag (Copenhagen: FADL)
ISBN: 87-7749-272-2

Thomsen JL (Ed.) (2004)
Retsmedicin: nordisk lærebog (Forensic Medicine: Nordic Textbook)
København: Fadls Forlag (Copenhagen: FADL)
ISBN: 87-7749-323-0

Udo de Haes HA, Jensen AA, Klöpffer W, Lindfors L-G (Eds.) (1994)
Integrating Impact Assessment into LCA
Brussels: SETAC-Europe

Van Straalen NM, Løkke H (Eds.) (1997)
Ecological Risk Assessment of Contaminants in Soil
Chapman & Hall Ecotoxicology Series 5
Chapman & Hall

Journals

In Denmark there are no special journals in the field of toxicology. One of the reasons for not having journals strictly in Danish is the fact that the Scandinavian countries collaborate in publishing journals, for example *Basic & Clinical Pharmacology & Toxicology*; *Scandinavian Journal of Work, Environment & Health*; *Scandinavian Journal of Forensic Sciences*; and *Scandinavian Journal of Laboratory Animal Science*.

Technical Reports and Other Documents

Examples of technical reports published in English during recent years are given here.

Simonsen FA, Stavnsbjerg M, Møller LM, Madsen T (2000)
Brominated Flame Retardants: Toxicity and Ecotoxicity
Danish Environmental Protection Agency
ISBN: 87-7944-289-7
ISBN electronic: 87-7944-288-9
Web: http://www2.mst.dk/common/Udgivramme/Frame.asp?pg=http://www2.mst.dk/Udgiv/publications/2000/87-7944-288-9/html/default_eng.htm

Danish Environmental Protection Agency and Danish Veterinary and Food Administration (2003)
Combined Actions and Interactions of Chemicals in Mixtures: The Toxicological Effects of Exposure to Mixtures of Industrial and Environmental Chemicals
Danish Environmental Protection Agency and Danish Veterinary and Food Administration.
Web:http://www.foedevarestyrelsen.dk/Publikationer/EnglishPublications/forside.htm

Nielsen SP, Andersson KG, Thørring H, et al (2006)
EcoDoses – Improving Radiological Assessment of Doses to Man from Terrestrial Ecosystems
A status report for the NKS-B project 2005. NKS-123
Web: http://www.risoe.dk/rispubl/nks/nks-123.pdf

Binderup M-L, et al (2004)
The Effect of Oil Spills on Seafood Safety: An Example of the Application of the Nordic Risk Analysis Model
Nordic Council of Ministers (TemaNord, 2004: 553)
Web: http://www.norden.org/pub/sk/showpub.asp?pubnr=2004:553

Ingerslev F, Halling-Sørensen B (2003)
Evaluation of Analytical Chemical Methods for Detection of Estrogens in the Environment Danish Environmental Protection Agency
Web: http://www2.mst.dk/common/Udgivramme/Frame.asp?pg=http://www2.mst.dk/Udgiv/publications/2003/87-7972-968-1/html/default_eng.htm

Nørhede P, Nielsen E, Ladefoged O, Meyer O (2004)
Evaluation of Health Hazards by Exposure to Triazines and Degradation Pproducts
Danish Environmental Protection Agency
Web: http://www2.mst.dk/common/Udgivramme/Frame.asp?pg=http://www2.mst.dk/Udgiv/publications/2004/87-7614-350-3/html/default_eng.htm

Müller AK, Nielsen E, Ladefoged O (2003)
Human Exposure to Selected Phthalates in Denmark
Danish Veterinary and Food Administration

ISBN: 87-91399-20-3
http://www.foedevarestyrelsen.dk/Publikationer/EnglishPublications/forside.htm

Andersen MM, Rasmussen B (2006)
Nanotechnology Development in Denmark – Environmental Opportunities and Risk
Risø National Laboratory, Denmark
Web: http://www.risoe.dk/rispubl/SYS/ris-r-1550.htm

Sørensen PB, Carlsen L, Fauser P, Vikelsøe J (2001)
Paradigm for Analysing Complex Model Uncertainty. A General Concept for Dealing with Uncertainties in Ecotoxicological Models. Miljøkemi – Environmental Chemistry
National Environmental Research Institute, Denmark
Research Notes from NERI 141
Web: http://www2.dmu.dk/1_viden/2_Publikationer/3_arbrapporter/rapporter/AR141.pdf

Jensen AA, Knudsen HN (2006)
Total Health Assessment of Chemicals in Indoor Climate from Various Consumer Products
Danish Environmental Protection Agency
Web: http://www2.mst.dk/common/Udgivramme/Frame.asp?pg=http://www2.mst.dk/Udgiv/publications/2006/87-7052-214-6/html/default_eng.htm

Kusk KO, Wollenberger L (2005)
Validation of Full Life-cycle Test with the Copepod Acartia tonsa. Report to Nordic Council of Ministers and OECD
Institute of Environment & Resources, Technical University of Denmark, Kgs: Lyngby
Web: http://www2.er.dtu.dk/publications/fulltext/2005/MR2005-146.pdf

Several technical reports published in English are accessible online on the websites of the institutions listed below:

The Danish Environmental Protection Agency
Web: http://www.mst.dk/Udgivelser/Rapporter/

The Danish Veterinary and Food Administration
Web: http://www.foedevarestyrelsen.dk/Publikationer/EnglishPublications/forside.htm

Institute of Environment & Resources, Technical University of Denmark
Web: http://www.er.dtu.dk/English/Publications.aspx

National Environmental Research Institute, University of Aarhus
Web: http://www.dmu.dk/International/Publications/

Nordic Council of Ministers
Web: http://www.norden.org/pub/sk/index.asp?lang=

Risø National Laboratory, Technical University of Denmark
Web: http://risoe-staged.risoe.dk/Knowledge_base/publications.aspx

DATABASES

(Q) SAR (Quantitative Structure Analysis Relationship) prediction database
Danish Environmental Protection Agency and National Food Institute, Technical University of Denmark
Web: http://www.dfvf.dk/Default.aspx?ID=20861

Relevant databases in Danish are mentioned in the section below. The section on organizations is based on information at the relevant websites and on contributions from the organizations. The number of toxicological academic man-years adds up to 240.

Organizations (Government)

Chemical Division
Ministry of Defence
Emergency Management Agency
Web: http://www.brs.dk/uk/chemical_laboratory.htm

The Chemical Division offers expert consulting and assistance to the authorities, including rescue preparedness, police, military, and health authorities in accidents involving hazardous materials or unknown substances. The assistance includes analytical chemical investigations of unknown substances, chemical warfare agents (CWA), and explosives. The expert consulting includes an information system for On-scene Commanders about hazardous materials. The information system (http://www.kemikalieberedskab.dk/english.shtml) comprises three levels:

- A guidebook for first response to hazardous materials incidents, covering about 2300 chemical substances and products.
- A manual providing more thorough information on individual hazardous chemicals.
- The National Response Centre where trained chemists offer 24-hour service on the telephone. The experts have access to the Product Register run by the Danish Working Environment Authority and to key functions within the chemical industry in Denmark. This level also covers any responses within Europe in the frame of the ICE organization (International Chemical Environment).
- http://www.kemikalieberedskab.dk/kemikalieberedskabsvagten.shtml (in Danish).

The contents of the latest editions of the two handbooks have been transferred into a database version:

- Førsteindsats ved kemikalieuheld (First response to hazardous materials incidents) – in Danish (http://www.kemikalieberedskab.dk/soeg_fi.shtml)
- Indsatskort for kemikalieuheld (Manual for response to hazardous materials incidents) – in Danish (http://www.kemikalieberedskab.dk/soeg_ik.shtml)

Danish Working Environment Authority
Ministry of Employment
Web: http://www.arbejdstilsynet.dk/sw7737.asp

From 1978 up till today the focus in occupational toxicology at the Danish Working Environment Authority has been and still is on chemicals. Carcinogens, neurotoxic substances and products, reprotoxic chemicals, and skin and airway irritants as well as allergens are the chemicals of primary concern. Rules, guidances, and sector information are the primary tasks in relation to occupational toxicology and are carried out in collaboration with toxicologists at the National Research Centre for the Working Environment, the Danish Environmental Protection Agency, and sister organizations in the Nordic countries and in the European Union.

The Danish Working Environment Authority runs the Product Register (described above) (http://www.arbejdstilsynet.dk/sw12537.asp).

The National Research Centre for the Working Environment
Ministry of Employment
Web: http://www.arbejdsmiljoforskning.dk/?lang=en

The Centre is a national centre for working environment research, including research into primarily environmental toxicology (gases and particles in outdoor and indoor air). Moreover, the Centre is involved in teaching at several Danish universities as well as at the Nordic Institute for Advanced Training in Occupational Health (http://www.niva.org), including teaching in toxicology.

Toxicology Group, an intramural network group, provides the framework for toxicological support to the authorities and for dissemination of relevant information to occupational safety professionals and to the public. The members of the group, who are scientists working part time in an advisory function, participate in The Scientific Committee on Occupational Exposure Limits (SCOEL) (http://ec.europa.eu/employment_social/health_safety/scoel_en.htm) and in the Nordic Expert Group (NEG), a Nordic collaboration for the production of criteria documents on chemicals for occupational exposure limits (http://www.av.se/arkiv/neg/). Once a year a postgraduate course in toxicology is arranged.

Danish Environmental Protection Agency
Ministry of the Environment
Web: http://glwww.mst.dk/homepage/

Danish EPA Chemicals Division is responsible for tasks relating to hazard and risk assessment of new and existing chemical substances, national and international regulation of risk chemicals, quality criteria for chemicals in soil, water and air, chemicals in consumer products, including cosmetics and toys, negotiations on the EU Chemicals Strategy, and strategies and action plans in the field of chemicals.

Danish EPA Pesticides & Gene Technology Division is responsible for the approval of pesticides and biocides, the Pesticide Research Programme, international chemicals conventions, and enforcement and supervision of the chemicals legislation. Furthermore, the division deals with applications for approval for use of genetically modified organisms (GMOs).

Danish Veterinary and Food Administration
Ministry of Food, Agriculture and Fisheries
Web: http://www.uk.foedevarestyrelsen.dk/Forside.htm

The Division for Chemical Food Safety, Animal Welfare and Veterinary Medicinal Products among other tasks is responsible for the regulation of chemical contaminants in foods, including dioxin, heavy metals, pesticides, and veterinary medicines. Furthermore, the Division is responsible for the regulation of materials and objects coming into contact with foods.

The Division for Food Quality, Technology and Marketing Practices among other tasks is responsible for the regulation of food additives, including aromatics and enzymes.

The Danish Medicines Agency
Ministry of Health and Prevention
Web: http://www.dkma.dk/1024/visUKLSArtikelBred.asp?artikelID=744

The Consumer Safety Division monitors the safety of medicinal products and is in charge of adverse reaction reports. Moreover, it is responsible for authorizing clinical trials with medicinal products.

The National Institute of Radiation Protection

Ministry of Health and Prevention
National Board of Health
Web:http://www.sst.dk/Forebyggelse/Straalehygiejne/Om_SIS.aspx?lang=da (in Danish)

The National Institute of Radiation Protection (SIS) is the radiation protection authority on ionizing radiation. Its tasks include protecting the Danish population, animals and the environment against unnecessary

radiation, formulating regulations, licensing and inspection of X-ray generators, inspecting the use of radioactive materials, providing information and advice, standardization, and carrying out supervision of the radiation area.

Organizations (Non-Government)

Department of Occupational and Environmental Medicine
Odense University Hospital
Web: http://www.ouh.dk/wm141566 (in Danish)

At present a research program 'Reprotoxicological effects of work in greenhouses' studies the exposure to pesticides, especially compounds with possible estrogenic effects, before and during pregnancy in greenhouse workers. The Department takes part in a course in pregnancy and child development for medical students.

Department of Occupational Medicine
Aarhus University Hospital
Web: http://www.sundhed.dk/wps/portal/_s.155/1921?_ARTIKELGRUPPE_ID_=1044040727120518 (in Danish)

The research of the Department of Occupational Medicine among other areas includes reproductive toxicology. For instance the Department participates in the cost-shard EU-project INUENDO studies on the impact of exposure to environmental xenobiotics with hormone-like action on human fertility.

Department of Occupational Medicine
Viborg Hospital
Web: http://www.sygehusviborg.dk/sw435.asp (in Danish)

The Department of Occupational Medicine performs toxicological risk assessments in projects carried out at the department as well as in projects carried out in collaboration with other institutions. An example is a project on emission of chemical substances from products made of exotic wood carried out for the Danish Environmental Protection Agency in collaboration with several other institutions.

Centre for Environment and Toxicology
DHI Water Environment Health
Web: http://www.dhigroup.com/Contact/DHIOffices/DenmarkDHIHeadOffice.aspx
Web: http://tox.dhigroup.com/Default.asp?ID=22

The Centre for Environment and Toxicology possesses broad international expertise in the fields of toxicology and ecotoxicology and offers a strong interdisciplinary knowledge base for chemical substances and their effects on humans, animals, and the environment. Furthermore, the Centre has in-depth knowledge of the European Union's new chemicals legislation REACH and offers courses and education in toxicology and chemicals management.

FORCE Technology
Web: http://www.force.dk

Force Technology is an independent technological institute working with measurements and testing, development, documentation, and assessments in many areas, including toxicological and ecotoxicological risk assessments of chemicals, materials, and products, often in connection with air pollution, indoor air quality, consumer products evaluation, and life cycle assessment studies. Furthermore, the Institute has special expertise in persistent organic pollutants (POPs), metals, and volatile organic compounds (VOCs).

SCANTOX
Web: http://www.scantox.dk

SCANTOX is a preclinical contract research organization performing routine and specialized tests, including dermal and inhalation studies, genotoxicity, reproductive toxicity, and pharmacological tests. Moreover, SCANTOX is very experienced in conducting research with minipigs.

Universities

Roskilde University
Department of Environmental, Social and Spatial Change
Web: http://www.ruc.dk/enspac_en/

The research activities of the Department of Environmental, Social and Spatial Change are organized around a variety of thematic areas including population and ecosystem ecology. The Department runs studies courses in ecotoxicology and PhD courses with some ecotoxicological relevance in the national Ph.D. school, GESS (Graduate School of Environmental Stress Studies (www.ruc.dk/gess) hosted by the department.

University of Aarhus
National Environmental Research Institute
Department of Environmental Chemistry and Microbiology
Web: http://www.dmu.dk/International/About+NERI/Departments/Environmental+Chemistry+and+Microbiology/

The research activities of the Department of Environmental Chemistry and Microbiology concentrate on

abating chemical and microbiological problems that arise from human impacts on the environment. The Department specializes in the characterization of the natural chemical, biochemical, and ecological processes that affect and moderate these chemicals and micro-organisms and in the implementation of monitoring programs. Current high-resolution analytical methods are combined in order to understand ecological processes that affect the distribution and fate of chemicals and their potential exposure to natural biota, and new analytical methods for assessing the distribution and fate of organic pollutants in the environment are developed.

University of Aarhus
Department of Public Health
Department of Environmental and Occupational Medicine
Web: http://www.folkesundhed.au.dk/en/en/mil/unit/presentation

The research most relevant for toxicology is molecular epidemiological studies using biomarkers of effect and susceptibility, respiratory toxicology, and endocrine disruption. As a part of the M.Sc. program in human biology the Department runs a course in human toxicology. The Department hosts Centre for Arctic Environmental Medicine (http://www.cam.gl/engelsk/index.htm).

University of Copenhagen
Institute of Forensic Medicine
Department of Forensic Toxicology
Address:
Frederik V's Vej 11
P. O. Box 2713
DK-2100 København Ø
Denmark
Phone: +45 35 32 79 00
Fax: +45 35 32 61 50
Email: forensic@forensic.dk

The Department of Forensic Toxicology performs post-mortem toxicology investigations in order to clarify deaths related to intoxication. Additionally, toxicological investigations are performed on blood samples from subjects involved in criminal cases and traffic cases. The analytical methods are mainly based on mass spectrometry (GC-MS or LC-MS/MS). The Department takes part in the course in forensic medicine for medical students.

University of Aarhus
Institute of Forensic Medicine
Department of Forensic Toxicology and Drug Analysis
Web: http://www.retsmedicin.au.dk/index.jsp (in Danish)

The Department of Forensic Toxicology and Drug Analysis carries out research into the field of forensic toxicology. Main themes are epidemiologic studies and method development, i.e. development of highly sensitive analytical procedures for detection of primarily drugs and narcotics in saliva, hair, urine, and blood. Research is also carried out in order to evaluate and understand (lethal) intoxications. Furthermore, the national focal points for the European Monitoring Centre for Drugs and Drug Addiction (http://www.emcdda.europa.eu/) are provided with information on the prevalence of new psychotropic substances on the Danish illicit drug market and on the monitoring of the purity of the 'well-known' narcotics. The Department takes part in courses for medical students and for chemistry students.

Aalborg University
Danish Building Research Institute
Department of Health and Comfort
Web: http://www.en.sbi.dk/research/health_and_comfort/department-of-health-and-comfort

The Department of Health and Comfort works with measurements of indoor exposures, including concentrations of particles in different size fractions and odor assessments. Full risk assessments are normally done in collaboration with external experts. The internal expertise includes hazard identification, exposure assessment, and contributions to risk management.

University of Aarhus
Institute of Anatomy
Department of Neurobiology
Web: http://www.anatomi.au.dk/neurobiology/presentation

The research of the Department of Neurobiology focuses primarily on degenerative and toxic processes in the nervous system. Expertise is available in a wide range of areas, including heavy metal toxicology. The Department hosts a research group involved in male reproductive toxicology.

University of Copenhagen
Institute of Public Health
Department of Occupational and Environmental Health
Web: http://pubhealth.ku.dk/mam_en/

The research of the Department of Occupational and Environmental Health involves an interplay between in vitro assays, experimental animal studies, and epidemiology/mechanistic studies applying biomarkers in humans, in particular the development and application biomarkers, including gene expression patterns, within the area of oxidative damage to DNA

and repair, cardiovascular function as well as foreign compound metabolism. Recently a professorship in toxicology of 5 years duration with focus on development of test methods has been established at the department. Placental perfusion is used as a human system for fetal exposure as a core in this work. The Department runs studies courses for medical students and, as a part of the M.Sc. program in human biology, a course in toxicology. Moreover, a postgraduate course in toxicology is run by the Department of Experimental Medicine at the University of Copenhagen (http://emed.ku.dk/kurser/toksikologi/).

University of Copenhagen
The Faculty of Pharmaceutical Sciences
Department of Pharmaceutics and Analytical Chemistry
Toxicology and Environmental Health
Web: http://www.farma.ku.dk/index.php/Toxicology-and-Environmental-C/3779/0/

The research activities focus on the emission to the internal or external environment of elements and compounds with biological activity, and on their processing and effects on these environments. In recent years, antibacterial agents, high-volume drugs, steroid hormones, hormone mimicking substances and degradation products hereof have been of particular interest as model compounds. Current research projects deal with the development of analytical methods, HPLC-MS in particular, modeling of effects of emissions on aquatic ecosystems, risk and effect analysis of the substances and the relationship between environment and health.

University of Aarhus
Department of Pharmacology
Web: http://www.pharmacology.au.dk/

The Department of Pharmacology comprises of divisions for basic pharmacology and toxicology and for clinical pharmacology. The emphasis of the basic research is on cardiovascular and endocrine pharmacology with special emphasis on diabetes research.

University of Southern Denmark, Odense
Institute of Forensic Medicine
Department of Toxicology
Web: http://www.sdu.dk/health/research/units/forensic.php

The Department of Toxicology performs post-mortem toxicology investigations, including identification of drugs, poisons, and narcotics and carries out research into forensic toxicology. Furthermore, the Department takes part in courses in forensic medicine for medical students.

Technical University of Denmark
DTU Food
National Food Institute
Department of Toxicology and Risk Assessment
http://www.food.dtu.dk/Default.aspx?ID=21033

The research of the Department of Toxicology and Risk Assessment contributes to a better understanding of mechanisms of actions of chemicals in food and food constituents and evaluation of possible health effects in humans. The main research areas include biomarkers and bioactive compounds, bionomics, diet and cancer, endocrine disrupters, food allergy, nanomaterials, and novel food. Furthermore, it contributes to a better understanding of mechanism of actions of chemicals in the environment, including products for industrial use and for house keeping and personal use, and evaluation of possible health effects in humans after exposure to such chemicals. The main research areas include alternatives to animal studies, genotoxicology, reproductive toxicology, QSAR (Quantitative Structure Analysis Relationship), and gene expression in plants.

Technical University of Denmark
DTU Environment
Department of Environmental Engineering
Web: http://www.er.dtu.dk/English.aspx

The Ecotoxicology and Environmental Chemistry group is concerned with the impact and fate of chemicals in the environment and the development of the tools required for environmental risk assessment of chemicals. A studies course in environmental chemistry and ecotoxicology is run by the group.

University of Southern Denmark, Odense
Institute of Public Health
Department of Environmental Medicine
Web: http://www.sdu.dk/health/research/units/environmed.php

The research activities include the following areas: adverse health effects of key environmental pollutants, especially in regard to developmental and reproductive outcomes, development and validation of biomarkers, environmental and reproductive epidemiology, methodology studies in environmental health risk assessment, and risk perception. The Department takes part in courses in toxicology for medical students.

University of Southern Denmark, Odense
Institute of Biology
The Ecotoxicology Group
Web: http://www.biologi.sdu.dk/gb/research_groups/ecotox/gruppe.htm

The Ecotoxicology Group carries out both basic and strategic research into aquatic toxicology and ecotoxicology. Principal areas of research are: trace metals in the aquatic environment; metallothionein synthesis; effects of pesticides in stream invertebrates; and estrogen mimicking compounds. A basic course in ecotoxicology and toxicology and graduate courses in toxicology, risk assessment of chemicals, ecotoxicology, and chemical analyses in environmental biology are run by the group.

Roskilde University
Department of Science, Systems and Models
Eucaryotic Cell Biology Group
Web: http://roskilde-university.com/nsm/forskning/forskningsgrupper/cellbiol/

The research activities of the Eucaryotic Cell Biology Group among other areas include DNA repair and genomic stability, intracellular messengers in cell signaling and toxicity, and toxicology and biokinetics of essential and toxic metals.

University of Copenhagen
Faculty of Life Sciences
Department of Veterinary Pathobiology
Laboratory of Toxicology
Web:http://www.ivp.kvl.dk/Om-instituttet/Faggrupper/Biomedicin/Toks.aspx (Danish/English)

The research activities of Laboratory of Toxicology focus mainly on the metabolism of toxicants in animals and their mode of actions. A studies course in basic pharmacology and toxicology is run by the laboratory.

Technical University of Denmark
Risø DTU
National Laboratory for Sustainable Energy
Radiation Research Department
Web: http://www.risoe.dk/About_risoe/research_departments/NUK.aspx/

The Radiation Research Department works in the fields of radiation safety, radiation physics, dosimetry, radioecology, tracer studies, radiochemistry, isotopes, nuclear instruments, and industrial and medical applications of nuclear methods. The risk to man from environmental radioactivity is assessed by taking into account exposure pathways from terrestrial and marine ecosystems involving external and internal exposure.

University of Aarhus
Institute of Anatomy
Reproductive Laboratory
Address:
Reproductive Laboratory
Institute of Anatomy
Building 1234
University of Aarhus
DK-8000 Aarhus C
Denmark
Phone +45 89496402 or 89423074
Email: erik.ernst@dadlnet.dk

The Reproductive Laboratory carries out clinical and experimental research into the area of reproductive toxicology. Moreover, the laboratory, in collaboration with Department of Occupational Medicine, Aarhus University Hospital, carries out reproductive toxicological and epidemiological research.

University of Copenhagen
Faculty of Life Sciences
Research School of Environmental Chemistry and Ecotoxicology
Web: http://www.receto.dk/

A postgraduate school of environmental chemistry and toxicology – molecular studies of fate and effects of pollutants in aquatic and terrestrial ecosystems.

University of Aarhus
National Environmental Research Institute
Department of Terrestrial Ecology
Section of Soil Fauna and Ecotoxicology
Web: http://www.dmu.dk/International/About+NERI/Departments/Terrestrial+Ecology/Section+of+Soil+Fauna+and+Ecotoxicology/

The Section of Soil Fauna and Ecotoxicology carries out basic, applied, and commercial contract research into soil fauna ecology, ecophysiology, and ecotoxicology and provides consultancy for national and international authorities within its areas of expertise. The main objective of the research activities is to describe and understand how different kinds of pollutants, climatic conditions, and various methods of farming affect soil living animals and the ecosystems that they are a part of.

University of Aarhus
Department of Biological Sciences
Zoophysiology Group, Ecotoxicology
Web: http://www.biology.au.dk/zoofys.velkom-en

The research in ecotoxicology focuses on effects of environmental contaminants on animal behavior with emphasis on mechanistic links to other levels of biological organization, e.g. effects of endocrine disrupters on the sexual behavior and reproduction in fish and mechanistic relationships between metabolism, respiration, and behavior in arthropods. Studies courses in basic ecotoxicology and experimental ecotoxicology are run by the group.

Professional Societies

The Danish Society of Pharmacology and Toxicology
Web: http://www.dsft.dk/index.php/_img_src__file-admin_filer_flag/44/0/ (English)

Web: http://www.dsft.dk/index.php/Forside/2/0/ (Danish)

The Danish Chemical Society
Web: http://www.chemsoc.dk (English)

Danish Society of Forensic Science
Web: http://www.forensic.dk/?pageid=0801 (English)
Web: http://www.forensic.dk/?pageid=0101 (Danish)

Dansk Selskab for Arbejds- og Miljømedicin (Danish Society of Occupational and Environmental Medicine)
Web: http://www.dasamnet.dk/ (Danish)

Poison Control Centers

The Danish Poison Control Centre
The Capital Region: Bispebjerg Hospital
Poison Hot Line
Web: http://www.giftlinjen.dk/english.6

The Danish Poison Control Centre is a collaboration between three departments at Bispebjerg Hospital: Clinic of Occupational and Environmental Medicine, Department of Clinical Pharmacology, and Department of Anesthesiology. The special knowledge about poisoning is used to detect and identify hazardous products and situations, which may pose a particular risk of poisoning. The Centre has an active surveillance program and contacts distributors or regulatory authorities when situations call for it. Furthermore, the center undertakes research in clinical toxicology, provides education, assists in cases of poisoning emergencies, and provides guidance and advice to the authorities.

The Poison Control Hotline is a telephone service offering immediate guidance for poisoning emergencies to all Danes 24 hours a day, seven days a week. Furthermore, The Poison Control Hotline offers guidance for treatment of poisonings to doctors, nurses, and other health personnel.

Two databases in Danish can be found at the website of the Poison Hot Line:

- Kemikalielisten (Database on chemicals: risks, symptoms and precautionary measures in poisoning with chemical products including household chemicals and other common chemical products).
- Plantelisten (Database on plants: risks, symptoms and precautionary measures in poisoning with specific plants).

Legislation

Retsinformation ('Legal Information'), established in 1985, is the official online legal information system of the Danish State and contains all Danish rules and regulations. All documents are in Danish but translations of some of the central acts can in some cases be found on the website of the relevant ministry.
Web: http://www.retsinfo.dk/

No. 753 of 25 August, 2001
Consolidated Act from the Ministry of Environment and Energy on Environmental Protection

No. 21 of 16 January, 1996
Consolidated Act from the Ministry of Environment and Energy on Chemical Substances and Products
See the website of the Danish Environmental Protection Agency.
Web: http://glwww.mst.dk/homepage

No 1180 of 12 December, 2005
The Danish Medicines Act
Web: http://www.dkma.dk/1024/visUKLSArtikel.asp?artikelID=1463

The Danish Preparedness Act, January 1993
Web: http://www.brs.dk/uk/danish_preparedness_act.htm

The Danish Working Environment Act, October 1999
Executive Orders
WEA Guidelines
Web: http://www.at.dk/sw12160.asp

Miscellaneous Resources

Danish Environmental Protection Agency
Attn: Ms Mona Mejsen Westergaard
Senior Advisor on International
Environmental Issues
Chemical Conventions and Pesticides Division
Strandgade 29
DK 1401 Copenhagen K
Denmark
Phone: (45 32) 66 01 00
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Email: momwe@mst.dk

CHAPTER

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Ecuador

HOMERO C. HARARI, RAUL E. HARARI, AND RAMIRO I. LOPEZ

INTRODUCTION

Toxicology has been a subject of little research in Ecuador, in some cases because of economic constraints and limited trained personnel but also because of limited interest and application. In spite of that, during the last 15 years, toxicology in Ecuador has developed due to the critical need to understand increasing occupational and environmental problems.

In 1941, the first step was taken by the Ecuadorian government with the creation of the National Institute of Hygiene and Tropical Medicine 'Leopoldo Izquieta Perez,' as a scientific center ascribed to the Ministry of Public Health, whose aim is the promotion of scientific research to: (a) prevent, diagnose and control infectious, endemic and epidemic diseases; (b) develop technologies for the production of safer preventive products used in human and animal health; (c) for the registry and sanitary control of drugs, biological products, food, hygienic products, cosmetics, pesticides and other products of general consumption and (d) for training personnel.

During these early years, only isolated scientists, like Dr. Rodrigo Fierro and Dr. Plutarco Naranjo, worked in this field and they were pioneers, looking for information and articulating questions of national interest concerning health issues such as goiters and allergies.

As industrial development matured, in the 1970s, toxicants became a concern, but it took two decades to develop initial activities in this field. At the beginning of the 1980s various official institutions tried to organize and oversee some basic labs. For example, the National Petroleum Industry (PETROECUADOR), built an important lab to deal with hydrocarbons and substances related to the oil industry and its impacts. Unfortunately, a fire destroyed this first lab and it took many years to construct a new one. Now, all three oil refineries in Ecuador have their own labs. They are trying to improve their techniques and to train their personnel in the environmental aspects of the industry.

The need for trained personnel led the government to give support to many professionals to travel to developed countries to advance their education, but also within Ecuador, some universities organized seminars and courses to improve the situation. In parallel, some universities created basic labs set up for new research. The technology was not optimal, but scientifically credible results were obtainable.

In Ecuador, poisoning incidents, according to statistics, increase 20% in incidence a year (INHLIP-CIATOX 2005) and are responsible for some 1000 deaths a year (INHLIP-CIATOX 2005). Among the causes of poisoning are violence, familiar disintegration, and depression, but all of them linked to voluntary poisoning. Other causes are unsafe conditions in the handling and use of chemicals at home, at work, and in the general environment. Acute intoxications due to pesticides increased from 3.54/100 000 inhabitants in 1990 to 14.52/100 000 inhabitants in 2003 (Ministry of Public Health, National Department of Epidemiology 2003), and in 2004, 156 intoxications were reported in classifications X40-X49 of the CIE (International Classification of Diseases 10-WHO). This signifies a rate of 0.1/10 000 inhabitants (Ministry of Public Health, Basic Health Indicators, Ecuador 2005). This information should be weighed carefully, though, because although the

tracking system is improving the capacity to collect information, misclassification and lack of information from remote areas where the incidence may be greater are a distinct possibility.

Information from the Social Insurance Ecuadorian Institute, Ministry of Labor, and Ministry of Environment is scarce. The private sector had minimal interest in toxicological questions and issues and only within the past few years have private labs started providing services to identify pesticides or heavy metals in urine.

The Ministry of Agriculture has its own lab for identifying pesticides in soil and water, and there is a lab of the CEEA (Ecuadorian Commission of Nuclear Energy) that could also help in the identification of some toxic substances from agriculture or industry. But this information is not published.

There is clearly a need to include Toxicology as a subject in more Graduate Programs as well as to cover the increased demand of poisoned patients who are unable to get treatment unless they have access to hospitals in major cities. Today we have as many as 200 professionals and technicians that can deal with toxicological emergencies at a basic level. Technology, in spite of several modern labs, is not quite state-of-the-art. One of the main problems is the lack of integration of information, training, and application of the knowledge and of encompassing multidisciplinary approach in the studies.

This has an even greater effect in tracking poisoned patients, since many go to private hospitals, and intoxications are not officially reported.

Recently, the creation of Toxicological Information Centers, such as the Toxicological Advisement and Information Center – CIATOX, formerly a unit of the National Institute of Hygiene and Tropical Medicine 'Leopoldo Izquieta Perez,' has become one of the options to support and improve the treatment of poisoned patients, as well as to reduce risks associated with chemical substances and for data collection. Such centers, though, must be complemented with other activities and resources, as part of a systematic development of toxicology. This chapter presents the primary resources and tools now available to help develop toxicology for the benefit of communities and the environment in Ecuador.

The critical objective continues to be seeking the development of methods, techniques, studies, and research seeking biological indicators to correlate with environmental measurements within a scientific design. The concept of exposure and its association with effects is lacking in the studies that some researchers are conducting in Ecuador.

Thus, we can say that the evolution of toxicology in Ecuador shows that there are many problems to be studied and solved. There is clearly an interest and many actors who could potentially participate. At the same time we need to organize a national system including stakeholders from governmental, private, and non-governmental organizations, together with universities and scientific institutions, to assess the situation in Ecuador as a whole and to develop a new framework, for the future.

RESOURCES

Books

Buitrón B (2006)
Guia para el Diagnostico, Atencion y Tratamiento por intoxicacion en plaguicidas en atencion primaria en salud (Guide for Diagnosis, Attention and Treatment for Pesticide Intoxications in Primary Health Attention)
Ministry of Public Health: Quito, Ecuador

Buitrón B, Aráuz V (2006)
Conociendo el mundo de los plaguicidas para ciudar nuestra salud (Knowing the World of Pesticides for Caring for our Health)
Ministry of Public Health: Quito, Ecuador

Cantos G, López R (1998)
Plomo: Genotoxicidad y Salud Humana (Lead: Genotoxicity and Human Health).
Ed. FUNDACYT: Quito, Ecuador.

Comba P, Harari R (2004)
El Ambiente y la Salud: Epidemiologia Ambiental (Environment and Health: Environmental Epidemiology)
Italian Institute of Health-IFA-Abya-Yala: Quito, Ecuador

Corral F, Cueva P, Yépez J (2004)
Cancer Epidemiology in Quito and others Ecuadorian Regions
National Cancer Registry, SOLCA Quito, SOLCA-MSP-INEC: Quito, Ecuador

FENACLE-IFA (2005)
Manual de Seguridad, Salud y Ambiente en la Produccion Bananera (Safety, Health and Environment in Banana Production. Manual)
Guayaquil, Ecuador

Harari R (2000)
Estrategia Industrial y Medio Ambiente Laboral en Ecuador: 1975–2000 (Industrial Strategy and Work Environment in Ecuador: 1975–2000)
IFA: Quito, Ecuador

Harari R, et al (2002)
Mejoramiento Ambiental y Sanitario en la Floricultura (Sanitary and Environmental Improvement in Flowerculture)
IFA-PROMSA: Quito, Ecuador

Harari R (2003)
Trabajo Infantil y Salud (Child Labor and Health)
National Institute of Health and Family of Ecuador, IFA: Quito, Ecuador

Harari R (2004)
Seguridad, Salud y Ambiente en la Floricultura (Safety, Health and Environment in Flowerculture)
IFA-PROMSA: Quito, Ecuador

IFA-INSTRUCT (2000)
La Relacion entre Comunidad y Floricola: Ambiente y Salud (Relation between Community and Flowerculture Company: Environment and Health)
Canadian International Development Agency: Quito, Ecuador

Landrigan P, Soffritti M, Harari R, Comba P, Harari H (2006)
Salud Ocupacional y Ambiental: Realidades Diversas (Occupational and Environmental Health: Diverse Realities Proceedings of the International Conference 'Occupational and Environmental Health: Emergencies in Developing Countries')
National Health Council of Ecuador, National Institute of Health of Italy, IFA: Quito, Ecuador

Paz-y-Miño C, Creus A, Cabré O, Leone PE (2004)
Genetica, Toxicologia y Carcinogenesis (Genetics, Toxicology and Carcinogenesis)
FUNDACYT-Pontificia Universidad Católica del Ecuador: Quito, Ecuador

Sevilla R, Pérez de Sevilla P (1985)
Plaguicidas en Ecuador: Mas alla de una simple advertencia (Pesticides in Ecuador, Beyond a Simple Warning)
Fundación Natura: Quito, Ecuador

Trujillo F, Bazante M (1996)
Manual de Intoxicaciones por Plaguicidas (Manual of Pesticides Poisonings)
AFEME: Quito, Ecuador

Journals

Bulletin Epidemiology and Action
Ministry of Public Health of Ecuador (Spanish)
National Department of Epidemiology of the Ministry of Public Health of Ecuador

Ecuadorian Journal of Hygiene and Tropical Medicine (Spanish)
Istitute of Higiene and Tropical Medicine 'Dr. Leopoldo Inquieta Pérez'
ISNN 004-7775
Web: http://www.inh.gov.ec/?pageIndex=28

Ecuadorian Journal of Public Health (Spanish)
Public Health Postgrade Institute, Medical Sciences Faculty of the Central University of Ecuador
ISNN 1390-3322

Journal Metro Ciencia (Journal of Metropolitan Hospital)
Quito, Ecuador (Spanish)
Web: http://www.opsecu.org/bevestre/nuevos%20artículos/metrociencia.htm

Journal of Medical Sciences Faculty
Central University of Ecuador (Spanish)
Web: http://es.geocities.com/revfcmquito/index.html
Web: http://es.geocities.com/revfcmquito/ContenidoV31N3y4.html

Scientific Journal of Guayas Physicians Association
Guayaquil, Ecuador (Spanish)
Web: http://www.medicosecuador.com/revistacmg

Technical Reports and Other Documents

Almeida A, Maldonado A, Martinez E (2006) Accion Ecologica Comunitary Environmental Monitoring Manual.

Cantos G, López R, Leobato L, Romero M, Torres C (1998) Analysis of the chromosomal damage in linfocites of workers of the ceramics exposed to Lead. La Victoria Cotopaxi Ecuador, 1997. Mendeliana 13(1): 36–48.

Colosio C, Harari R, Birindelli S, et al (2003) [Occupational exposure to fungicides in floriculture in Ecuador]. G Ital. Med. Lav. Ergon. 25(Suppl3): 107–108. (in Italian).

Counter SA, Buchanan LH, Laurell G, Ortega F (1998) Blood mercury and auditory neuro-sensory responses in children and adults in the Nambija gold mining area of Ecuador. Neurotoxicology 19(2): 185–196.

Counter SA, Buchanan LH, Laurell G, Ortega F (1998) Field screening of blood lead levels in remote Andean villages. Neurotoxicology 19(6): 871–877.

Counter SA, Buchanan LH, Ortega F (2001) Gender differences in blood lead and hemoglobin levels in Andean adults with chronic lead exposure. Int. J. Occup. Environ. Health 7(2): 113–118.

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Counter SA, Buchanan LH, Ortega F (2005) Neurocognitive impairment in lead-exposed children of Andean lead-glazing workers. J. Occup. Environ. Med. 47(3): 306–312.

Counter SA, Buchanan LH, Ortega F (2006) Neurocognitive screening of mercury-exposed children of Andean gold miners. Int. J. Occup. Environ. Health 12(3): 209–214.

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Databases

CENTOX
Toxicological Center. Not available online, in Spanish.

This database is available through a call center 1800-CENTOX or in the Clinica Pichincha in Quito, Ecuador.

CIATOX
Toxicological Advisement and Information Center. Institute of Hygiene and Tropical Medicine 'Dr. Leopoldo Inquieta Pérez'. Not available online, in Spanish.

This database is available through a call center (593-2 2905162) or in the CIATOX. The information is available for physicians and for all Ministry of Public Health Hospitals and others.

Poison Control Center

Centro de Control de Venenos. Hospital Luis Vernaza. Not available online, in Spanish. This database in available in the Hospital Luis Vernaza and only by physicians.

Toxicological Information Center of the Metropolitan Hospital in Quito

Only available by physicians at the same hospital.

Organizations (Government)

Ministry of Agriculture and Cattle
Web: http://www.mag.gov.ec/ (Spanish only)

Ministry Institutes include Ecuadorian Service of Animal and Farming Husbandry (http://www.sesa.mag.gov.ec/; Spanish only)

Ministry of Environment of Ecuador
Web: http://www.ambiente.gov.ec/ (Spanish only)

Projects and Secretaries include: Nacional Secretary of Chemical Products; Development of Implementation Plan for Persistent Organic Pollutants (POPs); Integrated National Plan for Rational Management of Chemical Substances (UNITAR); Registry of Emissions and Pollutants Transferency.

Ministry of Public Health
Web: http://www.msp.gov.ec/ (Spanish only)

Ministry Institutes include: Institute of Science and Technology; Institute of Hygiene and Tropical Medicine 'Dr. Leopoldo Inquieta Pérez' (http://www.inh.gov.ec/; Spanish only); Health Virtual Library of Ecuador (http://www.bvs.org.ec/; Spanish only).

Ministry of Labour
Web: http://www.mintrab.gov.ec/MinisterioDeTrabajo/index.htm (Spanish only)

Includes the Safety and Health Unit (http://www.mintrab.gov.ec/MinisterioDeTrabajo/Area%20Trabajo/Wfseguridsalud.aspx; Spanish only)

National Council of Health
Web: http://www.conasa.gov.ec/ (Spanish only)

National Secretary of Science and Technology
Web: http://www.senacyt.gov.ec/presentacion.html (Spanish only)

Environmental Direction of the Municipality of Quito
Web: http://www.quito.gov.ec/DMMA/index.htm (Spanish only)

National Institute of Social Security
Web: http://www.iess.gov.ec/ (Spanish only)

Includes Social Security Risks at Work Department (http://www.iess.org.ec/riesgos_del_trabajo1.htm; Spanish only)

Ministry of Foreign Relations
Environment Unit
Web: http://www.mmrree.gov.ec/ (Spanish only)
Phone: (593) 2256 3112
Quito, Ecuador

National Museum of Medicine 'Dr. Eduardo Estrella' (Museo Nacional de Medicina 'Dr. Eduardo Estrella')
Address: Dirección: Calle García Moreno 524 y 24 de mayo.
Phone: 593 2 2581768/ 2 2573792

Organizations (Non-Government)

Accion Ecologica

NGO dedicated to the defense of natural resources in Ecuador. Experience in oil, mining, pesticides, and water management policy.

Web: http://www.accionecologica.org (Spanish only)

CEAS

Health research and advisory center.

Web: http://www.ceas.med.ec/ (Spanish only)

CEDENMA – Ecuadorian Committee for the Defense of Nature and Environment

Group of non-governmental organizations for the defense of nature, environment and health.

Web: http://www.cedenma.org/ (Spanish only)

CEOSL – The Ecuadorian Confederacy of Trade Union Free Organizations

Confederacy at national level, in which it groups organized workers in commerce, services, crafts, and culture; and, in general workers with a degree of dependency.

Web: http://www.uocra.org/itcilo/vero.htm (Spanish only)

Cimas del Ecuador

Work in the design of alternative models of local development, which considers environmental, social, and cultural differences.

Web: http://www.cimas.edu.ec/ (Spanish and English)

Comunidec

Research systems on local development.

Email: comunide@ecuanex.net.ec

ECOLEX

Promotes and executes policy alternatives and legislation for sustainable development.

Web: http://www.ecolex-ec.org/ (Spanish and English)

FENACLE – National Federation of Peasants and Agricultural Workers of the Ecuador

Organization with great experience in the defense of labor rights of workers in banana and flower Plantations.

Guayaquil, Ecuador
Phone: +593 4 2414077
Email: fenacle@easynet.net.ec

FFLA – Fundacion Futuro Latinoamericano

ONG with experience in socio-environmental conflicts and environmental policy

Web: http://www.ffla.net/ (Spanish only)

Fundacion Ambiente y Sociedad

Research and advice in environment and society.

Phone: (593-2)-2904-815
Alemania 550 y Vancouver, piso 4
Quito, Ecuador

Fundación Ciencia Para el Estudio del Hombre y la Naturaleza

Address: Paúl Rivet 257 y Wimper
Phone: 593 2 2524455/593 9 94830562
Email: mps36@interactive.net.ec

Fundacion Natura

Develops activities of conservation of biodiversity, environmental policy and management.

Web: http://www.fnatura.org/ (Spanish only)

FUNSAD

Health, environment and development foundation.

Email: oscarbet@andinanet.net

IFA – Institute for Development of Production and Work Environment

Experience in research in occupational and environmental health in air pollution, mining, oil, flowers, banana, and potato production jointly with community organizations and unions.

Web: www.saludyambiente.org; ifa@ifa.org.ec (English and Spanish)

PLASA – Platform for Socio-Environmental Agreements

Place of meeting between diverse governmental and non-governmental organizations; interested in facilitating the construction of consensuses for the conservation and the sustainable and equitable handling of the natural resources.

Web: http://www.plasa-ecuador.net/ (Spanish only)

Universities

Andean University Simon Bolivar
Health
Web: http://www.uasb.edu.ec/acad/salud.html (Spanish only)

Catholic University
Web: http://www.puce.edu.ec/ (Spanish only)
School of Medicine
Web: http://www.puce.edu.ec/index.php?pagina=carrera27 (Spanish only)
School of Nursing
Web: http://www.puce.edu.ec/index.php?pagina=carrera14 (Spanish only)
Public Health Master Degree

Central University of Ecuador
Web: http://www.uce.edu.ec/ (Spanish only)
Quito, Ecuador
School of Medicine
Web: http://www.uce.edu.ec/carrerase.php?facesccar=62&facesc=39&fac=11&FN=Ciencias%20Médicas&EN=Medicina&CN=Medicina (Spanish only)
School of Pharmacy
School of Nursery
Biomedical Center
Web: http://www.uce.edu.ec/centrosdetalle.php?cencod=234&cennom=Centro%20de%20Excelencia%20de%20Biomedicina&cenpad=0 (Spanish only)
Public Health Master Degree

International University
Web: http://www.internacional.edu.ec/ (Spanish only)
School of Medicine

San Francisco University
Web:http://www.usfq.edu.ec/ (Spanish only)
School of Medicine
Web: http://www.usfq.edu.ec/1COLEGIOS/Salud/salud.htm#medicina (Spanish only)
Microbiology Master Degree
Web: http://www.usfq.edu.ec/POSTGRADOS/MMicro/Maestria_Micro.html (Spanish only)
Public Health Master Degree
Web: http://www.usfq.edu.ec/POSTGRADOS/Salud/Maestria_SP.html (Spanish only)

Technical Equinoctial University
Web: http://www.ute.edu.ec/ (Spanish only)
School of Medicine
School of Nursing

Professional Societies

Public Health Postgrade Institute (Instituto de Postgrado de Salud Pública)
College of Medicals
Web: http://www.cmpichincha.med.ec/ (Spanish only)

Poison Control Centers

Control Poison Center – Centro de Control de Venenos
Hospital Luis Vernaza
Julian Coronel 404 y Escobedo
Dr. Eduardo Duran Duran – Head
Phone: (593) 5 56 0300
Fax: (593) 5 31 1933
Guayaquil, Ecuador

Ecuadorian Commission of Atomic Energy
Laboratorio de Ecotoxicología
Sexto Piso – Edificio Matriz (Juan Larrea N15-36 y Riofrío, Quito, Ecuador)
Phone: (593 2) 254-5773; (5932) 254-5861 Ext. 26
Email: ceea.tox@andinanet.net
Quito, Ecuador

Ecuadorian Red Cross
Web: http://www.cruzroja.org.ec/ (Spanish only)

National Council of Control of Psicotropic Substances
Web: http://www.consep.gov.ec/Consep.htm (Spanish only)

Toxicological Information and Advisory Center (Centro de Información y Asesoría Toxicológica – CIATOX)
Attn. Dr. Marcelo Chiriboga, Head National Institute of Hygiene and Tropical Medicine
'Leopoldo Izquieta Pérez'
North Zone.
Dra. Consuelo Meneses, CIATOX
Dra. Beatriz Vargas, Toxicology Lab
Phone: (593 2) 290 – 5962
(593 2) 256 – 5858/250 – 2058 Ext. 221
Web: http://www.inh.gov.ec
Email: ciatoxecua@gmail.com
Quito, Ecuador

Toxicology Center
Hospital de Clínicas Pichincha. Centro Toxicológico – CENTOX
Dr. Iván Cabezas – Head
Phone: (593 2) 2998799/1800-CENTOX
Quito, Ecuador

Legislation

Environmental Law
Web: http://www.ambiente.gov.ec/paginas_espanol/3normativa/norma_ambiental.htm (Spanish only)

Environmental Law for Hydrocarbons Operations
Web: http://www.menergia.gov.ec/secciones/archivos/dinapaReglamentoAmbientalHidrocarburiferas.pdf (Spanish only)

Environmental Law for Mining Activities
Web: http://www.menergia.gov.ec/secciones/ambiental/uamMarcoLegal.html (Spanish only)

Health Organic Law
Registro Oficial Viernes 22 de Diciembre del 2006 – Nro. 423

Occupational Legislation – Ministry of Labour
Web: http://www.mintrab.gov.ec/MinisterioDeTrabajo/Documentos/54.doc

Social Security Risks at Work Legislation (Reglamento General Del Seguro de Riesgos del Trabajo)
Instituto Ecuatoriano de Seguridad Social (IESS)
División Nacional de Riesgos del Trabajo
Edificios Riesgos del Trabajo del IESS
Av. Naciones Unidas y Veracruz, sector 28
Quito
Tel.: (+593 2) 462 663
Fax: (+593 2) 446 394
Web: www.iess.gov.ec

CHAPTER

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Finland

HANNU KOMULAINEN

INTRODUCTION

Toxicology first came into its own in Finland in the late 1970s. The first full-time professorship in toxicology (precisely in toxicology and pharmacokinetics, changed later to toxicology) was founded at the University of Kuopio, Department of Pharmacology and Toxicology in 1976; the Finnish textbook, *Pharmacology and Toxicology* edited by Tuomisto and Vartiainen, was published in 1978, and contained a separate section on toxicology; the Finnish Society of Toxicology was founded in 1979 and the first postgraduate program in toxicology was launched to start at the beginning of 1980s at the University of Kuopio. Research on toxicological topics had been conducted at universities and institutes long before, but the above breakthroughs are formal signs of the evolution of the discipline. The term 'toxicology' appeared more often in university positions and the names of departments in the 1980s. Currently toxicology is an established science in Finland and, as described in the sections on 'Organizations' below, it has a clearly defined role in Finnish society. In several institutes, it is part of their activity or is integrated with other disciplines. Relatively few divisions are devoted solely to toxicology. This is true also for ecotoxicology, which has developed simultaneously. The Finnish Society of Toxicology has had about 300 members (out of the total population of 5.1 millions) through the years and the society has been active both nationally and internationally in multilateral organizations such as EUROTOX and IUTOX, and organizing, for example, the 10th IUTOX meeting (ICT-X) in Tampere in 2004.

As to information sources in toxicology in Finland, most essential information can be gained through the Internet. Compared to the previous edition of this book, fewer books are currently being published on toxicological topics. Although the key textbooks and handbooks are maintained by new editions and a whole series of books have appeared in subjects such as radiation, while the regulatory side of chemicals has received little attention. One reason may be that chemical legislation in the EU is in flux due to REACH. Perhaps, once it is established, more definitive regulatory documentation will become available. However, it is likely that the information will be increasingly digital even then because it can be more readily been updated. As to the use of the information, the main responsibility in several public functions in Finland resides at the local and municipal levels, with the guidance from ministries being informative rather than binding. For that reason, relevant information in easily and quickly accessible form is highly valued and will be a challenge in the future.

This chapter focuses on current information considered most useful – the newest relevant sources. The older literature dropped out from this edition is still long available through libraries. As to descriptions of the organizations, the perspective has been wide because it is often more important to know where to find the information than precisely what can be found there. Internet search engines are powerful tools for finding documents if one has a reliable reference. Most of the listed digital sources exist in both Finnish and English versions, and others include English summaries. Contact information is provided where feasible but it mostly can also be located from digital sources.

RESOURCES

Books

The listed handbooks and textbooks are largely in Finnish. A short description of their contents is provided. More information may be available at the website for the publication or the publisher.

Anttonen H, Lapinlampi T, Virtanen S (2006)
Elektoniikka-alan kemikaaliopas (Guide to the Safe Use of Chemicals in the Electronics Industry)
Työterveyslaitos: Helsinki
ISBN (pdf) 951-802-710-2

The guide helps to identify chemical risks in the electronics industry and provides tools for their systematic evaluation and assessment. Relevant chemicals, the associated health risks and risk prevention strategies are also are described by job.

Hoppu K, Pohjalainen T, Taalikka P (Eds.) (2002)
Lasten myrkytykset (Poisonings in Children)
Duodecim: Helsinki
ISBN 951-656-129-2

This book is aimed as guidance for household situations involving poisoning in children. Contains instructions for emergency help, information on typical agents causing poisonings in children and prevention of poisonings.

Ikäheimonen T (Ed.) (2002)
Säteily- ja sen havaitseminen (Radiation and its Detection) Säteilyturvakeskus: Helsinki
ISBN 951-712-496-1 (print)
ISBN 951-712-503-8 (pdf)

A book on the basics of nuclear physics, units of radiation, detectors of radiation and measurement of radiation. Available also as a pdf-file on the web pages of the Radiation and Nuclear Safety Authority (STUK). (Finnish only: http://www.stuk.fi/julkaisut_maaraykset/kirjasarja/fi_FI/kirjasarja). This is the first part of the series of seven books on radiation and nuclear safety.

Jantunen M, Komulainen H, Nevalainen A, Tuomisto J, Venäläinen R, Viluksela M (2005)
Selvitys elinympäristön kemikaaliriskeistä – Kansallisen kemikaaliohjelman taustaselvitys (Evaluation on Health Risks of Chemicals in our Environment – Report for National Chemical Programme)
Publications of the National Public Health Institute B 11/2005: Helsinki
ISBN 951-740-495-6 (print)
ISBN 951-740-533-2 (pdf)

A thorough evaluation and summary on the exposure and the associated health risks of environmentally relevant chemical substances in Finland in 2005. This is the most comprehensive summary published so far including food, water, indoor and outdoor air, contaminated soils, waste and waste water, consumer products, and even cosmetics. Some general recommendations are also given for risk assessment and the needs for future work in environmental chemical safety are prioritized. Contains an executive summary in English. Also available on the Internet (http://www.ktl.fi/attachments/suomi/julkaisut/julkaisusarja_b/2005b11.pdf).

Koulu M, Tuomisto J (Eds.) (2007)
Farmakologia ja toksikologia (Pharmacology and Toxicology), 7th Edition
Kustannusosakeyhtiö Medicina: Kuopio
ISBN 978-951-97316-2-9

This textbook is the first comprehensive presentation of pharmacology in the Finnish language aimed especially at students of medicine and pharmacy. The book also contains the basics of toxicology, including principles of general toxicology, organ toxicity, mutagenicity, carcinogenicity, teratogenicity, and the evaluation of toxicity. The toxicity of drugs, alcohols, solvents, carbon monoxide, metals, pesticides, and air pollutants have been dealt with in more detail in separate chapters, as has occupational toxicology.

Lähteenmäki P, Nuutinen T, Parkkinen P (2000)
Ravintomme lisäaineet (Food Additives), 2nd Edition
Suomen Ravitsemusinstituutti: Helsinki
ISBN 9789525046014

A handbook on food additives for consumers; also contains useful information for professionals in nutrition and food safety control.

Neuvonen PJ, Himberg J-J, Huupponen R, Kivistö K, Ylitalo P (Eds.) (2002)
Kliininen farmakologia ja lääkehoito (Clinical Pharmacology and Therapeutics)
Kandidaattikustannus Oy: Helsinki
ISBN 951-8951-17-9

A Finnish textbook on clinical pharmacology and therapeutics, also containing information on clinical toxicology.

Nikunen E, Leinonen R (2002)
Ympäristölle vaaralliset kemikaalit – riskinarviointi ja luokitus (Hazardous Chemicals in the Environment – Risk Assessment and Classification)
Kemianteollisuus ry.: Helsinki

A handbook on assessment of environmental effects of chemicals and classification and labeling.

Nordman H, Oksa P, Karjalainen A, Koskinen H (2006)
Asbestisairauksien diagnostiikka ja seuranta (Diagnostics and Surveillance of Asbestos-induced Diseases)
Työterveyslaitos: Helsinki
ISBN 951-802-628-9

A book on occupational asbestos-induced diseases; the diagnostics and surveillance of the exposed persons in Finland.

Nyberg J, Jokela K (Eds.) (2006)
Ionisoimaton säteily – Sähkömagneettiset kentät (Non-ionizing Radiation – Electromagnetic Fields)
Säteilyturvakeskus, Helsinki
ISBN 951-712-501-1 (print)
ISBN 951-712-508-9 (pdf)

A book on electromagnetic fields covering properties of radiation, exposure, dosimetry, biological effects, and health risks. The sixth part of a series of seven books on radiation and nuclear safety.

Pääkkönen R, Rantanen S (2003)
Työympäristön kemiallisten ja fysikaalisten riskien arviointi ja hallinta (Risk Assessment and Management of Chemical and Physical Risks in the Work Environment), 3rd Edition
Työterveyslaitos, Helsinki
ISBN 951-802-544-4

A guide book on occupational health risk assessment.

Paile W (Ed.) (2002)
Kirja säteilyn terveysvaikutuksista (Effects and Health Risks of Ionizing Radiation)
Säteilyturvakeskus: Helsinki
ISBN 951-712-499-6 (print)
ISBN 951-712-506-2 (pdf)

A book on effects of ionizing radiation, from the cellular level to health risks. The book focuses especially on cancer but also addresses developmental effects. There is also a section on the Chernobyl nuclear accident. The book is available also as a pdf file on the web pages of the Radiation and Nuclear Safety Authority (STUK) (Finnish only: http://www.stuk.fi/julkaisut_maaraykset/kirjasarja/fi_FI/kirjasarja). It is the fourth part of a series of seven books on radiation and nuclear safety.

Pelkonen O, Ruskoaho H (Eds.) (2003)
Lääketieteellinen farmakologia ja toksikologia (Medical Pharmacology and Toxicology), 3rd Edition
Kustannus Oy Duodecim: Helsinki
ISBN 951-656-090-3

A textbook in pharmacology and toxicology for medical, dental, and pharmacy students. The book contains sections of general pharmacology, systematic pharmacology, and toxicology. The emphasis is on mechanisms of action of drugs. The section of toxicology (140 pages) covers general principles of toxicology, organ-specific toxicity, clinical toxicology, occupational toxicology, environmental toxicology, and evaluation of toxicity and risk assessment.

Pöllänen R (Ed.) (2003)
Säteily ympäristössä (Radiation in Environment)
Säteilyturvakeskus: Helsinki
ISBN 951-712-497-X (print)
ISBN 951-712-995-5 (pdf)

A book on radioisotopes in nature and the associated radiation and doses in Finland. Possible health risks are also briefly addressed. The book covers radiation in indoor and outdoor air, in drinking water, in food, internal and external radiation, cosmic radiation, and basics of radiation protection. Available also as a pdf file on the web pages of the Radiation and Nuclear Safety Authority (STUK). (Finnish only: http://www.stuk.fi/julkaisut_maaraykset/kirjasarja/fi_FI/kirjasarja). The second part of the series of seven books on radiation and nuclear safety.

Pukkila O (Ed.) (2004)
Säteilyn käyttö (Radiation in Use)
Säteilyturvakeskus: Helsinki
ISBN 951-712-498-8 (print)
ISBN 951-712-505-4 (pdf)

A book on the use of radioisotopes and radiation in medicine (diagnostics and treatment), industry, and research. There is also a description of the relevant legislation, a section about radiation in consumer products and cases of accidents and unexpected situations in the use of radiation. It is available also as a pdf file on the web pages of the Radiation and Nuclear Safety Authority (STUK) (Finnish only: http://www.stuk.fi/julkaisut_maaraykset/kirjasarja/fi_FI/kirjasarja). The third part of the series of seven books on radiation and nuclear safety.

Riihimäki V, Isotalo L, Jauhiainen M, Kemiläinen B, Laamanen I, Luotamo M, Riala R, Zitting A (2005)
Kemikaaliturvallisuuden tiedonlähteet (Information Resources on Chemical Safety), 2nd Edition
Työterveyslaitos: Helsinki
ISBN: 951-802-556-8

This is the most comprehensive single compilation of information resources on chemicals in Finnish, containing both national and international sources. The book contains the sources, description of the contents of the information, some basics of toxicology, instructions on interpretation of the data, and classification

and labeling phrases of chemicals. In addition to a hardcopy, the book is available as an electronic form on the web pages of the publisher, the Finnish Institute of Occupational Health (Finnish only: http://www.ttl.fi/internet/kemikaalitieto/kemturva.pdf).

Sandberg J (Ed.) (2004)
Ydinturvallisuus (Nuclear Safety)
Säteilyturvakeskus: Helsinki
ISBN 951-712-500-3 (print)
ISBN 951-712-507-0 (pdf)

A book on nuclear power, from a Finnish perspective. Environmental and health risks associated with nuclear power plants and nuclear waste, regulation of nuclear safety, and the role of STUK as a responsible authority. Available also as a pdf file on the web pages of the Radiation and Nuclear Safety Authority (STUK) (Finnish only: http://www.stuk.fi/julkaisut_maaraykset/kirjasarja/fi_FI/kirjasarja). The fifth part of the series of seven books on radiation and nuclear safety.

Vainio H, Liesivuori J, Lehtola M, et al (2005)
Kemikaalit ja työ – Selvitys työympäristön kemikaaliriskeistä (Chemicals at work – Report of the Finnish Occupational Health Institute for the National Programme of Chemical Safety)
Työterveyslaitos: Helsinki
ISBN 951-802-636-X (hard copy)
ISBN 951-802-645-9 (pdf)

A thorough summary on occupational exposure to chemicals, their health effects, health risks, and risk management in Finland in 2005. In addition to descriptions of single chemicals and exposures, the book contains short chapters on management of chemical waste and risk management in general. The book contains an executive summary in English. The entire edition is also available on the Internet (http://www.ttl.fi/Internet/Suomi/Aihesivut/Kemikaaliturvallisuus/Kemikaalit+ja+tyo/sisallysluettelo.htm).

Journals

Most institutes have a bulletin or a newsletter to provide information on their work and some of them are mentioned later in the description of the organizations. The journals below may have a wider coverage of readers, are more technical or science-based, or otherwise relevant.

African Newsletter on Occupational Safety and Health
Finnish Institute of Occupational Health, Helsinki (financially supported by the World Health Organization and the International Labour Organization)
ISSN 0788 – 4877 (printed)
ISSN 1239 – 4386 (on-line)

An electronic journal on occupational safety and health issues of Africa. The journal is published in English and is available at the home page of the Finnish Institute of Occupational Health. Three issues per year.

Web: http://www.ttl.fi/Internet/English/Information/Electronic + journals/African + Newsletter (English only)

ALARA (Radiation Safety)
STUK – Radiation and Nuclear Safety Authority, Helsinki
ISSN 1235-1970

An information magazine from the Radiation and Nuclear Safety Authority for professionals in radiation and nuclear power issues. Contains articles on health and environmental safety with a summary in English, facts on radioisotopes, and information on the national regulations on radioactive agents and nuclear power. Offers information on study reports and publications of the institute. Four issues per year. The contents of each issue are available in the Internet.

Web: http://www.stuk.fi/julkaisut_maaraykset/alara/fi_FI/alara (Finnish only)

Asian-Pacific Newsletter on Occupational Safety and Health
Finnish Institute of Occupational Health, Helsinki
ISSN 1237-0843 (printed)
ISSN 1458-5944 (online)

An electronic journal on occupational safety and health issues in the Asian-Pacific region. The journal is available at the home page of Finnish Institute of Occupational Health, published in English. Three issues per year.

Web: http://www.ttl.fi/Internet/English/Information/Electronic + journals/Asian-Pacific + Newsletter/ (English only)

Barents Newsletter on Occupational Safety and Health
Finnish Institute of Occupational Health, Helsinki
ISSN 1455-8459 (printed)
ISSN 1458-5952 (online)

An electronic journal on occupational safety and health issues in the Barents region of Russia. The journal is available at the home page of Finnish Institute of Occupational Health. The articles are in English and in Russia. Three issues per year.

Web: http://www.ttl.fi/Internet/English/Information/Electronic + journals/Barents + Newsletter (English only)

Duodecim (Finnish Medical Journal Duodecim)
Finnish Medical Society Duodecim, Helsinki
ISSN 0012-7183

This is the oldest Finnish medical serial publication, founded in 1885. It is intended for medical professionals,

especially physicians. The primary purpose is to provide postgraduate scientific and vocational training for physicians. The journal publishes peer-reviewed original articles, reviews, and case reports in all specialties of clinical medicine as well as articles of general interest on biomedicine and public health. Six special issues are normally published each year; 24 issues are published annually. Toxicology is among the topics covered in this journal's articles. The contents and abstracts of the articles considered exceptionally important are also in English.

Web: http://www.terveysportti.fi/terveysportti/dlehti2.koti (English)
Web: http://www.terveysportti.fi/terveysportti/dlehti2.koti (Finnish)

Kansanterveys (Journal of National Public Health Institute)
National Public Health Institute, Helsinki
ISSN 1236-973X

An information journal of the National Public Health Institute for professionals working in the public and environmental health care system, from municipalities to ministries and other governmental institutes. Ten yearly issues, each focusing to some specific theme. Short notes on the ongoing research in the institute. The articles can also be accessed via the Internet.

Web: http://www.ktl.fi (Finnish)

Kemia-Kemi (Finnish Chemistry)
Kempulssi Oy, Helsinki
ISSN 0355-1628

A professional magazine dedicated to chemistry, *Kemia-Kemi* is a membership magazine of the Association of Finnish Chemical Societies. Published under the auspices of the Chemical Industry Federation. The magazine reviews news and developments in international and Finnish chemical trades and chemistry. Toxicology is among the topics covered. Maintains a comprehensive directory on enterprises and companies offering services related to chemistry.

Web: http://www.kemia-lehti.fi/english.htm (English)
Web: http://www.kemia-lehti.fi/index.htm (Finnish)

Scandinavian Journal of Work, Environment and Health
Finnish Institute of Occupational Health; National Institute of Occupational Health, Denmark; National Institute of Occupational Health, Norway; and National Institute for Working Life, Sweden
ISSN 0355-3140

A scientific journal publishing original papers and review articles concerning occupational health and the work environment. The fields covered are medicine, toxicology, epidemiology, industrial hygiene, safety, ergonomics, sociology, psychology, and physiology. Six issues per year. The papers are indexed in leading index services.

Web: http://www.sjweh.fi (English only)

Suomen Lääkärilehti (Finnish Medical Journal)
Finnish Medical Association, Helsinki
ISSN 0039-5560

Suomen Lääkärilehti, published by the Finnish Medical Association as a membership magazine, is the leading journal aimed at physicians in Finland. The journal serves as an information medium for the association and its members in vocational questions and supports the postgraduate training of physicians. The journal publishes articles mostly on diagnostics, treatment, and rehabilitation, and articles concerning the practical work of physicians. Toxicology, especially related to drugs, is frequently dealt with. The journal is published in 36 issues per year. The articles have an English summary, available also in the Internet.

Web: http://www.laakarilehti.fi/e/ (English)
Web: http://www.laakarilehti.fi (Finnish)

TABU (Drug information from the National Agency for Medicines)
National Agency for Medicines, Helsinki
ISSN 1236-7427

A safety information magazine of the National Agency for Medicines for healthcare professionals and pharmacists. Contains summaries on new active ingredients and reviews on the use and side effects of pharmaceuticals. Six issues per year. Contains summaries in English and Swedish. Available in the Internet.

Web: http://www.nam.fi/english/publications/tabu/index.html (English)
Web: http://www.nam.fi/julkaisut/tabu/2004/index.html (Finnish)

Työ, terveys, turvallisuus (Work, Health, Safety)
Finnish Institute of Occupational Health, Helsinki
ISSN 0041-4816

A magazine for all individuals interested in occupational health and safety. The topics cover all fields of occupational safety and health. Eight issues per year, in Finnish only. Short abstracts of key articles available on the web pages.

Web: http://www.ttl.fi/Internet/Suomi/Tiedonvalitys/Tyo + Terveys + Turvallisuus + –lehti (Finnish only)

Ympäristö (Environment)
Stellatum Oy, Espoo
ISSN 1237-0711

The magazine of the Ministry of the Environment and the Finnish Environment Institute on environmental

issues for all who are interested in environmental safety, waste management, contaminated soils, etc., the subjects dealt with by those institutes. Short articles and notes about ongoing activities elsewhere are included. Six issues per year, only in Finnish.

Web: http://www.ymparisto.fi/default.asp?contentid=222885&lan=fi (Finnish only)

Ympäristö ja Terveys (Environment and Health)
Suomen Ympäristö- ja Terveysalan Kustannus Oy, Helsinki
ISSN 0358-3333

A professional periodical for persons responsible for and interested in environmental and occupational health, as well as the hygiene of food in Finland. Contains useful information especially for authorities and persons responsible for environmental safety and occupational protection in industry. The journal frequently publishes special issues. One such issue (10/2006) is a summary on exposure of Finns to chemicals and radiation. Eight issues per year.

Web: http://www.ymparistojaterveys.fi/ytlehti/ytindex.php (Finnish only)

Databases

International study programmes database
Web: http://finland.cimo.fi (English)

The International Study Programmes Database, maintained by CIMO (Centre for International Mobility), gives information about study programs taught in English in Finnish universities and polytechnics. This database provides information about close to 400 international study programs. In almost all of the programs, the language of instruction is English.

KAMAT – Tietokortit kemiallisesta altistumisesta metalli- ja autoalojen työtehtävissä (Information cards on exposure to chemicals in metal and car industry)
Web: http://www.ttl.fi/Internet/partner/kamat (Finnish only)

A database, maintained by the Finnish Institute of Occupational Health, on exposure to chemicals in the metal and automobile industries in Finland. The database contains information arranged by job, on exposure to chemicals, health risks, occupational diseases and mitigation of the exposure and the risks.

Kansainväliset kemikaalitietokortit (International Data Cards on Chemicals)
Web: http://kappa.ttl.fi/kemikaalikortit (Finnish only)

The Finnish translation of the database produced by the International Programme on Chemical Safety (IPCS) and the European Union (EU), maintained by the Finnish Institute of Occupational Health. Data on over 1500 industrial chemicals including physical-chemical properties of the chemical, classification and labeling, exposure, health risks, instructions for emergency situations and safe storage. Data may be searched by different keywords. The original international cards have been translated to several other languages and there is access to them through the website.

Kemikaalien ympäristötietorekisteri (Data bank of Environmental Properties of Chemicals – EnviChem)
Web: http://www.ymparisto.fi/default.asp?contentid5141944&lan=fi&clan=en (Finnish only)

This database, maintained by Finnish Environment Institute, Chemicals Division covers about 2700 chemicals. The database consists of information on the toxicity of substances in relation to different species, especially aquatic organisms, together with information on the persistence and accumulation of these substances in the environment. The list of species and abbreviations helps in the interpretation of the data. The information is mainly compiled from scientific literature, handbooks, and databases in the field of ecotoxicology and contains some 3500 references. The scientific value of the compiled information has not been assessed. The database is useful to environmental authorities, researchers, consultants, and companies dealing with chemicals. The database is also available on CD-ROM.

Kemikaalirekisterin tuoterekisteri, KETU (The Product Register of the Chemicals Register)
Web: http://www.sttv.fi/kemo/TURE/In_English.htm (English)

A database of chemical products marketing commerce in Finland, maintained by the National Product Control Agency for Welfare and Health (STTV). The database is based on the Decree of the Ministry of Social Affairs and Health on submitting information on chemicals (374/2002). The collection and registration of data started in 1979. KETU contains data on approximately 100 000 industrial chemical products and compounds registered in Finland. Of them, about 30 000 are in commerce. The data are based on information submitted by the manufacturers and importers, according to the Chemical Act, and within the context of the registration of the product. The register contains information such as classification of the chemical, safety instructions, components hazardous

to health, physical–chemical properties, health risks, precautions in handling and instructions for storage and disposal. The safety data sheets (see below) are based on the same information. Since some data may be confidential, access is restricted to authorities responsible for chemical control.

Käyttöturvallisuustiedotteet (Safety Data Sheets)
Web: http://www.onemed.com:8080/ipublisher/medlabwww.nsf/sivut/finnishtemplate?OpenDocument&cid=Kayttoturvallisuustiedotteet (Finnish only)

A compilation of safety data sheets provided by the manufacturers of chemicals. The database is maintained by OneMed Company. Each entry contains information on classification of the chemical, safety instructions, components hazardous to health, physical–chemical properties, health risks, precautions in handling, and instructions for storage and disposal. An electronic database.

LEO
Web: http://pretty.ttl.fi/LEO/search.htm (Finnish only)

LEO is a reference database of publications concerning occupational safety and health published since 1978 in Finland. The database is maintained by the Finnish Institute of Occupational Health. It contains more than 40 000 computerized references and the number increases by about 2000 per year.

Onnettomuuden vaaraa aiheuttavat aineet-turvallisuusohjeet (OVA-ohjeet) (Safety sheets on substances causing potentially accidents)
Web: http://www.ttl.fi/ova (Finnish only)

The database, maintained by the Finish Institute of Occupational Health, on 88 industrial chemicals which have the most potential to cause accidents in Finland. OVA-cards offer rescue instructions for rescue workers and persons responsible for occupational health. There is also access to R- and S-sentences (classification and labeling).

TOKEVA-ohjeet (Instructions for rescue workers in chemical accidents)
Web: http://www.pelastusopisto.fi/pelastus/home.nsf/Pages/6CB9D53FDFE9D71FC22571CE003DD9E2 (Finnish only)

Provides instructions for handling of chemical accidents and other incidents for rescue workers. The information is meant for rescue professionals but the data and the source are very useful for anyone who handles (dangerous) chemicals. In addition to general instructions, substance-based instructions are given on hazards, personal protection and equipment needed in rescue work, as well as detailed advice on what to do and how. The database can be uploaded from the Pelastusopisto home page.

Torjunta-ainerekisteri (A register on pesticides)
Web: http://www.evira.fi/portal/fi/kasvintuotanto_ja_rehut/torjunta-aineet/torjunta-ainerekisteri

A register and database on pesticides (pesticide products) in use in Finland, maintained by Finnish Food Safety Authority (EVIRA). The file contains basic information on each product, assessment of health and environmental risks, safety instructions and the text in containers of the products. The register is a useful source of information on pesticide products on market.

TYKI
Web: http://pretty.ttl.fi/TYKI/search.htm (Finnish only)

A databank of the Information Center of the Finnish Institute of Occupational Health containing bibliographic data on books, journals, series of monographs, reports, and standards available in the library since 1983. Altogether, there are over 35 000 references, many of them in English, Swedish, or German.

Organizations (Government)

The web pages of the organizations and research institutes are the major sources of relevant information in their fields. The documents are available as files, behind links or there are instructions on how to retrieve them physically, e.g. from a library. Therefore, it is advisable to start the information search from the web page of the relevant institute, if the exact title of the document is not known. The web pages have variable information in English and many of them in Swedish. The web pages typically contain the relevant legislation, access to series of publications of their own, descriptions of the research projects, lists of publications, newsletters and information on the services they provide. For this reason, the emphasis in the annotations below is on the institute's general expertise and activities.

Finnish Environment Institute (SYKE)

Conducts research on environmental issues from global problems such as climate change and declining biodiversity, to regional and local questions. Provides expert assistance for the administration, local authorities, industries, companies, and other organizations, both in Finland and abroad. SYKE's wide-ranging information services are designed to benefit everyone

interested in environmental issues. Publishes a series of monographs. A responsible authority on environmental effects of chemicals.

Web: http://www.environment.fi/default.asp?node=5297&lan=en (English)
Web: www.ymparisto.fi (Finnish)
Address: Finnish Environment Institute
P.O. Box 140, FI-00251 Helsinki, Finland
Phone: +358 20 490 123
Fax: +358 20 490 2190

Finnish Food Safety Authority (EVIRA)

This agency, under the ministries of Agriculture and Forestry, Trade and Industry and Social Affairs and Health, is responsible for food control (including contaminants), control of plant production and animal feeds and animal diseases. The agency is responsible for the evaluation of pesticides and chemical contaminants in food and feed. It performs risk assessments and chemical analyses on inorganic compounds, a wide range of organic compounds and mycotoxins. The web pages contain related legislation, daily intakes of contaminants in food, results from monitoring of pesticide use, lists of accepted veterinary medicines, dietary advice of fish consumption, etc. The agency publishes Kaari magazine ('from the field to the table') and has its own series of publications (in Finnish with English summaries).

Web: http://www.evira.fi/portal/en (English)
Web: http://www.evira.fi/portal/fi (Finnish)
Address: Finnish Food Safety Authority
Mustialankatu 3
FI-00790 Helsinki, Finland
Phone: +358 20 77 2003
Fax: +358 20 77 24350
Email: info@evira.fi

Finnish Forest Research Institute (Metla)

The Finnish Forest Research Institute (Metla) is a governmental, sectoral research institute, subordinate to the Ministry of Agriculture and Forestry. Its duty is to promote through research, the economic, ecologic, and socially sustainable management and use of forests. Some research topics address terrestrial ecotoxicology, especially effects of contaminants in forests. The institute also has laboratories for different chemical analyses.

Web: http://www.metla.fi/index-en.html (English)
Web: http://www.metla.fi/index.html (Finnish)
Address: Finnish Forest Research Institute
Unioninkatu 40 A
FI-00170 Helsinki, Finland
Phone: +358 10 2111
Fax: +358 10 211 2101
Email: kirjaamo@metla.fi

Finnish Game and Fisheries Research Institute (RKTL)

The Institute generates data on fisheries, game, and reindeer for sustainable use of natural resources, and helps to maintain biodiversity through research and aquaculture. The web pages contain, e.g., statistics on fish consumption in Finland.

Web: http://www.rktl.fi/english (English)
Web: http://www.rktl.fi (Finnish)
Address: Finnish Game and Fisheries Research Institute
Viikinkaari 4
P.O. Box 2, FI-00791 Helsinki, Finland
Phone: +358 (0) 205 7511
Fax: +358 (0) 205 751 201
Email: firstname.lastname@rktl.fi

Finnish Institute of Occupational Health (TTL, FIOH)

The Finnish Institute of Occupational Health is the main research and specialized organization in occupational health and safety in Finland. The Institute produces, compiles, and disseminates research-based information on the interaction between work and health, and promotes the practical application of this information. The institute and its web pages are the main source of information on industrial chemicals, exposure to chemicals, biomonitoring, occupational diseases, and industrial hygiene. The Institute maintains registers in areas such as occupational diseases and exposure to carcinogenic substances (ASA-registry) at work, and offers different services related to occupational health. The Internet information services include comprehensive compilation of publications (LEO), reports and books (TYKI) of the institute by subject, some English electronic publications and electronic journals, free of charge (see Journals) and the database on instructions for the handling of dangerous chemicals most likely to cause accidents (OVA-cards). Several international Newsletters of Occupational Health (Asian, Barents and Asian-Pacific) are also available in an electronic form. The pages contain the information related to the national expert network on emergency preparedness in chemical accidents in Finland (COSK). There is also a method (ELMERI) to assess and score workplace safety and health. The institute publishes Työ Terveys Turvallisuus (TTT) magazine, in Finnish.

Web: http://www.ttl.fi/internet/english (English)
Web: http://www.ttl.fi (Finnish)
Address: Finnish Institute of Occupational Health
Topeliuksenkatu 41 aA
FI-00250 Helsinki, Finland

Phone: +358-30-4741
Fax: +358-30-474 2779
Email: firstname.lastname@ttl.fi

Finnish Meteorological Institute

The Finnish Meteorological Institute generates and collects information about the atmosphere, and is the information source on weather, climate, and air pollution. The web pages contain statistics on air pollutants, information on health effects of air pollutants, health-based guideline values, weather forecasts, a comprehensive questions/answers section, and a glossary of terms. The concentrations of nitrogen oxides, ozone and PM_{10} are shown countrywide in real-time. The Institute has published Meteorological Yearbooks of Finland covering the time since the beginning of the 1900s.

Web: http://www.fmi.fi/en/index.html (English)
Web: http://www.fmi.fi (Finnish)
Address: Finnish Meteorological Institute
P.O. Box 503
FI-00101 Helsinki, Finland
Phone: +358 9 19291
Fax: +358 9 179 581
Email: firstname.lastname@fmi.fi

Geological Survey of Finland (GTK)

The Geological Survey of Finland, operating under the Ministry of Trade and Industry, is Finland's national geosciences agency and a national geological research centre. GTK's core activities include geological mapping, exploration, evaluation, and processing of natural resources. The GTK has made for example comprehensive analyses of elements in ground water, surface water, and soil, and produced maps of these data. The website of the institute contains information on maps, services offered (including analytical services), research projects, and publications and reports.

Web: http://en.gtk.fi (English)
Web: http://www.gtk.fi (Finnish)
Address: Geological Survey of Finland
P.O. Box 96
FI-02151 Espoo, Finland
Phone: +358 20 550 11
Email: gtk@gtk.fi

Ministry of Agriculture and Forestry (MMM)

The administrative sector of the Ministry of Agriculture and Forestry comprises agriculture and horticulture, rural development, forestry, veterinary services, control of foodstuffs of animal origin, fisheries, game and reindeer husbandry, use of water resources and land surveying. The Ministry has two official publication series.

Web: http://www.mmm.fi/en/index/frontpage.html (English)
Web: http://www.mmm.fi/fi/index/etusivu.html (Finnish)
Address: Ministry of Agriculture and Forestry
P.O. Box 30
FI-00023 GOVERNMENT, Finland
Phone: +358 9 16001
Fax: +358 9 160 54202

Ministry of the Environment (YM)

The Ministry responsible for environmental issues in Finland including legislation on air and water quality, housing, land use and building, effects of chemicals on the environment, contaminated soils, waste disposal, and ecotoxicological risk assessment. The Ministry has three series of publications: *The Finnish Environment*, *Environment Guides*, and *Reports*. *The Finnish Environment* contains publications on research, reports and work group memoranda. *Environment Guides* contains various manuals and guides. Most of these publications are in Finnish, with brief documentation pages in Swedish and English. In addition, the Ministry of the Environment publishes the periodical *Asu ja rakenna* (Live and Build) which deals with housing policies, building and planning and together with the Finnish Environment Institute, *Ympäristö* (The Environment), which covers a wide range of environmental issues.

Web: http://www.environment.fi/ (English)
Web: http://www.environment.fi/default.asp?node=67&lan=fi (Finnish)
Address: Ministry of the Environment
P.O. Box 35, FI-00023 GOVERNMENT, Finland
Phone: +358 9 160 07
Fax: +358 9 1603 9545
Email: firstname.lastname@ymparisto.fi

Ministry of Social Affairs and Health (STM)

The Ministry directs and guides the development and policies of social protection, social welfare, and health care. It prepares legislation and key reforms and steers their implementation. The Ministry is, in general, responsible for the assessment of health effects of different factors, including occupational and environmental health issues, chemicals, and pesticides. The website of the Ministry contains different reports on health, most in Finnish with English summaries.

Web: http://www.stm.fi/Resource.phx/eng/index.htx (English)
Web: http://www.stm.fi/Resource.phx/stm/index.htx (Finnish)
Address: Ministry of Social Affairs and Health

P.O. Box 33
FI-00023 GOVERNMENT, Finland
Phone: +358 9 160 01
Fax: +358 9 160 74126
Email: kirjaamo.stm@stm.fi

Ministry of Trade and Industry (KTM)

The web pages of the Ministry of Trade and Industry contain information on legislation related to mining, energy sources in Finland, and chemical impurities in food. The Ministry coordinates the safety evaluation of novel food including genetically modified food, and administers consumer affairs issues.

Web: http://www.ktm.fi/?l5 en&s5 1 (English)
Web: http://www.ktm.fi (Finnish)
Address: Ministry of Trade and Industry
P.O. Box 32, FI-00023 Government, Finland
Phone: +358 9 160 01
Fax: +358 9 1606 3666 or +358 9 5786 3666
Email: kirjaamo@ktm.fi

MTT Agrifood Research Finland (MTT)

The largest research institute in Finland. Operates under the Finnish Ministry of Agriculture and Forestry, at 14 locations. Produces and disseminates scientific research information and develops and promotes the transfer of new technology for the agriculture and food sector. Research topics include bioactive peptides, product development of new healthy foods and food technology, reduction of greenhouse gas emissions and water pollution caused by agriculture and the food processing industry. MTT has a chemistry laboratory to make analyses on trace elements, organic contaminants, microbial toxins, food components and bioactive molecules in food and feedstuffs.

Web: http://www.mtt.fi/english (English)
Web: http://www.mtt.fi/index.html (Finnish)
Address: MTT Agrifood Research Finland
FI-31600 Jokioinen, Finland
Phone: +358 3 41 881
Fax: +358 3 4188 2222
Email: firstname.lastname@mtt.fi

National Agency for Medicines

The agency is responsible for regulatory control of medicinal products, medicinal devices, and blood products. The web pages contain drug consumption statistics, links to national and EU legislation, and administrative regulations including reporting on pharmacovigilance. The agency publishes TABU magazine, with drug information in Finland.

Web: http://www.nam.fi/english (English)
Web: http://www.nam.fi (Finnish)
Address: National Agency for Medicines
Mannerheimintie 103b
P.O. Box 55
FI-00301 Helsinki
Phone: +358 9 473 341
Fax: +358 9 714 469

National Public Health Institute (KTL)

The National Public Health Institute is a governmental research institute operating under the Ministry of Social Affairs of Health. KTL carries out research on different aspects of public health including infectious, cardiovascular, and other diseases. KTL is responsible for vaccines and the development of vaccination programs. The Department of Environmental Health is devoted to environmental health issues and carries out research on chemical, biological, and physiological factors and exposures. The web pages of the Department of Environmental Health contain information on health effects of pollutants in urban air, drinking water (both chemical impurities and microbiological risks), mold, household microbes, and some chemicals (e.g. dioxins), in Finnish. KTL publishes three series of monographs, available on the Internet, reports of the national health surveys, dissertations and instructions, and recommendations of the Institute.

Web: http://www.ktl.fi/portal/english (English)
Web: http://www.ktl.fi (Finnish)
Address: National Public Health Institute
Mannerheimintie 166
FI-00300 Helsinki, Finland
Phone: +358 (0) 9 47 441
Fax: +358 9 4744 8408
Email: firstname.lastname@ktl.fi

National Product Control Agency for Welfare and Health (STTV)

The Product Control Agency is a central office which operates under the Ministry of Social Affairs and Health. STTV is responsible for overseeing and steering the implementation of the Alcohol Act, the Chemicals Act, the Tobacco Act, and the Health Protection Act at national level, and for supervisory activities according to the Gene Technology Act. Accordingly, the agency is responsible for the regulatory assessment of health effects of chemicals, pesticides, and biocides and is a national authority on GLP. STTV maintains the chemicals product register (KETU) and supervises compliance with regulations concerning material safety data sheets. The web pages contain information on the related legislation and links to legislation, statistics on for example alcohol consumption, concentrations of tar, nicotine and carbon monoxide in

cigarettes sold, pages for REACH, a help desk for REACH implementation (reach@sttv.fi), and annual summaries of the results of monitoring of drinking water and swimming water quality in Finland. The GLP instructions of the OECD are available as well as the list of the laboratories complying with them.

Web: http://www.sttv.fi (English)
Web: http://www.sttv.fi (Finnish)
Address: National Product Control Agency for Welfare and Health
Säästöpankinranta 2 A
P.O. Box 210
FI-00531 Helsinki, Finland
Phone : +358 9 3967 270
Fax: +358 9 67 2797
Email: sttv@sttv.fi

National Research and Development Centre for Welfare and Health (STAKES)

STAKES is an expert agency in the field of social welfare and health care, under the Ministry of Social Affairs and Health. It produces information and expertise for policymakers and other stakeholders, acts as a statistical authority and maintains registries. Most of the information produced by the statistical groups at STAKES is freely available through the web pages. The statistics include data on alcohol consumption, drug use, and the frequency of congenital malformations in Finland.

Web: http://www.stakes.fi/EN/index.htm (English)
Web: http://www.stakes.fi (Finnish)
Address:
National Research and Development Centre for Welfare and Health (STAKES)
P.O. Box 220
FI-00531 Helsinki, Finland
Phone: +358 9 396 71
Fax: +358 9 761 307
Email: firstname.lastname@stakes.fi

Radiation and Nuclear Safety Authority (STUK)

STUK is the authority, operating under the Ministry of Social Affairs of Health. It is responsible for radiation and nuclear safety in Finland. The STUK monitors radiation constantly throughout the country and provides the data from automated stations on the internet daily. The Institute offers companies and private citizens various radiation-associated measuring and expert services. The web pages contain much essential and useful information; legislation, regulatory guides on radiation (ST Guides) and nuclear safety, also in English. The Finnish web pages contain information on sources, doses, and health effects of different types of radiation, such as radon, plus answers to frequently asked questions.

Web: http://www.stuk.fi/en_GB (English)
Web: http://www.stuk.fi (Finnish)
Address: STUK – Radiation and Nuclear Safety Authority
P.O. Box 14
FI-00881 Helsinki, Finland
Phone: +358 9 759 881
Fax: +358 9 759 88 500
Email: stuk@stuk.fi

Safety Technology Authority (TUKES)

The Safety Technology Authority (TUKES) is a state agency under the Ministry of Trade and Industry and is responsible for the technical safety and reliability of different products. Its goal is to protect people, property, and the environment from risks of accidents in the manufacture, process, transport, and storage of dangerous goods, such as explosives, flammable liquids, natural gas, and chemicals hazardous to health and to the environment. On its website, the authority publishes *TUKES Review* (in English) which contains accident statistics including fatalities in accidents related to industries and products under the authority of the agency.

Web: http://www.tukes.fi/englanti/index_englanti.html (English)
Web: http://www.tukes.fi (Finnish)
Address: Safety Technology Authority (TUKES)
P.O. Box 123
FI-00181 Helsinki, Finland
Phone: +358 10 6052 000
Fax: +358 9 605 474

Statistics Finland

Statistics Finland, operating administratively under the Ministry of Finance, produces and maintains about 200 different statistics from Finland. Data from all statistics produced are published on the Statistics web pages.

Web: http://www.stat.fi/index_en.html (English)
Web: http://www.stat.fi (Finnish)
Address: FI-00022 Statistics Finland, Finland
Phone: +358 9 17341
Fax: +358 91734 2750
Email: kirjaamo@stat.fi

Technical Research Center of Finland (VTT)

VTT Technical Research Centre of Finland is a large contract research organization on technology. Some of its projects (listed on the web pages) also address toxicology, food, food safety, and monitoring of environmental

pollutants. For example, there is available a calculation system (LIPASTO) on the website for traffic exhaust emissions and energy consumption in Finland. The Centre's work is published in its magazines *Impulssi* (in Finnish) and *VTT Innozone* (in English) and are also available on its website.

Web: http://www.vtt.fi/?lang5 ev (English)
Web: http://www.vtt.fi (Finnish)
Address: VTT Technical Research Centre of Finland
P.O. Box 1000
FI-02044 VTT, Finland
Phone: +358 20 722 111
Fax: +358 20 722 7001
Email: kirjaamo@vtt.fi

The Finnish Consumer Agency & Consumer Ombudsman

The Consumer Agency is responsible for the safety of the consumer products. Its web pages contain information on legislation, and reports on consumer products and Finnish and Swedish educational materials on the use of chemicals.

Web: http://www.kuluttajavirasto.fi/user_nf/default.asp?site=36&tmf=0&lmf=0&id=0 English — Web://http://www.kuluttajavirasto.fi (Finnish)
Address: The Finnish Consumer Agency & Consumer Ombudsman
P.O.Box 5
FI-00531 Helsinki, Finland
Phone: +358 9 77261
Fax: +358 9 7726 7557
Email: posti@kuluttajavirasto.fi

Organizations (Non-Government)

Several non-profit organizations deliver health-related information aimed primarily for laymen but some specific information is also useful for professionals and may not be available elsewhere. A few such sources are introduced below.

Allergia- ja Astmaliitto

Allergia- ja Astmaliitto is a public organization whose mission is to provide information on asthma and allergy to citizens, in Finnish. The web pages contain significant information on cosmetics. The Society has collected data on the adverse health effects of cosmetics in Finland and its website includes ingredient information on over 5000 cosmetics products. An allergic person may select non-allergic products on the basis of this ingredient data. There are also booklets on the health effects of different air pollutants.

Web: http://www.allergia.com (Finnish only)
Address: Allergia- ja Astmaliitto ry
Paciuksenkatu 19
FI- 00270 HELSINKI, Finland
Phone: +358 9 473 351
Fax: +358 9 4733 5330

Finnish Cancer Registry

The Finnish Cancer Registry, funded basically by The Cancer Society of Finland (www.cancer.fi), maintains a nationwide database on all cancer cases in Finland and conducts epidemiological and statistical research on cancer. The collection of this data is mandated by legislation. The data on cancer statistics and mass screening of cancer are comprehensively available on the web pages of the Registry.

Web: http://www.cancerregistry.fi/eng (English)
Web: http://www.cancerregistry.fi (Finnish)
Address: Finnish Cancer Registry
Liisankatu 21 B
FI-00170 Helsinki, Finland
Phone: +358 9135 331
Fax: +358 9 135 5378

Hengitysliitto Heli (Pulmonary Association Heli)

Pulmonary Association Heli is Finland's largest social and health, non-profit organization for people with respiratory diseases and their families. The web pages contain information (booklets), prepared by professionals, on the health effects of air pollutants and smoking, in Finnish. There are also slide presentations for education and preventive work, including smoking cessation.

Web: http://www.hengitysliitto.fi/english (English)
Web: http://www.hengitysliitto.fi (Finnish)
Address: Hengitysliitto Heli ry
Oltermannintie 8
PL 40, 00621 Helsinki, Finland
Phone: +358 20 757 5000
Email: etunimi.sukunimi@heli.fi,

Sisäilmayhdistys ry

Sisäilmayhdistys ry is a non-profit society which promotes the construction of healthy buildings and the maintenance of good indoor air quality. It has published guidelines for healthy indoor air and classification criteria for emissions in construction materials (Sisäilmastoluokitus 2000).

Web: http://www.sisailmayhdistys.fi (Finnish only)
Address: Sisäilmayhdistys
Valkjärventie 1
P.O. Box 25

FI-02131 Espoo, Finland
Phone: +358 9 4355 560
Fax: +358 9 4355 5655
Email: etunimi.sukunimi@sisailmayhdistys.fi

Universities

There is only one university, the University of Kuopio, which offers a full degree in toxicology (M.Sc. in toxicology) in Finland. The universities with medical faculty teach some basics of toxicology and several universities have courses in ecotoxicology in their curriculum. Those same universities also have the strongest research programs. The Internet pages of each university are the best source of information on degrees, courses, graduate schools, research profiles, and lists of publications. There is also comprehensive coverage in English. Direct contact addresses of faculties and departments can also be found there. In the listing below, key universities are briefly highlighted from the perspective of toxicology and ecotoxicology, and the main contact information is provided. All universities in Finland are governmental and there is no tuition for students, including foreigners. There is a separate database for international study programs (see DATABASES).

Åbo Akademi

In Åbo Akademi the basic language in teaching is Swedish. The university has 8000 students. The Faculty of Natural Sciences and Mathematics offer studies in, for example, chemistry, physics, biochemistry, pharmacy, and geology.

Web: http://www.abo.fi/aa/engelska/index.sht (English)
Web: http://www.abo.fi/aa/finska/index.sht (Finnish)
Address: Åbo Akademi
Domkyrkotorget 3
FI-20500 Turku, Finland
Phone: +358 2 215 31
Email: firstname.lastname@abo.fi

Helsinki University of Technology (TKK)

Helsinki University of Technology (TKK) is the largest (about 15 000 students), oldest, and most diversified university of technology. Teaching and research of some units (e.g. Water and Waste Water Engineering) cover environmental and health issues from the technological perspective. The topics include water and wastewater treatment processes, water supply and sewer networks as well as municipal solid waste management.

Web: http://www.tkk.fi/English (English)
Web: http://www.tkk.fi (Finnish)
Address: Helsinki University of Technology
P.O. Box 1000
FI-02015 TKK, Finland
Phone: +358 9 4511
Fax: +358 9 451 2017
Email: firstname.lastname@hut.fi

Tampere University of Technology

The Department of Environmental Engineering and Biotechnology teaches and conducts research on issues of drinking water, wastewater and solid waste management, and remediation of contaminated environments. The university has 10 000 students.

Web: http://www.tut.fi/public/index.cfm?siteid=32 (English)
Web: http://www.tut.fi (Finnish)
Address: Tampere University of Technology
P.O. Box 527
FI-33101 Tampere, Finland
Phone: +358 3 3115 11
Email: firstname.lastname@tut.fi

University of Helsinki

The University of Helsinki is the largest university in Finland, having the widest range of disciplines and 38 000 degree students. There are faculties in medicine, pharmacy, biosciences, natural sciences, microbiology, and veterinary medicine. The faculties of Medicine and Pharmacy each have their own departments of Pharmacology and Toxicology, to teach the basics of toxicology.

Web: http://www.helsinki.fi/university/index.html (English)
Web: http://www.helsinki.fi/yliopisto (Finnish)
Address: University of Helsinki
Yliopistonkatu 4
P.O. Box 33
FI-00014 HELSINGIN YLIOPISTO, Finland
Phone: +358 9 1911
Email: firstname.lastname@helsinki.fi

University of Joensuu

The University of Joensuu has several faculties related to biology and environment and is a center of ecotoxicology in Finland. The Faculty of Biosciences offers instruction in biology, biochemistry, ecotoxicology and hydrobiology, and applied biology. There are also a Botanical Garden and Ecological Research Institute and faculties of Forestry and Science. The university is coordinating or is part of several graduate schools on ecological/environmental sciences. The university has over 8200 students.

Web: http://www.joensuu.fi/englishindex.html (English)
Web: http://www.joensuu.fi/joyindex.html (Finnish)
Address: University of Joensuu
P.O. Box 111
FI-80101 Joensuu, Finland
Phone: +358 13 251 111
Fax: +358 13 251 2050
Email: firstname.lastname@joensuu.fi

University of Jyväskylä

The University of Jyväskylä has strong natural sciences and ecotoxicology in its curriculum. The Institute for Environmental Research (http://www.jyu.fi/erillis/ymtk/en) provides scientific research, and services and training in the environmental field for authorities, private and public organizations and enterprises. The Institute also provides accredited laboratory services on analytical chemistry from environmental samples (inorganic and organic compounds) and offers noise measurements as a service work.

Web: http://www.jyu.fi/en (English)
Web: http://www.jyu.fi (Finnish)
Address: University of Jyväskylä
P.O. Box 35
FI-40014 University of Jyväskylä, Finland
Phone: +358 14 260 1211
Fax: +358 14 260 1021
Email: firstname.lastname@jyu.fi

University of Kuopio

The University of Kuopio is a health-oriented university including departments of medicine, biotechnology, pharmacy, and environmental sciences. The Department of Pharmacology and Toxicology is the one instance in Finland with a comprehensive curriculum in toxicology and can confer a full degree in toxicology (master of science, M.Sc.). The University is in the process of beginning an international training program in toxicology (all courses and training in English). There is also a graduate school in environmental health, with courses in English. The total number of students in the university is around 5400.

Web: http://www.uku.fi/english (English)
Web: http://www.uku.fi (Finnish)
Address: University of Kuopio
P.O. Box 1627
FI-70211 Kuopio, Finland
Phone: +358 17 162 211
Email: firstname.lastname@uku.fi

University of Oulu

The University of Oulu is one of the centers of medicine and pharmacology and toxicology in Finland. It has faculties/departments in medicine, biochemistry, biology, chemistry, geochemistry, and also technology. There are about 17000 students. The Department of Pharmacology and Toxicology is devoted especially to xenobiotic metabolism. The department offers a battery of services on metabolism on contract basis, partly through a spin-off company (http://www.oulu.fi/farmakologia). The University also coordinates a national graduate school in toxicology.

Web: http://www.oulu.fi/english (English)
Web: http://www.oulu.fi/yliopisto (Finnish)
Address: University of Oulu
P.O. Box 8000
FI-90014 University of Oulu, Finland
Phone: +358 8 553 1011
Fax: +358 8 553 4112
Email: oulun.yliopisto@oulu.fi

University of Tampere

The University of Tampere is a multidiscipline university, with 15600 degree students and has a medical faculty. The Cell Research Center (http://www.uta.fi/laitokset/laaket/bio/linkit/cellresearchcenter.html) develops novel cell and tissue culture techniques based on normal human cells, and also cell culture models which reflect an organ structure. The methods are aimed at evaluation of newly developed drugs and for in vitro toxicology tests. The center also specializes in automation technology for cell culture, manipulation, and analysis. Some services are offered as a contract basis.

Web: http://www.uta.fi/english/index.html (English)
Web: http://www.uta.fi (Finnish)
Address: University of Tampere
FI-33014 Tampere University, Finland
Phone: +358 3 3551 6204
Fax: +358 3 213 4473
Email: kirjaamo@uta.fi

University of Turku

The University of Turku has a medical faculty, and a Department of Pharmacology and Clinical Pharmacology. There is also a faculty on mathematics and natural sciences including departments of chemistry, biology, biochemistry and food chemistry, and geology. The university offers a two-year Master's Degree Programme in Environmental Sciences by the

above-mentioned departments, principally for foreigners. Teaching is in English. The program includes ecotoxicology, geoinformatics, and tropical environments and development. The university has about 17 000 students.

Web: http://www.utu.fi/en (English)
Web: http://www.utu.fi (Finnish)
Address: University of Turku
FI-20014 Turku, Finland
Phone: +358 2 333 51
Fax: +358 2 333 63 63
Email: firstname.lastname@utu.fi

Professional Societies

Finnish Society for Environmental Science

The Society's aim is to promote environmental science research, to be a link between members, and to spread information about the protection of environment. The society was founded in 1987 and has about 200 members. Its main activity has been the Finnish Conference of Environmental Sciences, the 8th held in 2007.

Web: http://www.uku.fi/laec/yts/english (English)
Web: http://www.uku.fi/laec/yts/suomi (Finnish)

Finnish Society of Toxicology

The Finnish Society of Toxicology was founded in 1979 by toxicologists and ecotoxicologists. The society has a membership of approximately 300. The society is a member of EUROTOX and IUTOX. The members of the national society have served as a Secretary or in other posts of EUROTOX and IUTOX. The main activity of the society is to transmit information to members about congresses and other events, via email and in the newsletter *Toksikologi*. The Society organizes an annual scientific meeting. It has published *Ethical Guidelines* for toxicologists and maintains the *Register of Finnish Toxicologists*. Most registered toxicologists are also EUROTOX Registered Toxicologist. The society organized the 10th International Congress of Toxicology (ICT X) in 2004, in Tampere. The statutes of the society, the rules of the register, and the guidelines are printed in the membership directory in Finnish and English.

Web: http:/.www.toksikologit.fi/indexen.htm (English)
Web: www.toksikologit.fi (Finnish)

Poison Control Centers

Poison Information Centre

The Poison Information Centre provides services especially for the treatment of ambulatory and acute poisonings, on a 24-hour basis for hospitals and the general public. The center also distributes general information on poisonings and their treatment. The internet pages contain information by agent/compound for users who need to contact the Poison Information Centre. There is also a special information service on teratogenic compounds for healthcare professionals and parents.

Web: http://www.hus.fi/default.asp?path=1;28;824;2049;2265;2260 (Finnish only)
Address: Helsinki University Hospital
Stenbäckinkatu 11
FI-00290 Helsinki, Finland
Phone: +358 9 4711

Legislation

Acts, decrees and official decisions and regulations (secondary legislation) are best found from FINLEX databases in the internet (a governmental website). The internet pages of the ministries and the agencies may contain some information on the legislation they are responsible for and have links to exact texts. The most convenient way to find a specific regulation in FINLEX is to use the number or the year of the act. The regulations are organized by the year of adoption. For several regulations translations are available, most in English. The web pages of FINLEX contain also the drafts of acts and decrees under consideration by the parliament for adoption, in the preparatory phase.

Access to the web pages of FINLEX (http://www.finlex.fi/en (English); http://www.finlex.fi (Finnish)).

IFCS National Focal Point

Ministry of the Environment
Attn: Ms Pirkko Kivelä
Counsellor
P.O. Box 35
FI-00023 Government, Helsinki
Finland
Phone: +358 9 160 39733
Fax: +358 9 160 39716
Email: Pirkko.Kivela@ymparisto.fi

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France

NATHALIE FOUILHÉ SAM-LAÏ, PHILIPPE SAVIUC, AND VINCENT DANEL

INTRODUCTION

The history of toxicology in France is closely linked to crimes and to forensic medicine. Most of the first toxicologists were forensic medicine specialists. Some famous criminal stories where toxicology played a key role are part of this history: 'l'affaire des poisons' under the reign of Louis XIV, where the Marquise de Montespan, a former mistress of the king, was suspected of being at the head of a group of poisoners (many of them were condemned to death, even the then Marquise de Brinvilliers); the famous Marie Lafarge who was convicted of murdering her husband with arsenic in 1840 (he probably died of typhoid); Hélène Jegado, a famous Briton poisoner, who was condemned to death in 1852; Marie Besnard, suspected in 1947 of having poisoned 12 people with arsenic (she was eventually acquitted after some famous experts battles). More recently, French toxicologists reported from some hair analysis that Napoleon might have died from a criminal arsenic poisoning! Toxicology was also linked to occupational health rather early. Lead poisoning was the first ever poisoning recognized as an occupational pathology in 1919; amazingly enough, years later, child lead poisoning is (since 1998) the only accidental poisoning which must be declared to health authorities on a mandatory basis.

Toxicology is, perhaps, not as well recognized or organized as it might be in France, largely due to the lack of cohesive university programs devoted to the subject. It tends to fall largely within the scope of academic programs in pharmacy. Apart from some postgraduate courses, there are no programs in medical or veterinary schools. Most physicians practicing clinical toxicology have a background in intensive care and emergency medicine, forensic medicine, or occupational medicine. Analytical toxicology is mainly the field of pharmacists, pharmacologists, and biologists, either in hospitals or in some Forensic Medicine Institutes.

A poisoned patient is normally admitted to a general emergency department or an intensive care unit. The only dedicated poisoning unit that remains in France is in Hospital Lariboisière in Paris. Before being transferred to Hospital Lariboisière, this unit was the famous Fernand-Widal Clinical Toxicology unit, set up in the 1960s, together with the Paris Poison Control Center. A real French 'school' of Clinical Toxicology originated in Fernand-Widal and is still very lively in Lariboisière hospital. Two other dedicated clinical units that existed in Marseille and in Grenoble have now disappeared. Some people have particularly contributed to the recent history of Clinical Toxicology: Chantal Bismuth in Paris, Jacqueline Jouglard in Marseille and Louis Roche in Lyon. Louis Roche founded with some others the European Association of Poisons Control Centres and Clinical Toxicologists (EAPCCT) in 1964. There are currently ten Poisons Control Centers (PCC) that answer the general public round the clock, and three Toxicovigilance Centers opened only during working hours; on the whole those centers receive about 200 000 calls per year. The people who answer on the phone are mainly physicians, sometimes pharmacists. All cases are registered in a national database maintained by the Paris Center; a chemical products and compounds composition database is run by the Nancy Center. Each Poisons Center is mainly funded by the university hospital to which it belongs; all centers depend upon the Direction Générale de la Santé at the Ministry of Health.

Some funding is provided by the National Institute for Public Health Surveillance, especially for toxicovigilance purposes. A good number of calls are also answered by the SAMU health system (dial 15). Mostly for economical reasons, there is now a clear trend towards the diminution of the number of PCC and towards setting up closer links between the SAMU system and the PCC. The Société de Toxicologie Clinique is obviously mainly interested in Clinical Toxicology.

The Toxicovigilance system, coordinated by the National Institute for Public Health Surveillance, relies on the Poisons Control and Toxicovigilance Centers network; some poisonings such as carbon monoxide and lead poisoning are registered and followed-up at a national level.

Animal and experimental research is mainly done by pharmacists, biochemists, and biologists; there are very few laboratories working exclusively in the field of Toxicology; they are located either in universities or in some private pharmaceutical firms. The Société Française de Toxicologie, the biggest French Toxicology Society, is mainly interested in research.

Risk assessment studies and epidemiological studies, as carried out in most health agencies, are mainly conducted by pharmacists or epidemiologists.

There are 13 different Toxicology scientific societies, encompassing all fields of Toxicology and having from tens to hundreds of members. Efforts are underway, however, to set up the French Federation of Toxicology. The main objectives at the moment are to organize a joint meeting as soon as possible, to list all possible Toxicology resources and to list all possible Toxicology courses that may exist at the university at a post-graduate level.

There are no specialized toxicology journals published in France, and most toxicologists submit their works to international journals; an electronic journal has just been launched in Lyon.

RESOURCES

Books

Baud F (1995)
Réanimation des Intoxications Aiguës (Management of the Critically Poisoned Patient).
Paris: Masson
State-of-the-art of the management of severe acute poisonings in man.

Baud F, Barriot P, Riou B (1992)
Les Antidotes (Antidotes)
Paris: Masson
Pharmacological properties and therapeutic uses of antidotes.

Bédry R, Llanas B, Danel V, Fayon M (2007)
Guide Pratique de Toxicologie Pédiatrique (Practical Guide of Pediatric Toxicology)
Paris: Arnette
Clinical features, diagnosis, and management of the main acute poisonings in children.

Bismuth C, Baud F, Conso F, Dally S, Fréjaville JP, Garnier R, Jaeger A (2000)
Toxicologie Clinique (Clinical Toxicology)
Paris: Flammarion Médecine-Sciences
Clinical features, diagnosis, and management of poisonings.

Bruneton J (2005)
Plantes Toxiques: Végétaux Dangereux pour l'Homme et les Animaux (Toxic Plants: Dangerous Plants to Human and Animals)
Paris: Lavoisier
Clinical features, diagnosis, and management of poisonings by plants.

Danel V, Barriot P (1999)
Intoxications Aiguës en Réanimation (Acute Poisonings)
Paris: Arnette
Clinical features, diagnosis, and management of the main acute poisonings.

Danel V, Mégarbane B (2009)
Urgences Toxicologiques de l'adulte (Toxicologic Emergencies)
Paris: Arnette
Clinical features, diagnosis, and management of the main toxicological emergencies in the prehospital and in the hospital settings.

Descotes J (1998)
An Introduction to Immunotoxicology
London: Taylor & Francis
Basic principles of immunotoxicology.

Descotes J, Testud F, Frantz P (1992)
Les Urgences en Toxicologie (Toxicologic Emergencies)
Paris: Maloine
Clinical features, diagnosis, and management of poisonings.

Jaeger A, Vale JA (1999)
Intoxications Aiguës (Acute Poisonings)
Paris: Elsevier
Clinical features, diagnosis, and management of main acute poisonings.

Kintz P (1998)
Toxicologie et Pharmacologie Médicolégales (Forensic Toxicology and Pharmacology)
Paris: Elsevier
Toxicology and pharmacology of the main drugs from a forensic point of view.

Lauwerys RR, Haufroid V, Hoet P, Lison D (2007)
Toxicologie Industrielle et Intoxications Professionnelles (Industrial Toxicology and Occupational Poisonings)
Paris: Masson
Industrial poisonings and occupational health hazards.

Mebs D (Trans Goyffon M) (2006)
Animaux venimeux et vénéneux (Venomous and Poisonous Animals)
Paris: Lavoisier.

Mion G, Goyffon M (2000)
Les Envenimations Graves (Severe Envenomations) Paris: Arnette
Clinical features, diagnosis, and management of severe envenomations by snakes, hymenoptera, scorpions, and spiders.

Reichl FX (Trans/adapted from German by Prudhomme C) (2002)
Atlas de Poche de Médecine de l'Environnement (Pocket Atlas of Environmental Medicine)
Paris: Maloine

Reichl FX (Trans/adapted from German by Perraud R, Krahe EC) (2004)
Guide pratique de toxicologie (Practical guide of toxicology)

Testud F (2005)
Pathologie Toxique Professionnelle et Environnementale (Occupational and Environmental Toxic Pathology)
Paris: Eska
Toxic effects of occupational and environmental chemicals.

Testud F, Garnier R, Delemotte B (2001)
Toxicologie Humaine des Produits Phytosanitaires: Tome I (Human Toxicology of Pesticides: Part I)
Paris : Eska
Toxicology of pesticides.

Testud F, Grillet JP (2007)
Produits Phytosanitaires: Intoxications aiguës et Risques professionnels (Pesticides: Acute Poisonings and Occupational Risk)
Paris: Eska
Toxicology of pesticides in occupational environment.

Viala A, Botta A (2005)
Toxicologie (Toxicology)
Paris: Lavoisier
General textbook of toxicology.

Weber M, Rothmann C (2006)
Mémo Intoxications Aiguës (Pocket Handbook Acute Poisonings)
Paris: Arnette
Pocket handbook of clinical toxicology.

Zetlaoui P, Lenoble M (2004)
Intoxications aux Urgences (Acute Poisonings in the Emergency Department)
Paris: Elsevier
Clinical features, diagnosis, and management of main acute poisonings.

Journals

Annales de Toxicologie Analytique (Annals of Analytical Toxicology)
Poitiers: Journal of the French Society of Analytical Toxicology

Archives des maladies professionnelles et de l'environnement (Archives of Occupational and Environmental Pathology)
Paris: Masson

Encyclopédie médico-chirurgicale. Toxicologie, pathologie professionnelle (Medico-Surgical Encyclopedia. Toxicology, Occupational Deseases)
Paris: Ed Techniques

Encyclopédie médico-chirurgicale. Urgences (Medico-Surgical Encyclopedia. Emergency)
Paris: Ed Techniques

Environnement, Risques et Santé (Environment, Risk and Health)
Montrouge: John Libbey Eurotext

Infotox
Liaison Bulletin of the Society of Clinical Toxicology

Journal électronique de Toxicologie (Electronic Journal of Toxicology)
Web: http://www.jtox.fr

Journal Européen des Urgences (European Journal of Emergencies).
Paris: Masson

Médecine d'urgence (Emergency Medicine)
Paris: Société Française d'Editions Médicales

Réanimation (Resuscitation)
Paris: Elsevier
Journal of the Francophon Society of Intensive Care.

Technical Reports and Other Documents

Cannabis: quels effets sur le comportement et la santé ? (Cannabis: Effects on Behavior and Health) (2001/2004)
Collective Expert Report. National Institute of Health and Medical Research.

Dioxines dans l'environnement. Quels risques pour la santé? (Dioxins in the Environment. What are the Health Hazards?) (2000)
Collective Expert Report. National Institute of Health and Medical Research.

Épuration digestive lors des intoxications aiguës (Gastrointestinal Decontamination in Acute Poisonings) (1992) Francophon Society of Intensive Care.

Ethers de Glycol. Quels risques pour la santé ? (Glycol ethers. What are the Health Hazards ?) (1999)
Collective Expert Report. National Institute of Health and Medical Research.

Ethers de Glycol – Nouvelles Données Toxicologiques (Glycol ethers – New Toxicological Data) (2006)
Collective Expert Report. National Institute of Health and Medical Research.

L'amalgame dentaire et ses alternatives (Dental Amalgams and its Alternatives) (1998)
Report. French Public Health Council.

Le mercure des amalgames dentaires (Mercury in Dental Amalgams) (2005)
Report. French Health Products Safety Agency.

Plomb dans l'environnement. Quels risques pour la santé? (Lead in the Environment. What are the Health Hazards?) (1999)
Collective Expert Report. National Institute of Health and Medical Search.

Databases

Catalog and Index of Francophon Internet Health resources
Web: http://www.chu-rouen.fr/cismef/cismefeng.html (English)
Web: http://www.chu-rouen.fr/cismef/ (French)

Dopage
A site on medical and legal aspects of drug abuse in sports
Web: http://dopage.com/ (French only)

French Poison Control Centers on-line Library
Web: http://www.centres-antipoison.net/cdoc/rech_simple.htm (Search page; French only)
Web: http://www.centres-antipoison.net/cdoc/index.html (Collection; French only)

French University Thesis Database
Web: http://www.sudoc.abes.fr/ (French only)

INERIS Database
Web: http://chimie.ineris.fr/en/index.php (English)
Web: http://chimie.ineris.fr/fr/index.php (French)

Information Center on Water
A site dedicated to water quality and safety, including data on water pollution
Web: http://www.cieau.com/accueil.htm (French only)

INRS Toxicological data sheets
Web: http://en.inrs.fr/ (English)
Web: http://www.inrs.fr/ (French)

Observatory of the Quality of Indoor Air
Web: http://www.air-interieur.org/OQAI.aspx?idarchitecture=18Country=United_Kingdom (English)
Web: http://www.air-interieur.org/ (French)

Official French Catalog of Pesticides
Web: http://e-phy.agriculture.gouv.fr/ (French only)

Pregnancy and Occupational Hazards
Web: http://www.ast67.org/PDF/grossesse_sm.htm (French only)

Public health Database
Web: http://www.bdsp.tm.fr/ (French only)

TELETOX
A database devoted to pesticides.
Web: http://www.uvp5.univ-paris5.fr/TELETOX/ (French only)

Thériaque
A database on pharmaceuticals.
Web: http://www.theriaque.org/ (French only)

Toxibase
A database on drug abuse.
Web: http://www.toxibase.org/ (French only)

Toxic Plants
Web: http://www.chru-lille.fr/cap/ca3c-1.htm (French only)

Toxic Plants – Jean Bruneton
A monthly updated supplement to two books dedicated to toxic plants and phytotherapy respectively.
Web: http://ead.univ-angers.fr/~pharma/bruneton/index.php (French only)

Vidal
A database on health products and pharmaceuticals.
Web: http://www.vidal.fr/ (French only)

Virtual University of Occupational Medicine
Web: http://www.uvmt.org/ (French only)

Organizations (Government)

French Atomic Energy Agency
Web: http://www.cea.fr/english_portal (English)
Web: http://www.cea.fr/ (French)

CEA
91191 Gif-sur-Yvette Cedex
Phone: +33 (0) 1 64 50 10 00

French Food Safety Agency
Web: http://www.afssa.fr (English)
Web: http://www.afssa.fr/ (French)
AFSSA
27-31 avenue du général Leclerc
94701 Maisons-Alfort cedex
Phone: +33 (0) 49 77 13 50

French Health Products Safety Agency
Web: http://afssaps.sante.fr/ang/indang.htm (English)
Web: http://afssaps.sante.fr/ (French)
AFSSAPS
143–147 boulevard Anatole France
93285 Saint-Denis Cedex
Phone: +33 (0) 55 87 30 00

Health and Safety at Work
Web: http://en.inrs.fr/ (English)
Web: http://www.inrs.fr/ (French)
INRS
30 rue Olivier Noyer
75680 Paris Cedex 14
Phone: +33 (0) 1 40 44 30 00

Ministry of Ecology and Sustainable Development
Web: http://www.environnement.gouv.fr/sommaire.php3 (French only)
Ministère de l'Écologie, du Développement, et de l'Aménagement du territoire
20 avenue de Ségur
75302 Paris 07 SP
Phone: +33 (0) 1 42 19 20 21

Ministry of Health
Web: http://www.sante.gouv.fr/ (French only)
Ministère de la Santé, de la jeunesse, des sports et de la vie associative
8 avenue de Ségur
75700 Paris
Phone: +33 (0) 1 40 56 60 00

National Institute for Agricultural Research
Web: http://www.international.inra.fr/ (English)
Web: http://www.inra.fr/agritox/ (French)
INRA
147 rue de l'université
75338 Paris Cedex 07
Phone: +33 (0) 1 42 75 90 00

National Institute of the Industrial Environment and Risk
Web: http://www.ineris.fr/index.php (English)
Web: http://www.ineris.fr/index.php (French)
INERIS
Parc Technologique ALATA
BP 2-60550 Verneuil-en-Halatte
Phone: +33 (0) 3 44 55 66 77

French Agency of Environmental and Occupational Health Safety
Web: http://www.afsset.fr/index.php?siteid=54 (English)
Web: http://www.afsset.fr/ (French)
AFSSET
253 avenue Général Leclerc
94701-Maisons-Alfort cedex
Phone: +33 (0) 1 56 29 19 30

French Institute for Public Health Surveillance
Web: http://www.invs.sante.fr/ (French only)
InVS
12, rue du Val d'Osne
94415 Saint-Maurice cedex
Phone: +33 (0) 1 41 79 67 00

French Institute of Health and Medical Research
Web: http://www.inserm.fr/en/home.html (English)
Web: http://www.inserm.fr/fr/home.html (French)
INSERM
101 rue de Tolbiac
75654 PARIS cedex 13
Phone: +33 (0) 1 44 23 60 00

French Institute for the Environment
Web: http://www.ifen.fr/ (French only)
Institut Français de l'Environnement
5, route d'Olivet
BP 16105-45061 Orléans Cedex 2
Phone: +33 (0) 02 38 79 78 78

Health Agencies Portal
Web: http://www.sante.fr/ (French only)
Ministère de la Santé et de la Solidarité
8 avenue de Ségur
75700 Paris
Phone: +33 (0) 1 40 56 60 00

Institute for Radiological Protection and Nuclear Safety
Web: http://www.irsn.org/en (English)
Web: http://www.irsn.org (French)
IRSN
BP17-92262 Fontenay-aux-Roses Cedex
92140 Clamart
Phone: +33 (0) 1 58 35 88 88

Organizations (Non-Government)

Association of Agricultural Technology Coordination
Web: http://www.acta.asso.fr/ (French only)
ACTA
149 rue de Bercy
75595 Paris Cedex 12
Phone: +33 (0) 1 40 04 50 00

Consumer Safety Commission
Web: http://www.securiteconso.org/english_version.html (English)
Web: http://www.securiteconso.org/ (French)
CSC
Cité Martignac – 111 rue de Grenelle
75353 Paris 07 SP
Phone: +33 (0) 1 43 19 56 60

France-Chimie
Representing the French chemical industry.
Web: http://www.france-chimie.com/fiche.md (French only)

Pasteur Institute
A site dedicated to toxicogenetics.
Web: http://www.ipl-groupe.fr/index.php?id=toxicologie (French only)
Institut Pasteur de Lille
1, rue du Professeur Calmette
BP 245-59019 Lille Cedex
Phone: +33 (0) 3 20 87 78 00

TELEGIS
A site dedicated to material safety data sheets.
Web: http://www.telegis.fr/english/ (English)
Web: http://www.telegis.com/francais/ (French)
TELEGIS
6, rue des Boucheries-60400 Noyon
Phone: +33 (0) 3 44 44 25 00

Universities

Database on all available qualifications
Web: http://www.dcav.u-bordeaux2.fr/wsuio/ (French only)

French Universities of Medicine and Pharmacy
Web: http://www.chu-rouen.fr/ssf/univfr.html (French only)

French Universities
Web: http://dr.education.fr/Serveurs_Etab/Univ_alpha.html (French only)

Professional Societies

Association for the Promotion of Fundamental and Applied Toxicology
Web: http://atctoxicologie.free.fr/ (French only)

Association for the Promotion of Research and Teaching in Toxicology
Web: http://www.aret.asso.fr/ (French only)

French Mycologic Society
Web: http://www.mycofrance.com/ (French only)

French Public Health Society
Web: http://www.sfsp.info/sfsp/index.php (French only)

French Society for the Promotion of Toxins Study
Web: http://www.sfet.asso.fr/ (French only)

French Society of Analytical Toxicology
Web: http://www.sfta.org/ (French only)

French Society of Toxicology
Web: http://www.sftox.com/ (French only)

Society of Cellular Pharmaco-Toxicology
Web: http://sptc.free.fr/ (French only)

Society of Clinical Toxicology
Web: http://www.toxicologie-clinique.org/ (French only)

Society of Genetic Toxicology
Web: http://www.sftg.org/ (French only)

Some information provided by ARET (formation)
Web: http://www.aret.asso.fr/formation.htm (French only)

Working group on metabolism and pharmacokinetics
Web: http://www.gmp.asso.fr/en/index_en.htm (English)
Web: http://www.gmp.asso.fr/ (French)

Poison Control Centers and Toxicovigilance Centers

Poison Control Centers and Toxicovigilance Centers Association
Web: http://www.centres-antipoison.net/index.html (French only)

Angers
Centre Hospitalier Régional
4 rue Larrey
49033 Angers Cedex 01
Phone: +33 (0) 241-48-21-21
Fax: +33 (0) 241-35-55-07

Bordeaux
Hôpital Pellegrin-Tripode
Pl. Amélie Raba-Léon
33076 Bordeaux Cedex
Phone: +33 (0) 556-96-40-80
Fax: +33 (0) 556-79-60-96

Grenoble
Hôpital Albert Michallon
BP 217
38043 Grenoble Cedex 9
Phone: +33 (0) 476-76-56-46
Fax: +33 (0) 476-76-56-70

Lille
Centre Hospitalier Régional
5 avenue Oscar Lambret
59037 Lille Cedex
Phone: +33 (0) 825-812-822
Fax: +33 (0) 320-44-56-28
Web: http://www.chru-lille.fr/cap/english.htm (English)
Web: http://www.chru-lille.fr/cap/lille.htm (French)

Lyon
Bat. A, 4° ét.
162 Av. Lacassagne
69424 Lyon Cedex 03
Phone: +33 (0) 472-11-69-11
Fax: +33 (0) 472-11-69-85

Marseille
Hôpital Salvator
249 Bd Sainte Marguerite
13274 Marseille Cedex 9
Phone: +33 (0) 491-75-25-25
Fax: +33 (0) 491-74-41-68

Nancy
Hôpital Central
29 avenue M[a1] de Lattre de Tassigny
54035 Nancy Cedex,
Phone: +33 (0) 383-32-36-36
Fax: +33 (0) 383-85-26-15

Paris
Hôpital Fernand Widal
200 rue du Faubourg Saint-Denis
75475 Paris Cedex 10
Phone: +33 (0) 140-05-48-48
Fax: +33 (0) 140-05-41-93

Reims
Hôpital Maison Blanche
45 rue Cognac-Jay
51092 Reims Cedex
Phone: +33 (0) 326-06-07-08
Fax: +33 (0) 326-78-41-36

Rennes
Hôpital Pontchaillou
2 rue Henri Le Guilloux
35033 Rennes Cedex 09
Phone: +33 (0) 299-59-22-22
Fax: +33 (0) 299-28-42-30

Rouen
Hôpital Charles Nicolle
1 rue de Germont
76031 Rouen Cedex
Phone: +33 (0) 235-88-44-00
Fax: +33 (0) 232-88-81-28

Strasbourg
Hôpitaux Universitaires
1 place de 1'Hôpital, BP 426
67091 Strasbourg Cedex
Phone: +33 (0) 388-37-37-37
Fax: +33 (0) 388-11-54-75

Toulouse
Hôpital Purpan
place du Docteur Baylac
31059 Toulouse Cedex 9
Phone: +33 (0) 561-77-74-47
Fax: +33 (0) 561-77-25-72
Web: http://www.chu-toulouse.fr/H-centre-antipoison-toxicovigilance- (French only)

Legislation

Official Government Laws
Web: http://www.legifrance.gouv.fr/ (French only)
Official Ministry Regulations
Web: http://www.legifrance.gouv.fr/html/bo/bo.htm (French only)

CHAPTER

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Germany

HERBERT DESEL AND REGINE KAHL

INTRODUCTION

The formation of toxicology as a scientific discipline in Germany originated with basic research in chemistry and medicine at universities on the one hand and in occupational toxicology programs associated with 19th century industrialization. In academia, lectures on toxicology were presented by Georg Augustin Bertele (1767–1818) at the medical faculty in Landshut. Experimental research on toxic gases was performed by Hermann Eulenberg between 1865 and 1876 in Cologne. The state of the art in toxicology at the end of the 19th century was presented by Rudolf Kobert (1854–1918) in his famous textbook on intoxications first published in 1893 and in an extended form from 1902–1906 when he was a professor in Rostock. Equally reknowned is the textbook on toxicology published in 1928 by Louis Lewin (1850–1918) a reprint of which appeared in 1992.

Physicians employed by chemical companies were instrumental in formulating the discipline of occupational toxicology in Germany. The first medical officer at BASF was Carl Knaps in 1868, followed by Wilhelm Grandhomme at Farbwerke Hoechst in 1874. In the 1870s, Ludwig Hirt (1844–1907) published a textbook on occupational medicine with a focus on toxic substances at the workplace. In his institute in Würzburg, Karl Bernhard Lehmann (1858–1940) first established threshold values for industrial gases at the workplace in 1884. In 1898, he described chloracne in people working in electrolytic factories. A medical department was founded at the Badische Anilin- und Soda-Fabrik (BASF) in 1903 when it became clear that aromatic amines induce bladder cancer in exposed workers. State authorities also began to show concern for toxicological problems, e.g. in the Kaiserliches Gesundheitsamt (later Reichsgesundheitsamt, i.e. Imperial Health Office) founded in 1876. Soon, legislation on chemical safety was implemented, e.g. the law on the use of colors harmful to human health in 1887. In 1905, a conference on the instruction of workers about the hazards of toxic substances was held at the central office for labor welfare in Hagen.

The flourishing of toxicological research around 1900 did not, however, result in the establishment of toxicological institutes at German universities. Rather, toxicology was looked upon as a part of pharmacology, and toxicological research was performed in some of the university institutes of pharmacology which were founded in increasing numbers in the early 20th century. Even today, the state-controlled curricula for students of medicine and pharmacy contain pharmacology and toxicology as one common subject.

The first full professorship for toxicology in an independent institute was awarded to Paul Pulewka in Tübingen in 1951, later followed by Herbert Remmer. The German Science Council (Wissenschaftsrat) in 1960 and the Deutsche Forschungsgemeinschaft (DFG) in 1975 called for the foundation of toxicological institutes at all universities, and in the following decades a number of universities complied with this demand. In the 1960s the Institutes of Toxicology in Würzburg (1965, Dietrich Henschler) and Marburg (1966, Wolfgang Koransky) and the Departments of Toxicology in Mainz (1966, Karl-Joachim Netter), Homburg (1967, Karl Pfleger), Kiel (1969, Friedrich Karl Ohnesorge) and at the Institute for Occupational Physiology in Dortmund (1978 Hubert Antweiler, 1982 Hermann Bolt) were established. In the German

Democratic Republic, the Institute for Industrial Toxicology in Halle led by Werner Ponsold was founded in 1968. In the 1970s, the Institute for Toxicology and Embryonic Pharmacology in Berlin (1972, Dieter Neubert), the Institute for Toxicology in Düsseldorf (1974, Friedrich Karl Ohnesorge), the Institute for Toxicology in Hannover (1977, Hans Wellhöner), and the Department of Toxicology in Hamburg (1978, Hans Marquardt) came up. Later, university institutes of toxicology were also established in Kaiserslautern, Mainz, Jena, München, and Potsdam. In parallel with the foundation of university institutes, a number of toxicological research institutes outside academia or associated to academia emerged, such as the Institute of Toxicology at the GSF in Neuherberg (1975, Helmut Greim). In industry, a number of pharmaceutical companies including Bayer, BASF, Hoechst, Merck, and Schering founded toxicological departments in the 1950s and 1960s.

As in other countries, this positive development was reversed in the 1990s, with a diminishment of toxicological research. In 1999, the Deutsche Forschungsgemeinschaft published a memorandum critical of the situation. With the advent of REACH (Registration, Evaluation and Authorisation of CHemicals), the new European Union's chemicals legislation, the need for toxicologists will steeply increase in the next few years. This will hopefully cause universities to stop the close-down of toxicological institutes.

RESOURCES

Books

General Monographs

Marquardt H, Schäfer S (eds) (2004)
Lehrbuch der Toxikologie (Textbook of Toxicology), 2nd Edition
Stuttgart: WVG
ISBN: 3-8047-1777-2

This comprehensive multi-author textbook covers most aspects of toxicology in 1348 pages. Contains sections on general toxicology, organ toxicology, the most important groups of toxic substances, specific fields of toxicology, toxicological methodology, and risk assessment.

Student textbooks

Wolf HU (Ed.) (1992)
Hagers Handbuch der Pharmazeutischen Praxis, Band 3: Gifte (Hager's Textbook of Pharmaceutical Practice, Vol.3: Poisons), 5th Edition
Berlin Heidelberg, New York: Springer
ISBN: 3-540-52633-1

Data, in condensed form, on the properties, signs, and therapy of intoxication, and regulation of toxic substances, listed in alphabetical order and comprising both generic names and product trade names.

Textbooks on Toxicology

Dekant W, Vamvakas S (2005)
Toxikologie – Eine Einführung für Chemiker, Biologen und Pharmazeuten (Toxicology – An Introduction for Chemists, Biologists and Pharmacists), 2nd Edition
Heidelberg: Spektrum Akademischer Verlag
ISBN: 3-8274-1452-0

Eisenbrand G, Metzler M, Hennecke FJ (2005)
Toxikologie. Für Naturwissenschaftler und Mediziner (Toxicology for Natural Scientists and Physicians), 3rd Edition
Weinheim: Wiley VCH
ISBN: 3-527-30989-6

Two textbooks mainly designed for students of chemistry and biology and in part also for students of medicine. The focus is on general toxicology, toxicological mechanisms, German law regulating treatment of hazardous substances and less amply on the actions of specific compounds. In addition, basic anatomical and pathophysiological information is provided.

Most Important Textbooks on Pharmacology and Toxicology

Aktories K, Förstermann U, Hofmann F, Starke K (Eds) (2005)
Allgemeine und spezielle Pharmakologie und Toxikologie. Begründet von W. Forth, D. Hentschler, W. Rummel (Forth, Hentschler & Rummel's General and Special Pharmacology and Toxicology), 9th Edition
München, Jena: Urban & Fischer
ISBN: 3-437-42521-8

A comprehensive general textbook covering the theoretical basis as well as the clinical aspects of pharmacology, with an extensive chapter on toxicology. Each chapter was written by an expert and starts with the pathophysiological basis.

Mutschler E, Geisslinger G, Kroemer HK, Ruth P, Schäfer-Korting M (2005)
Mutschler Arzneimittelwirkungen kompakt. Basiswissen Pharmakologie und Toxikologie (Effects of Drugs – Compact. Basic Knowledge of Pharmacology and Toxicology)
Stuttgart: Wissenschaftliche Verlagsgesellschaft
ISBN: 3-8047-2214-8

General textbook for students of medicine, pharmacy, and the life sciences contains three major sections

(general pharmacology, special pharmacology, toxicology). For the non-medical reader, a brief introduction to anatomy, physiology, and pathophysiology precedes each chapter.

Schmidt H (Ed.) (2007)
Pharmakologie und Toxikologie. Begründet von C. J. Estler (Estler's Pharmacology and Toxicology), 6th Edition
Stuttgart: Schattauer Verlag
ISBN: 3-7945-2295-8

A multi-author book with 22 chapters, one of which covers toxicology in a brief but systematic manner.

Further Important Textbooks on Pharmacology and Toxicology

Lüllmann H, Mohr K, Hein L (2006)
Pharmakologie und Toxikologie (Pharmacology and Toxicology), 16th Edition
Stuttgart: Thieme
ISBN: 3-13-368516-3

Oberdisse E, Hackenthal E, Kuschinsky K (Ed.) (2001)
Pharmakologie und Toxikologie (Pharmacology and Toxicology), 3rd Edition
Berlin: Springer
ISBN: 3-540-41993-4

Two popular textbooks addressed to medical students with main focus on pharmacology

Most Important Textbooks on Analytical and Medical Toxicology

Pfleger K, Maurer H, Weber A (2000)
Mass Spectral and GC Data of Drugs, Poisons, Pesticides, Pollutants and Their Metabolites I/ II/ III/IV
Weinheim: VCH Verlagsgesellschaft
ISBN: 3-527-26989-4

Reference to mass spectra of more than 4000 substances, most of them important for toxicological analyses in cases of intoxications; written in English, intensively used throughout the world.

Schaefer C, Spielmann H, Vetter K (2006)
Arzneiverordnung in Schwangerschaft und Stillzeit (Drugs in Pregancy and Lactation), 7th Edition
Stuttgart: Urban und Fischer
ISBN: 978-3-437-21332-8

By far most important monograph on teratogenic effects in German language. Frequently updated, based on authors' long consulting experience and research in the field.

von Mühlendahl KE, Oberdisse U, Bunjes R (2003)
Vergiftungen im Kindesalter (Intoxications in Childhood), 4th Edition
Stuttgart: Thieme
ISBN: 3-13-129814-6

The experience of more than 20 years of poisons information is presented in this standard book for diagnosis and treatment of intoxications. The main focus is on intoxications in childhood, but useful hints for intoxications in adults are also included for many toxic agents.

Further Important Textbooks on Analytical and Medical Toxicology

Ludewig R, Regenthal R
Akute Vergiftungen und Arzneimittelüberdosierungen (Acute Intoxications and Drug Overdoses), 10th Edition
Stuttgart: WVG
ISBN: 978-3-8047-2280-4

A valuable guide for the clinical management of intoxications, and a comprehensive index to many uncommon substances and products. Substances are grouped by chemical or use. Each entry comprises toxicokinetic and toxicodynamic data and the symptoms and therapy of intoxication.

Wirth W, Gloxhuber C (1994)
Toxikologie (Toxicology), 5th Edition
Stuttgart: Thieme
ISBN: 3-13-421105-X

Although over 10 years old, this is still an important textbook on medical toxicology. Following a shorter section on general toxicology, the main section is divided into the toxicology (chemistry, exposure, symptoms and mechanisms of acute and chronic intoxication, and therapy) of inorganic compounds, organic compounds, plant poisons, and animal poisons.

Environmental Toxicology and Biotoxins

Biogene Gifte (Poisons from Biological Sources), 2nd Edition
Stuttgart: Fischer
ISBN: 3-437-30747-9

This book presents the biology, chemistry, and toxicology of toxins from all types of biological organisms. Many color pictures and chemical structures are included.

Bresinsky A, Besl H (1985)
Giftpilze (Poisonous Fungi)
Stuttgart: WVG
ISBN: 3-8047-0680-0

This monograph contains short information on intoxication syndromes and more detailed information on the identification of poisonous fungi.

Frohne D, Pfänder HJ (2005)
Giftpflanzen (Poisonous Plants), 5th Edition
Stuttgart: WVG
ISBN: 3-8047-2060-9

In this handbook many plants with toxic ingredients are presented with photographs and comprehensive descriptions of their basic and clinical toxicology.

Junghanss T, Bodio M (1996)
Notfall-Handbuch Gifttiere (Emergency Handbook Venonous and Poisonous Animals)
Stuttgart: Thieme
ISBN: 3-13-100441-X

This valuable handbook is a collection of very detailed and comprehensive data on poisonings caused by exotic animals from the whole world. Designed for the use in specialized treatment centers and poisons centers.

Lindner E (1990)
Toxikologie der Nahrungsmittel (Toxicology of Food), 4th Edition
Stuttgart: Thieme
ISBN: 3 13-490804-2

A book about the toxic substances in food which are either natural or formed during storage or preparation, as well as about food additives.

Mebs D (2002)
Venomous and Poisonous Animals. A Handbook for Biologists, Toxicologists and Toxinologists, Physicians and Pharmacists
Stuttgart: Medpharm/WVG
ISBN: 3-88763-093-9

German version: Mebs D (2000) Gifttiere. Ein Handbuch für Biologen, Toxikologen, Ärzte und Apotheker, 2nd edition

Merian E, Anke M, Ihnat M, Stoeppler M (Ed.) (2004)
Elements and their Compounds in the Environment, 2nd Edition
Weinheim: VCH
ISBN: 3-527-30459-2

Formerly titled 'Metals and their Compounds in the Environment' (German and English versions). This is the standard reference monograph on many aspects of environmental and toxicological chemistry. Each chapter deals with a specific element and written by an international expert.

Stuttgart: WVG
ISBN: 3-8047-1639-3

In this comprehensive handbook many poisonous animals are presented with photographs, and their toxins, as well as the symptoms of and therapy for the intoxication are described.

Teuscher E, Lindequist U (1994)
Wichmann HE, Schlipköter H-W, Fülgraff G (2006)
Handbuch der Umweltmedizin. Toxikologie – Epidemiologie – Hygiene – Belastungen – Wirkungen – Diagnostik – Prophylaxe (Handbook of Environmental Medicine)
Landsberg: Ecomed (loose leaflet book)
ISBN: 978-3-609-71180-5

Environmental toxicology is an important field in environmental medicine. Among many other data this book contains toxicological reviews on substances present in the environment. The looseleaf book is continuously updated and has chapters on ozone, sulfur dioxide, passive smoking, polycyclic aromatic hydrocarbons, a number of metals, benzene, formaldehyde, pentachlorphenol, polychlorinated biphenyls, tetrachloroethene, herbicides, and nitrite/nitrate.

Occupational Toxicology – Monographs on Workplace Concentration Values

Deutsche Forschungsgemeinschaft (DFG) (Ed.) (2006)
List of MAK and BAT Values 2006. Maximum Concentrations and Biological Tolerance Values at the Workplace. Report 42
Weinheim: Wiley-VCH
ISBN: 3-527-31599-3

German version: Deutsche Forschungsgemeinschaft (DFG) (Ed.) MAK- und BAT-Werte-Liste 2006. Maximale Arbeitsplatzkonzentrationen und Biologische Arbeitsstofftoleranzwerte. Mitteilung 42

Weinheim: Wiley-VCH
ISBN: 3-527-31598-5

The MAK value (Maximale Arbeitsplatzkonzentration=maximum concentration in the workplace) is defined as the maximum permissible concentration of a chemical compound present in the air within a working area which, according to current knowledge, generally does not impair the health of the employee nor cause undue annoyance. These values are established annually by the Commission for the Investigation of Health Hazards in the Workplace of the German Science Foundation.

The BAT value (Biologische Arbeitsstofftoleranzwert= biological exposure value) is defined as the maximum permissible quantity of a chemical compound, its metabolites, or any deviation from the norm of biological parameters induced by these substances in exposed humans. The BAT values are also established by a commission of the Senate of the German Science Foundation and are published annually.

This periodical provides cumulative tables listing established Maximum Concentrations at the Workplace and the Biological Exposure Values for Occupational Toxicants, and also contains classification proposals for carcinogens. These values and classification proposals provide the basis for the legislative process on hazardous substances, which is prepared by the Bundesministerium für Arbeit und Sozialordnung (see below).

Drexler H, Greim H (Eds.) (2006)
Biologische Arbeitsstofftoleranz Werte (BAT-Werte), Expositionsäquivalente für krebserzeugende Arbeitsstoffe (EKA) und Biologische Leitwerte (BLW). Arbeitsmedizinisch toxikologische Begründungen (Biological Exposure Values for Occupational Toxicants and Carcinogens. Critial Data Evaluation for BAT, EKA and BLW Values)
Weinheim. Wiley-VCH (loose leaflet series, volumes 1 to 13)
ISBN: 3-527-19032-5

Critical data evaluations of the newly established or revised BAT values are published as supplementary material to this loose-leaf book.

Greim H (Ed.) (2006)
Gesundheitsschädliche Arbeitsstoffe. Toxikologisch arbeitsmedizinische Begründungen von MAK-Werten (Occupational Toxicants. Critical Data Evaluation for MAK Values and Classification of Carcinogens).
Weinheim: Wiley-VCH (loose leaflet series, volumes 1 to 41)
ISSN 0930-1984

MAK values are established by a commission of the Senate of the German Science Foundation and are published annually (see above). The critical data evaluations of newly established or revised MAK values are published as supplementary monographs to this loose-leaf book (in total about 3000 pages).

Occupational Toxicology – Further Important Monographs

Berufsgenossenschaft Chemie (BG Chemie) (Ed.) (2004)
Toxikologische Bewertungen (Toxicological Evaluations)
Heidelberg
ISSN 0937-4248
Web: http://www.bgchemie.de/webcom/show_article.php/_c-85/_nr-232/i.html (English)
Web: http://www.bgchemie.de/webcom/show_page.php/_c-86/_nr-1/_lkm-438/i.html (German)

In this series, more than 240 chemical substances are carefully evaluated with respect to their toxicological effects. English translations have been published as 'Toxicological Evaluations' for most of these chemicals.

Roth L, Rupp G (2000)
Krebserzeugende Stoffe (Carcinogenic Substances), 3rd Edition
Stuttgart: Wissenschaftliche Verlagsgesellschaft
ISBN: 3-8047-1724-1

This book aims at improving safety in handling of carcinogenic compounds at the workplace. A list of established and suspected carcinogens is provided together with a detailed profile of the individual carcinogens (physicochemical properties, toxicological data, safety regulations, and recommendations for safe handling). The book also lists the pertinent regulations for manufacturing and handling carcinogens.

Journals

Traditional professional journals of toxicology in Germany are no longer published in German but have switched to English language in order to gain a wider readership. These journals are listed elsewhere.

However, recently two German language journals focusing on environment-related topics have been founded that contain in part information related to toxicology:

Umweltmedizin in Forschung und Praxis (Environmental Medicine – Research and Practice)
Landsberg: ecomed
ISSN 1430-8681
Umweltwissenschaften und Schadstoff-Forschung (Environmental Sciences and Hazardous Substance Research)
Landsberg: ecomed
ISSN 0934-3504

Databases (Free Access)

Chemicals and Contact Dermatitis (Chemikalien und Kontaktallergie)

Managed by the Federal Institute for Risk Assessment. The database contains data of 244 chemical substances that have been evaluated for their potential for causing contact dermatitis.

Web: http://www.bfr.bund.de/cd/1934 (German only)

GESTIS International

Limit values for chemical agents provided by the BG-Institute for Occupational Safety and Health. This database contains a collection of occupational limit values for hazardous substances, gathered from various EU member states and the United States.

Web: http://www.hvbg.de/e/bia/gestis/limit_values (English)
Web: http://www.hvbg.de/d/bia/gestis/limit_values (German)

GESTIS Substance Database (GESTIS-Stoffdatenbank)

The Information system on hazardous substances of the Berufsgenossenschaften (i. e. German institutions for statutory accident insurance and prevention). To date, this is the most important database on hazardous substances with free and public access via internet in German language.

Web: http://www.hvbg.de/e/bia/gestis/stoffdb (English)
Web: http://www.hvbg.de/d/bia/fac/stoffdb (German)

Index of Authorized Plant Protection Products

Only in German (Verzeichnis zugelassener Pflanzenschutzmittel) by the Federal Office of Consumer Protection and Food Safety.

Web: http://www.bvl.bund.de/infoppp (German only)

International Chemical Safety Cards (ICSC)

German version (Internationale chemische Sicherheitsdatenblätter) provided by the BG-Institute for Occupational Safety and Health.
Web: http://www.hvbg.de/d/bia/gestis/icsc (German only)

Phytomedicine (Plant protection – Phytopathology – Stored Products Protection) Online searchable bibliographical database including more than 452 000 literature citations. Managed by the Federal Biological Research Centre for Agriculture and Forestry.

Web: http://www.bba.de/english/database/phytomed/phytomed.htm (English only)

Plastics Recommendations (Kunststoffempfehlungen)

Managed by the Federal Institute for Risk Assessment. The Plastics Recommendations represent the current level of science and technology for the conditions under which consumer goods made of high polymer substances meet the requirements of Article 3, paragaph 1 a of the EC Regulation 1935/2004 in respect of their health safety.

Web: http://www.bfr.bund.de/cd/1711 (English)
Web: http://www.bfr.bund.de/cd/447 (German)

Technical Rules for Hazardous Substances (Technische Regeln Gefahrstoffe, TRGS)

Developed by the Committee on Hazardous Substances. TRGS are collections of rules for the handling of hazardous substances at the workplace outlined within the Ordinance on Hazardous Substances (Gefahrstoffverordnung).

Web: http://www.baua.de/nn_7554/en/Topics-from-A-to-Z/Hazardous-Substances/TRGS/TRGS__content.html__nnn=true (mainly German, at the bottom of the list, several TRGS are presented in English translation)

WINGIS online Information System for Hazardous Substances (WINGIS Gefahrstoff-Informationssystem) of the Institution for Statutory Accident Insurance and Prevention for the Construction Industry (BG Bau)

Information on technical products used in the construction industry, utilizing the GISCODE nomenclature.
Web: http://www.wingis-online.de (German only)

Organizations (Government)

Germany is a member state of the European Union (EU). It is formed of 16 federal states (Bundesländer). Legislation is divided between the European Parliament, the Federal parliament (Bundestag), and parliaments of the Länder. Federal administration duties are mainly directed to national and international harmonization and development of guidelines. Federal Ministries in Germany have changed their name and duties in the last decade. Responsibilities for toxicological topics are widely distributed between the ministries and the institutes listed below.

Committee on Hazardous Substances (Ausschuss für Gefahrstoffe, AGS)
Web: http://www.baua.de/prax/ags (German only)

The main duty of the AGS is the development of technical rules for handling of hazardous substances in the workplace (Technischen Regeln Gefahrstoffe, TRGS, see below).

Committee for Occupational Safety and Safety Technology of the Federal States (Länderausschuss für Arbeitsschutz und Sicherheitstechnik)
c/o Landesamt für Arbeitsschutz, Postfach 90 02 36, D-14438 Potsdam
Web: http://lasi.osha.de (German only)

Federal Agency for Nature Conservation (Bundesamt für Naturschutz, BfN)
Konstantinstr. 110, D-53179 Bonn
Web: http://www.bfn.de (German only)

The BfN is the central federal administration for the international and national aspects of nature conservation.

Federal Biological Research Centre for Agriculture and Forestry (Biologische Bundesanstalt für Land- und Forstwirtschaft, BBA)
Messeweg 11-12, D-38104 Braunschweig
Web: http://www.bba.bund.de/cln_044/nn_813794/EN/Home/homepage__node.html__nnn=true (English)

Web: The BBA's tasks are defined by the Plant Protection Act and the Gene Technology Act, and include conducting research in the field of plant protection, development of environmentally sound plant protection practices and involvement in the evaluation and authorisation of plant protection products (among many others).

Federal Environmental Agency (Umweltbundesamt)
Wörlitzer Platz 1, D-06844 Dessau
Web: http://www.umweltbundesamt.de/index-e.htm (English)
Web: http://www.umweltbundesamt.de (German)

The Federal Environmental Agency provides support to the BMU, in particular at a scientific and technical level in the fields of air pollution control, noise abatement, waste and water management, soil protection and environmental chemicals, in particular in the drawing up of statutory and administrative provisions.

Federal Institute for Drugs and Medical Devices (Bundesinstitut für Arzneimittel und Medizinprodukte)
Kurt-Georg-Kiesinger-Allee 3, D-53175 Bonn
Web: http://www.bfarm.de/cln_043/nn_424302/EN/Home/homepage__node.html__nnn=true (English)
Web: http://www.bfarm.de (German)

Authorization and registration of drugs, collection and evaluation of side effects of drugs and medical devices.

Federal Institute for Occupational Safety and Health (Bundesanstalt für Arbeitsschutz und Arbeitsmedizin, BAUA)
Friedrich-Henkel-Weg 1-25, D-44149 Dortmund
Web: http://www.baua.de/eindex.htm (English)
Web: http://www.baua.de (German)

BAUA is the knowledge service provider and service institution for industry, government, social partners on occupational safety and is the authority mainly responsible for the notification of biocides.

Federal Institute for Risk Assessment (Bundesinstitut für Risikobewertung)
Thielallee 88-92, D-14195 Berlin
Web: http://www.bfr.bund.de/cd/template/index_en (English)
Web: http://www.bfr.bund.de (German)

The Federal Institute for Risk Assessment (BfR) was founded in 2002. It prepares expert reports and opinions on questions of food safety and consumer health protection on the basis of internationally recognized scientific risk assessment criteria.

Federal Ministry of Food, Agriculture and Consumer Protection (Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz, BMELV)
D-11055 Berlin. Phone: +49-30-2006-0
Web: http://www.bmelv.de/cln_044/nn_754188/EN/00Home/homepage__node.html (English)
Web: http://www.bmelv.de (German)

The BMELV was renamed in 2005 (formerly BMVEL) and has many responsibilities in the control of food, agriculture, and rural development.

Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, BMU)
Alexanderstraße 3, D-10178 Berlin
Web: http://www.bmu.de/english/aktuell/4152.php (English)
Web: http://www.bmu.de (German)

Responsible for the protection of human health against hazardous substances, for prevention of hazardous incidents in industrial plants and for dealing with other environmental issues.

Federal Ministry of Health (Bundesministerium für Gesundheit)
D-11055 Berlin
Web: http://www.bmg.bund.de/cln_041/nn_600110/EN/Home/homepage__node,param=.html__nnn=true (English)
Web: http://www.bmg.bund.de (German)

The Bundesministerium für Gesundheit located in Bonn and in Berlin is active in all fields of health and medicine, e.g. medicinal drugs, prevention, health insurance, as well as the protection of consumer and veterinary medicine.

Federal Ministry of Labor and Social Affairs (Bundesministerium für Arbeit und Soziales)
D-10117 Berlin
Web: http://www.bmas.bund.de/Englisch/Navigation/root.html (English)
Web: http://www.bmas.de (German)

Among many responsibilities on economic topics this ministry is responsible for occupational safety in Germany.

Federal Office for Radiation Protection (Bundesamt für Strahlenschutz)
Web: http://www.bfs.de (English/German)

BfS is responsible for the safety and protection of man and the environment against damage due to ionizing and non-ionizing radiation. Of special importance are

defense against immediate hazards, and precautions for the protection of the general public, workers, and patients.

Federal Office of Consumer Protection and Food Safety (Bundesamt für Verbraucherschutz und Lebensmittelsicherheit)
Rochusstraße 65, D-53123 Bonn
Web: http://www.bvl.bund.de/cln_027/nn_493778/EN/Home/homepage__node.html__nnn=true (English)
Web: http://www.bvl.bund.de (German)

The Federal Office of Consumer Protection and Food Safety (BVL) exercises several duties through which it contributes to safer food, feed, and commodities in Germany (risk management). It is responsible for the authorization of plant protection products, veterinary drugs, feed additives, and genetically modified organisms.

German Institute for Medical Documentation and Information (Deutsches Institut für Medizinische Dokumentation und Information)
Waisenhausgasse 36-38a, D-50676 Köln
Web: http://www.dimdi.de/dynamic/en (English)
Web: http://www.dimdi.de (German)

The DIMDI is hosting about 90 databases for access via the internet, part of which is freely accessible to the public after entering into a contract. The DIMDI cooperates with the central medical library in Cologne and thus provides full text archival medical literature for a fee.

Organizations (Non-Government)

Bau-Berufsgenossenschaft (Bau-BG) – Institution for Statutory Accident Insurance and Prevention for the Construction Industry
Hildegardstraße 29/30, D-10715 Berlin
Web: http://www.bgbau.de (German only)

Berufsgenossenschaft Chemie (BG Chemie) – Institution for Statutory Accident Insurance and Prevention for Chemical Industry
Kurfürsten-Anlage 62, D-69115 Heidelberg
Web: http://www.bgchemie.de (German only)

BG – Institute for Occupational Safety and Health – (BGIA, Berufsgenossenschaftliches Institut für Arbeitssicherheit)
Alte Heerstraße 111, D-53757 Sankt Augustin
Web: http://www.hvbg.de/e/biahttp://www.hvbg.de/e/bia (English)
Web: http://www.hvbg.de/d/bia (German)

The BGIA is a research and testing institute affiliated with the German Berufsgenossenschaften (BG), the institutions for statutory accident insurance and prevention in Germany.

Centre for Environmental Research Leipzig-Halle (Umweltforschungszentrum Leipzig-Halle)
Permoserstraße 15, D-04318 Leipzig
Web: http://www.ufz.de/index.php?en=616 (English)
Web: http://www.ufz.de (German)

Chemical Industry Federation (Verband der Chemischen Industrie)
Karlstr. 21, D-60329 Frankfurt am Main
Web: http://www.vci.de (Germany only)

Fraunhofer Institute of Toxicology and Experimental Medicine (Fraunhofer Institut für Toxikologie und Experimentelle Medizin)
Nikolai-Fuchs-Str. 1, D-30625 Hannover
Web: http://www.item.fraunhofer.de/english (English)
Web: http://www.item.fraunhofer.de (German)

Important fields of research at the Fraunhofer ITEM are drug research, and bio- and genetic engineering. From the beginning, research activities have focused on changes in the lungs, as they result from exposures at workplace and environment.

German Cancer Research Center (Deutsches Krebsforschungszentrum)
Im Neuenheimer Feld 280, D- 69120 Heidelberg
Web: http://www.dkfz.de/index_e.htm (English)
Web: http://www.dkfz.de (German)

The DKFZ was founded in 1964 as a non-profit organization and supraregional research center by the Land (state) Baden-Württemberg. It is mainly funded by the Bundesforschungsministerium (Federal Ministry for Research and Technology) (90%). After the dissolution of the former institutes, a new program-oriented organizational structure of the DKFZ was adopted in 1991. Today, multidisciplinary cancer research is performed by more than 50 divisions and working groups.

German Federal Foundation for the Environment (Deutsche Bundesstiftung Umwelt)
An der Bornau 2, D-49090 Osnabrück
Web: http://www.dbu.de/english (English)
Web: http://www.dbu.de (German)

German Institute of Human Nutrition (Deutsches Institut für Ernährungsforschung Potsdam-Rehbrücke)
Arthur Scheunert-Allee 114-116, D-14458 Nuthetal
Web: http://www.dife.de/en (English)
Web: http://www.dife.de (German)

German Research Foundation (Deutsche Forschungsgemeinschaft, DFG)
Kennedyallee 40, D-53175 Bonn
Web: http://www.dfg.de/en (English)
Web: http://www.dfg.de (German)

The DFG is the central, self-governing research funding organization that promotes research at universities and other publicly financed research institutions in Germany.

Senate Commission for the Investigation of Health Hazards of Chemical Compounds in the Work Area (Senatskommission zur Prüfung gesundheitsschädlicher Arbeitsstoffe)
Web: http://www.dfg.de/en/dfg_profile/structure/statutory_bodies/senate/senate_commissions_and_committees/investigation_health_hazards (English)
Web: http://www.dfg.de/dfg_im_profil/struktur/gremien/senat/kommissionen_ausschuesse/senatskommission_pruefung_arbeitsstoffe (German)

Senate Commission on Food Safety (Senatskommission zur Beurteilung der gesundheitlichen Unbedenklichkeit von Lebensmitteln)
Web: http://www.dfg.de/en/dfg_profile/structure/statutory_bodies/senate/senate_commissions_and_committees/food_safety (English)
Web: http://www.dfg.de/dfg_im_profil/struktur/gremien/senat/kommissionen_ausschuesse/sklm (German)

Senate Commission on Substances and Resources in Agriculture (Senatskommission für Stoffe und Ressourcen in der Landwirtschaft)
Web: http://www.dfg.de/en/dfg_profile/structure/statutory_bodies/senate/senate_commissions_and_committees/chemicals_used_in_agriculture (English)
Web: http://www.dfg.de/dfg_im_profil/struktur/gremien/senat/kommissionen_ausschuesse/sklw (German)

National Research Center for Environment and Health (GSF – Forschungszentrum für Umwelt und Gesundheit)
Ingolstädter Landstraße 1, D-85764 Neuherberg
Web: http://www.gsf.de/index_en.php (English)
Web: http://www.gsf.de (German)

The GSF research focus is on chronic degenerative diseases such as lung diseases, allergies, cancer, and cardiovascular diseases that are influenced to a large extent by environmental conditions.

Oeko-Institut – Institute for Applied Ecology (Öko-Institut)
Postfach 50 02 40, D-79028 Freiburg
Web: http://www.oeko.de/index_engl.htm (English)
Web: http://www.oeko.de (German)

Oeko-Institut is a leading European research and consultancy institution working for a sustainable future.

Research and Advisory Institute for Hazardous Substances (FoBiG – Forschungs- und Beratungsinstitut Gefahrstoffe)
Werderring 16, D-79098 Freiburg
Web: http://www.fobig.com (English)
Web: http://www.fobig.de (German)

FoBiG is a private company specializing in toxicological risk assessment.

Universities

Postgraduate scientific work in toxicology can be carried out at all universities with a medical faculty in the departments of toxicology or pharmacology. A few universities have such departments in the faculty of pharmacy or veterinary medicine. Postgraduate work leads to a doctorate in the discipline of the student's basic degree, e.g., medicine, chemistry, pharmacy, biology, food chemistry, etc. There is no degree of 'doctor of toxicology' nor is there a degree in toxicology at the graduate level.

Berlin
Charité Universitätsmedizin Berlin – Institut für Klinische Pharmakologie und Toxikologie – Abteilung Toxikologie
Garystrasse 5, D-14195 Berlin
Web: http://www.medizin.fu-berlin.de/copharma (German only)

Bochum
Ruhr-Universität Bochum – Berufsgenossenschaftliches Forschungsinstitut für Arbeitsmedizin
Bürkle-de-la-Camp Platz 1, D-44789 Bochum
Web: http://www.bgfa.ruhr-uni-bochum.de/e (English)
Web: http://www.bgfa.ruhr-uni-bochum.de (German)

Dortmund
Universität Dortmund – Institut für Arbeitsphysiologie – Projektgruppe Chemikalienwirkungen
Ardeystr. 67, D-44139 Dortmund
Web: http://www.ifado.de/en/research/chemicals (English)
Web: http://www.ifado.de/forschung/chemicals (German)

Düsseldorf
Heinrich-Heine-Universität Düsseldorf – Institut für Toxikologie
Postfach: 101007, D-40001 Düsseldorf
Web: http://www.uniklinik-duesseldorf.de/toxikologie (German only)

Erlangen
Friedrich-Alexander-Universität Erlangen-Nürnberg – Institut für Experimentelle und Klinische Pharmakologie und Toxikologie
Fahrstrasse 17, D-91054 Erlangen
Web: http://www.pharmakologie.uni-erlangen.de (German only)

Freiburg
Albert-Ludwigs-Universität Freiburg – Institut für Experimentelle und Klinische Pharmakologie und Toxikologie
Albertstraße 25, D-79104 Freiburg i. Brsg.
Web: http://www.pharmakologie.uni-freiburg.de/english (English)
Web: http://www.pharmakologie.uni-freiburg.de (German)

Gießen
Justus-Liebig-Universität Gießen – Institut für Pharmakologie und Toxikologie
Frankfurter Straße 107, D-35392 Gießen
Web: http://www.vetmed.uni-giessen.de/pharmtox (German only)

Göttingen
Georg-August-Universität Göttingen – Bereich Humanmedizin – Zentrum Pharmakologie und Toxikologie
Robert-Koch-Str. 40, D-37075 Göttingen
Web: http://regulus.pharbp.med.uni-goettingen.de (German only)

Halle
Martin-Luther-Universität Halle-Wittenberg – Institut für Umwelttoxikologie
Franzosenweg 1a, D-06097 Halle/Saale
Web: http://ws1-iut.medizin.uni-halle.de (German only)

Hamburg
Universität Hamburg – Zentralinstitut und Ordinariat für Arbeitsmedizin
Martinistraße 52, D-20246 Hamburg
Web: http://www.uke.uni-hamburg.de/institute/arbeitsmedizin (German only)
Institut für Experimentelle und Klinische Toxikologie
Vogt-Kölln-Str. 30, D-22527 Hamburg
Web: http://www.uke.uni-hamburg.de/zentren/experimentelle_medizin/toxikologie (German only)

Hannover
Medizinische Hochschule Hannover – Institut für Toxikologie
Carl- Neuberg-Straße 1, D-30625 Hannover
Web: http://www.mh-hannover.de/institute/toxikologie/ (German only)

Tierärztliche Hochschule Hannover – Institut für Lebensmitteltoxikologie
Bischofsholer Damm 15, D-30173 Hannover
Web: http://www.tiho-hannover.de/einricht/lmtox (German only)

Heidelberg
Ruprecht-Karls-Universität Heidelberg – Institut für Pharmakologie und Toxikologie
Maybachstr. 14, D-68169 Mannheim
Web: http://www.ma.uni-heidelberg.de/inst/phar (German only)

Homburg/Saar
Universität des Saarlandes – Experimentelle und Klinische Pharmakologie und Toxikologie
Kirrbergerstraße, D-66421 Homburg
Web: http://wwwalt.med-rz.uni-sb.de/med_fak/pharma-toxi/Seiten/Maurer_frame.html (German only)

Jena
Friedrich-Schiller-Universität Jena – Institut für Pharmakologie und Toxikologie
D-07740 Jena
Web: http://mti-n.mti.uni-jena.de/~pawww/pharma.html (German only)

Friedrich-Schiller-Universität Jena – Institut für Ernährungswissenschaften, Lehrstuhl für Ernährungstoxikologie

Dornburgerstr. 25, D-07743 Jena
Web: http://www2.uni-jena.de/biologie/ieu/et/english/start_eng.htm (English)
Web: http://www2.uni-jena.de/biologie/ieu/et (German)

Kaiserslautern
Technische Universität Kaiserslautern – Fachbereich Chemie, Fachrichtung Lebensmittelchemie und Umwelttoxikologie
Gottlieb-Daimler-Straße, Gebäude 47, D-67663 Kaiserslautern

Web: http://www.chemie.uni-kl.de/fachrichtungen/lmctox/index.php?lang=en (English)
Web: http://www.chemie.uni-kl.de/fachrichtungen/lmctox/index.php?lang=de (German)

Kiel
Christian-Albrechts-Universität zu Kiel – Institut für Toxikologie und Pharmakologie für Naturwissenschaftler
Brunswiker Str. 10, D-24105 Kiel
Web: http://www.uni-kiel.de/toxikologie (German only)

Konstanz
Universität Konstanz – Abteilung Biologie – Molecular Toxicology Group

Postfach X911, D-78457 Konstanz
Web: http://gutenberg.biologie.uni-konstanz.de (English only)

Leipzig
Univeristät Leipzig – Veterinärmedizinische Fakultät – Institut für Pharmakologie, Pharmazie und Toxikologie
An den Tierkliniken 15, D-04106 Leipzig
Web: http://www.uni-leipzig.de/~vetppt (German only)

Mainz
Johannes Gutenberg-Universität Mainz Institut für Toxikologie
Obere Zahlbacher Str. 67, D-55131 Mainz
Web: http://www.toxikologie.uni-mainz.de/Homepage-englisch/Start-e.jsp (English)
Web: http://www.toxikologie.uni-mainz.de (German)

Munich
Ludwig-Maximilians-Universität München – Walther-Straub-Institut für Pharmakologie und Toxikologie
Goethestraße 83, D-80336 München
Web: http://wsi.web.med.uni-muenchen.de (German only)

Technische Universität München – Institut für Pharmakologie und Toxikologie
Biedersteiner Str. 29, D-80802 München
Web: http://www.ipt.med.tu-muenchen.de/english.html (English)
Web: http://www.ipt.med.tu-muenchen.de (German)

Technische Universität München – Lehrstuhl für Toxikologie und Umwelthygiene
Biedersteiner Straße 29, Bau 602, 80802 München
Web: http://univis.tu-muenchen.de/formbot/dsc_3Danew_2Fpande_26dir_3Dme_2Ftoxik_2Ftoxik_26ref_3Dpande (German only)

Potsdam
Universität Potsdam – Institut für Ernährungswissenschaft – Lehrstuhl für Ernährungstoxikologie
Arthur-Scheunert-Allee 114-116, D-14558 Nuthetal
Web: http://www.uni-potsdam.de/u/ewi/Etox (German only)

Rostock
Universität Rostock – Zentrum für Pharmakologie und Toxikologie
Schillingallee 70, D-18057 Rostock
Web: http://www-ipharma.med.uni-rostock.de/ZPT (German only)

Tübingen
Eberhard-Karls-Universität Tübingen – Institut für Pharmakologie und Toxikologie – Abteilung Toxikologie
Wilhelmstraße 56, D-72074 Tübingen
Web: http://www.uni-tuebingen.de/toxikologie (German only)

Würzburg
Bayerische Julius-Maximilians-Universität Würzburg – Institut für Pharmakologie und Toxikologie
Versbacher Strasse 9, D-97078 Würzburg
Web: http://wwwalt.uni-wuerzburg.de/toxikologie (German only)

Professional Societies

Gesellschaft für Toxikologie in der DGPT (Society of Toxicology associated with the German Society of Experimental and Clinical Pharmacology and Toxicology) GT is engaged in development of toxicological science and education in Germany. Since the 1980s GT has been running a postgraduate training program with qualified courses in more than ten toxicological subdisciplines. GT and its members also teach toxicological topics in training programs with the main focus outside toxicology (e.g. environmental medicine). Expert committees regularly develop and publish position statements on toxicological topics of political and public concern. Today, GT has 950 personal members.
Web: http://www.toxikologie.de (German only)

Deutsche Gesellschaft für experimentelle und klinische Pharmakologie und Toxikologie (German Society of Experimental and Clinical Pharmacology and Toxicology)
Web: http://www.dgpt-online.de (German only)

Deutschen Gesellschaft für DNA-Reparaturforschung (DGDR, German Society for DNA Repair Research)
Web: http://www.dna-rep-net.de (German only)

Gesellschaft Deutscher Chemiker – Fachgruppe Umweltchemie und Ökotoxikologie (Society of German Chemists – Expert Group on Environmental Chemistry and Ecotoxicology)
Web: http://www.gdch.de/strukturen/fg/uoe.htm (German only)

Gesellschaft für Klinische Toxikologie (Society of Clinical Toxicology of German Speaking Countries)
Web: http://www.klinische-toxikologie.de/28.0.html (English)
Web: http://www.klinische-toxikologie.de (German)

Gesellschaft für Toxikologische und Forensische Chemie (GTFCh, Society of Toxicological and Forensic Chemistry)
Web: http://www.gtfch.org (English and German)

Gesellschaft für Umwelt-Mutationsforschung (German Environmental Mutagen Society)
Web: http://www.gum-net.de (German only)

Poisons Centers

Berlin
Giftnotruf Berlin – Institut für Toxikologie – Berliner Betrieb für Zentrale Gesundheitliche Aufgaben
Oranienburger Str. 285, D-13437 Berlin
Phone: +49-30-19240
Web: http://www.giftnotruf.de (German only)

Bonn
Informationszentrale gegen Vergiftungen – Zentrum für Kinderheilkunde der Rheinischen Friedrich-Wilhelms-Universität Bonn
Adenauerallee 119, D-53113 Bonn
Phone: +49-228-19240
Web: http://www.meb.uni-bonn.de/giftzentrale/eindex.html (English)
Web: http://www.meb.uni-bonn.de/giftzentrale (German)

Erfurt
Gemeinsames Giftinformationszentrum der Länder Mecklenburg-Vorpommern und Sachsen-Anhalt sowie der Freistaaten Sachsen und Thüringen (GGIZ)
Nordhäuserstr. 74, D-99089 Erfurt
Phone: +49-361-730730
Web: http://www.ggiz-erfurt.de (German only)

Freiburg
Informationszentrale für Vergiftungen – Universitäts – kinderklinik Freiburg
Mathildenstr. 1, D-79106 Freiburg
Phone: +49-761-19240
Web: http://www.giftberatung.de (German only)

Göttingen
Giftinformationszentrum-Nord der Länder Bremen, Hamburg, Niedersachsen und Schleswig-Holstein (GIZ-Nord Poisons Centre)-Universität Göttingen-Bereich Humanmedizin
D-37099 Göttingen
Phone: +49-551-383 180
Web: http://www.giz-nord.de/php/index.php?option=com_content&task=category&sectionid=19&id=44&Itemid=134 (English)
Web: http://www.giz-nord.de (German)

Homburg
Informations- und Behandlungszentrum für Vergiftungen – Universitätsklinik für Kinder- und Jugendmedizin
Kirrberger Straße, D-66421 Homburg/Saar
Phone: +49-6841-19240
Web: http://www.med-rz.uni-sb.de/med_fak/kinderklinik/Vergiftungszentrale/vergiftungszentrale.html (German only)

Mainz
Beratungsstelle bei Vergiftungen – II. Medizinische Klinik und Poliklinik der Universität
Langenbeckstr. 1, D-55131 Mainz
Phone:+49-6131-19240
Web: http://www.giftinfo.uni-mainz.de/gift_en (English)
Web: http://www.giftinfo.uni-mainz.de (German)

München
Giftnotruf München – Toxikologische Abteilung der II. Medizinischen Klinik rechts der Isar der Technischen Universität München
Ismaningerstr. 22, D-81675 München
Phone: +49-89-19240
Web: http://www.toxinfo.org/about/giz.html (German only)

Nürnberg
Giftinformationszentrale Nürnberg, Med. Klinik 2, Klinikum Nürnberg – Universität Erlangen-Nürnberg
Prof.-Ernst-Nathan-Str. 1, D-90340 Nürnberg
Phone: +49-911-398 2451
Web: http://www.giftinformation.de (German only)

List of Poisons Centers in Germany

Web:http://www.giz-nord.de/php/index.php?option=com_content&task=view&id=52&Itemid=86 (German only)

Legislation

Although handling of chemical compounds is regulated by national legislation, this must be harmonized with legislation in the European Union. Binding guidelines of the European Union must be adopted nationally. The most important laws dealing with chemical compounds are described below.

Chemicals Act-Protection Against Hazardous Substances Act (Gesetz zum Schutz vor gefährlichen Stoffen-Chemikaliengesetz) and Ordinance on Hazardous Substances (Gefahrstoffverordnung)

Responsibility: Federal Ministry of Labor and Social Affairs (Bundesministerium für Arbeit und Soziales)

Federal agency in charge: Federal Institute for Occupational Safety and Health (Bundesanstalt für Arbeitsschutz und Arbeitsmedizin)

The law prescribes a registration procedure for all chemical compounds to be introduced into the market except those regulated by another law. The extent of toxicological data required for registration depends on the amount of the chemical to be marketed. The law

regulates the classification and labeling of chemicals and the handling of chemicals in the workplace, including the establishment of threshold values.

Drug Law (Arzneimittelgesetz)

Responsibility: Federal Ministry for Health (Bundesministerium für Gesundheit) Federal agency in charge: Federal Institute for Drugs and Medical Devices (Bundesinstitut für Arzneimittel und Medizinprodukte)

The Drug Law prescribes a procedure for the marketing authorization for drugs in which the quality, clinical efficiency, and safety of new drugs is assessed. Extensive toxicological data are required for this procedure. The Drug Law requires benefit assessment in addition to risk assessment.

Federal Immissions Control Act (Bundesimmissionsschutzgesetz)

Responsibility: Federal Ministry of the Environment, Nature Conservation and Nuclear Safety (Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit)

Federal agency in charge: Federal Environmental Agency (Umweltbundesamt)

The law is devoted to the protection of humans, animals, plants, and objects from harmful effects arising from the environment, in particular from the air. It prescribes a procedure for the approval of installations in order to minimize the emission of dangerous substances into the environment.

Foods and Feed Code (Lebensmittel- und Futtermittelgesetzbuch)

Responsibility: Federal Ministry for Health (Bundesministerium für Gesundheit) Federal agency in charge: Federal Office of Consumer Protection and Food Safety (Bundesamt für Verbraucherschutz und Lebensmittelsicherheit)

The law regulates the handling of foods, cosmetics, and commodities. It is devoted to the protection of the consumer by prohibiting products that may affect human health. It prescribes that only approved food additives may be used.

Plant Protection Act (Pflanzenschutzgesetz)

Responsibility: Federal Ministry of Food, Agriculture and Consumer Protection (Bundesministerium für Ernährung, Landwirtschaft und Verbraucherschutz)

Federal agency in charge: Federal Office of Consumer Protection and Food Safety (Bundesamt für Verbraucherschutz und Lebensmittelsicherheit)

In implementing Directive 91/414/EEC, the Plant Protection Act prescribes a procedure for the marketing authorization for pesticides in which extensive toxicological data are required in order to ensure that the compounds do not exhibit harmful effects on humans, animals, or the environment.

These laws contain authorizations for the government to enact ordinances (Verordnungen) that regulate issues of the law in detail below the legislation level. For instance, details concerning the issues of the Chemicals Act are regulated by the Ordinance on Dangerous Substances (Gefahrstoffverordnung) published by the Federal Ministry for Labour and Social Affairs. Since Germany is a confederation, the approval of the Bundesrat (Federal Council, representing the federal states) is required for many of these ordinances. As a rule, federal agencies are responsible for registration and marketing authorization, for establishment of threshold values, and for recommendation of precautions for health protection, whereas agencies of the states are responsible for supervision and prosecution.

CHAPTER

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India

SHRUTI PATEL AND ARUNA DEWAN

INTRODUCTION

The Indian economy is surging ahead and the current decade has witnessed extensive industrial growth in India, although agriculture still remains the main occupation for a large segment of the Indian population. According to the 2001 census, the employment of women in agriculture and household industries has increased remarkably as compared to the 1991 census. Though per hectare use of pesticides has been reported to be much less when compared to developed countries, pesticide exposures, both acute and chronic, continue to cause serious health problems to farm workers. Employment of women translates into higher exposures for vulnerable groups, including children. There are vast populations in India who are being exposed to arsenic-contaminated ground water. Also of concern is chemical waste dumped in the country in the guise of recycling. This has added to the already existing burden of infectious diseases, compounded by widespread malnutrition. Environmental groups backed by media are playing a significant role in creating public awareness and building up pressure on policy makers. Some recent examples include the controversy related to pesticide residues in soft drinks and asbestos-related hazards in ship-breaking yards. Regulatory bodies are implementing stringent laws, and analytical facilities in private and Government institutions are being upgraded to meet international standards.

Most of the regulations concerning pharmaceuticals, food additives, preservatives, air and water pollutants, industrial chemicals, and pesticides rely on toxicological data, and toxicity testing is becoming more and more elaborate. Experimental toxicological research in India has been following in the footsteps of its Western counterparts, and research is being carried out in universities throughout the country. The country is also upgrading its capabilities to keep up with global standards for measuring and monitoring chemicals at ppb levels.

India has lagged behind in an important aspect of toxicology. Practice and teaching of clinical toxicology has yet to find its due place in the medical curriculum and healthcare system. Pesticide poisoning continues to take a heavy toll on human lives. There is limited clinical toxicological research on acute and chronic poisoning due to pesticides and industrial chemicals. Poison Information Centers which act as focal points of consultation and information dissemination for emergency treatment of poisoning are few and have yet to make their presence felt in this country of more than a billion people. Training in medical management of chemical emergencies is rudimentary and only very recently have programs on advanced HAZMAT life support been started for emergency physicians. Toxicology training for paramedics and pre-hospital management of chemical exposures is almost non-existent. Research on occupational and environmental human exposure and bio-monitoring needs to be strengthened.

Toxicology has made considerable strides in India, although further progress is necessary.

RESOURCES

Books

Abbasi SA (1998)
Heavy Metals in the Environment
New Delhi: Mittal Publications

The natural occurrence of heavy metals in the environment, the elevation of these natural levels due to pollution, and the toxic effect this has on the environment in general and in human beings in particular, is a topic of interest for a very large cross-section of people – ranging from metallurgists to environmentalists, geologists to biologists, engineers to doctors, social scientists to journalists, city planners to health workers. In this volume the three authors have pooled their combined expertise of over 50 years in this field to provide us with a goldmine of information and deep insight. A must for everyone interested in environment.

Aggrawal A (2006)
Self-Assessment and Review of Forensic Medicine and Toxicology
New Delhi: Peepee Publishers
ISBN: 81-88867-85-3

Agrawal KC (2001)
Environmental Pollution: Causes, Effects & Controls
Bikaner: Nidhi Publishers
ISBN: 8190118145

This book presents up-to-date and all basic information about the major types of environmental pollution – air, water, indoor, noise, solid and hazardous waste, radiation, thermal, and oil pollution and their adverse effects on man and the environment. Technological and legal pollution control measures have been discussed in the Indian context. The text has been updated in light of current status of Government policies and programs. Notable international treaties and protocols viz., Stockholm Conference, World Charter for Nature, Rio Earth Summit, Montreal Protocol and Kyto Protocol, have also been described. Glossary of relevant terms is given at the end. The book will serve as a major text for students of botany, zoology, geography, geology, environmental biology, environmental science, environmental chemistry, environmental engineering, home science, law, and medical and veterinary sciences.

Ahluwalia SK (2005)
Environment Problems in India
Jaipur: ABD Publishers
ISBN: 8183760031

Environmental problems have impacted on and attracted the attention of every community and nation of the world. Global warming, ozone layer depletion and numerous other phenomena have made globalization of environmental problems. Therefore, efforts are made worldwide to find solutions that are global in nature, require international cooperation and a scientific and political consensus. This has resulted in evolution of various approaches and techniques toward solution of these problem and sustainable development. 'Environmental Problems in India' makes a thorough investigation into various concepts, approaches, methods, techniques, rules, regulations, and laws dealing with environmental problems. Delving deep into social dimensions of these problems and the relationship between society and nature, the book arrives at certain conclusions for the alleviation and/or mitigation of these problems. The book includes all latest energy-saving conservation and sustainable development strategies. This all-encompassing book on management of environmental problems will suit the needs of teachers, students, environmental NGOs, and general readers.

Arora M (2001)
Environmental Management of Toxic and Hazardous Chemicals
New Delhi: Ivy Publishing House
ISBN: 8178900009

Bajaj YPS, Peles JD, Barrett GW (1999)
Transgenic Medicinal Plants
Springerlink Publisher
ISBN: 3540651209

Banerjee BN (1987)
Environmental Pollution and Bhopal Killings
New Delhi: Gyan Publishing House
ISBN: 8121201195

This book alleges that Union Carbide Corporation (UCC; the US chemical multinational)'s criminal irresponsibility simply ruined hundreds of innocent lives in Bhopal by the sudden releases of over 40 tonnes of methyl isocyanate (MIC) and the associated lethal chemicals. The tragedy was totally man-made and created by those unscrupulous death-dealers who would for making easy profit, not hesitate in any kind of reckless behavior. The same death-dealing US Company – Union Carbide contributed to spreading disinformation to evade the responsibility and in the process contributed to untold suffering to thousands of people. However, the Bhopal tragedy with its suffering and agony continues and thousands of people are afflicted by lung, eye and skin diseases besides psychological problems. The official agencies categories the gas victims as severely affected (65 000), mildly affected (20 000) and those under controlled effects (14 000). The abortion, mortality, and infant mortality rates in the severely affected category have been found to be three to four times higher than in the controlled category during April, 1965 to March, 1986. While official agencies' reports, kept confidential, point to a very serious situation, the Madhya Pradesh Government wants people to believe that all is well in Bhopal. In fact, statistics bleed

with reality of significant number of gynecological disorders, record abortions and corneal opacity (blurred vision). The Madhya Pradesh Government's approach to the Bhopal disaster by way of suppression of information, inadequate medical relief, and economic rehabilitation as well as persecution of voluntary relief workers have come in for severe criticism both in the press and the public. Thus the human agony continues.

Bhushan B, Kumar V (2006)
Environmental Impact Assessment
New Delhi: Shree Publishers & Distributors
ISBN: 8183290817

Environment Impact Assessment (EIA) is an activity designed to identify and predict the impact on the biogeophysical environment and on man's health and well-being of legislative proposals, policies, programs, projects, and operational procedures, and to interpret and communicate information about the impacts. EIA should be an integral part of all planning for major actions, and should be carried out at the same time as engineering, economic, and socio-political assessments. This book responds to both the evolution in EIA thinking and to the maintenance of the basic approach. The emphasis in this book is on developing understanding of the EIA processes. It is intended to place the reader in the position of being able to apply these processes to any situation, while being aware of the strengths and limitations of the approaches being used and the assumptions being made. The intended readers of this book include decision-makers, policy and management advisors, the assessors, technical staffs, students and teachers of environmental science and laymen with an interest in environmental quality.

Bhushan B, Kumar V (2006)
Environmental Management
New Delhi: Shree Publishers & Distributors
ISBN: 8183290884

The environment is integral to the overall process of development. It includes the relationship and interdependencies that exist between people and natural resources. Environmental change is thus the product not only of natural events, but also of the application of development models, practices, and life-styles. The last two decades have seen a renewed interest in the use of environmental management as part of an integrated approach toward disease vector control. This interest has originated in part from a growing concern about the possible adverse health impacts of the continued development of water resources. This book discusses various techniques for environmental assessment and management. It will enable the users to incorporate the principles of environmental management and sustainable development into their daily activities, particularly in their efforts to promote a sustainable, equitable, and participatory development process. It will also enable them to identify environmental opportunities as well as constraints when pursuing economic and social development objectives.

Caius JF (2003)
The Medicinal and Poisonous Plants of India
Jodhpur: Scientific Publisher
ISBN: 81-7233-326-9.

Dev S, Koul O (1997)
Insecticides of Natural Origin
Harwood Academic Publishers

Dikshith TSS (1991)
Toxicological Study of Pesticides in Animals
CRC Press
ISBN: 084936907X

This book discusses studies that have been conducted on various animal species. The book reviews the effects of pesticides through changes in behavior, the nature of morphological and biochemical lesions, as well as the tracking of the metabolic disposition of pesticides in target sites of an organism. In vitro studies provide information regarding cellular responses and biochemical lesions with pesticides. Toxicological profiles of pesticides are cited using different species of animals for in vivo and in vitro studies. This information should help scientists and decision-makers reach conclusions regarding the toxicological effects of pesticides on humans and the environment.

Dwivedi P (2004)
Environmental Pollution and Environmental Management
Jodhpur: Scientific Publisher
ISBN: 81-7233-358-7

This book highlights critical environmental issues, and touches upon various environmental pollution with focus on the causes, sources, and remediation. The emphasis has been laid on key environmental management strategies to combat the menace caused by various pollutants, and also to be prepared in advance to tackle the effects of such pollutants as well as natural hazards.

Gupta HCL (1999)
Insecticides: Toxicology and Uses
Udaipur: Agrotech Publishing Academy

Gupta IC, Kumar D, Joshi DC (2001)
Industrial Waste Waters and Environmental Pollution
ISBN: 81-7233-244-0

Gupta RD (2006)
Environmental Pollution: Hazards and Control
New Delhi: Concept
ISBN 81-8069-260-4

This book attempts to address the multidimensional problems of environmental pollution. Explaining the concept of environment, change of ecological balance and pollution, it traces the causes accountable for producing air, water, noise, vehicular, metal dust, soil, pesticidal, radioactive, and food pollution. It further analyses the impact of different pollutants on human and animal life. Suggestions for their better management and control have been given as well. The book will be of special interest to the policy makers, researchers, environmentalists and development agencies.

Hussain A (2006)
Environment and Health
New Delhi: Sumit Enterprises
ISBN: 8184200110

Environmental education has close links with the other four cross-curricular themes sharing many of the same features of investigative skills and body of knowledge. Pupils may research original and secondary sources, set up simulations, reach conclusions, and discuss the validity of their ideas. The five themes share the possibilities for promoting the discussion of value and beliefs, extending knowledge and understanding, encouraging practical activities and decision-making and providing opportunities for pupils to make positive contributions to their community's way of life.

Jain B (Ed.) (2005)
Guide to Forensic Medicine and Toxicology
New Delhi: B. Jain Publishers
ISBN: 8180565262

Designed to provide the reader with essential and practical knowledge of forensic medicine, this book has been written in a concise manner to help students get a grasp of the subject.

Jasra OP (2003)
Encyclopaedia of Toxicology
New Delhi: Ivy Publishers
ISBN: 81-7890-080-7

Karmakar RN (2004)
Forensic Medicine and Toxicology
Kolkata: Academic Publishers
ISBN: 8187504692

Khan RR (2001)
Environment and Metal Pollution
Jaipur: ABD Publishers
ISBN: 8185771197

This book comprehensively deals with the subject of metals and their environmental and health consequences. It contains 12 major chapters besides references and index, covering the topics on almost all aspects of metals. Not only the environment-related topics, but also the topics covering the general aspects of metals such as nature and classification, uses and production, metals as micronutrients and metal interaction with microbes have been included in the book. Topics dealing with the surveys on metal pollution, recycling and recovery, and treatment and disposal have been dealt with in detail. The environmental test procedures and bioassays with metals have also found a place in the book.

Khitoliya RK (2005)
Environment Protection and The Law
New Delhi: A.P.H. Publishing Corporation
ISBN: 8176487961

It is widely felt that proper legislative measure enacted and implemented in time, can save the earth from environmental disaster. The need for environmental protection is an area that has been at the forefront of social concern during the last three decades globally. What is needed is balance between development and environment. An integration of the environment and development is required at the policy planning and management level. The problems of environmental degradation are addressed and emphasis on the need for legal instrument to protect the same has been attempted. The important judicial pronouncements have also been added besides role of people's participation. Important constitutional provisions relating to protection and improvement of the environment have been discussed in detail and the various aspects of environment have been narrated at length. The book integrates the various aspects of environmental pollution control to tackle environmental problems for achieving sustainable development. The relevant conference, summit, rules, and acts are also included in appendices.

Kishore J (2006)
National Health Programs of India: National Policies & Legislations Related to Health
New Delhi: Century Publications
ISBN: 8188132152

This book is first of its kind intended to fulfill the long felt need of providing information about national programs, policies, and legislation related to health at one

place. It is a tribute not only to the vibrancy of the type of health program management but also to the volume and quality of recent academic research on public health interventions that this book has to be so thoroughly revised and updated within a short period of time. There are many significant changes in government approach in relation to public health since the beginning of this new century. As public health is a dynamic process so is its information. One can observe a progressive change in the field of Public Health in India. Many new public health institutions are coming up. New goals and targets are set in various policies, programs, and legislations by the government. India is making a presence globally and targets are set in various policies, programs, and legislation by the government. India is making a presence in the global market and taking part in globalization. Each chapter of this popular book provides current and concise coverage of a wide range of programs, policies, and legislations related to health. Its presentation offers a great opportunity to learn about public health delivery by the government and to practice preventive and social medicine in the community. The book has all the facts one needs to know about health programs in India. It is a unique book providing valuable updated information useful for undergraduate, postgraduate medical, nursing and social science students, public health experts, policy makers, project officers, and social workers.

Krishna V (2005)
Forensic Medicine and Toxicology: Principles and Practice, 3rd Edition
Elsevier
ISBN: 81-8147-568-2

Kulkarni VS, Kaul SN, Trivedy RK (2002)
A Handbook of Environment Impact Assessment
Jodhpur: Scientific Publishers
ISBN: 81-7233-299-8

Kumar R (1987)
Environmental Pollution and Health Hazards in India
New Delhi: Ashish Publishing House

Kumar A (1999)
Environmental Problems, Protection and Control (2 Volumes)
New Delhi: Anmol Publications Pvt. Ltd.
ISBN: 8126103558
Vol. 1: Environmental Concept (ISBN: 8126103566); Vol. 2: Environmental Problems, Protection and Control (ISBN: 8126103574).

Kumar R (2000)
Environmental Chemical Hazards
New Delhi: Sarup & Sons
ISBN: 8176251267

The study of environmental chemical hazards in the recent past has gained tremendous importance because of their dangerous dimensions and occurs largely by the activities of man. This book is a serious attempt to cover most aspects of environmental chemical hazards. Every chapter included in this book is self sufficient and well explained with a number of diagrams and case studies, selected from different countries. An effort has been made to describe each chapter in light of newer developments in a simple language and elegant style. This book may serve as a ready reference for all environmentalists including students of environmental science, regulatory pollution control authorities, city planners, health technicians, agriculture scientists, government departments, and industries.

Kumar A (Ed.), Goel PK (2000)
Industry, Environment and Pollution
Jaipur: ABD Publishers
ISBN: 8185771073

Kumar H (2001)
Environmental Health Hazards
New Delhi: Ivy Publishing House
ISBN: 8178900092

Kumar A (2004)
Environmental Contamination and Bioreclamation
New Delhi: APH
ISBN 81-7648-587-X

The growing population and relentless marches towards development have forced man towards urbanization and industrialization. With the mushrooming of industrial concerns over many years, the concentrations of different pollutants in various ecosystems have increased, causing eco-degradation. Most of the water bodies have been thoughtlessly used for the disposal of wastes as a dustbin far beyond assimilative capacities and they have been grossly polluted. The waste, which is posing a serious ecological problem, could be gainfully used for agriculture as well as aquaculture. Bioreclamation strategy must be used for sustainable development and to conserve the non-renewable resources for future generations.

Kumar A (Ed.) (2005)
Environment and Toxicology
New Delhi: A.P.H. Publishing Corporation
ISBN: 8176489174

Untoward effects of any substance in the environment, including drug toxicities or poisoning whether as a

consequence of internal or external exposure and relating to both immediate and long-term implications in the realm of human ecology, or to transformation which leads to an understanding of the mechanisms through which toxic manifestations arise and to the means for alleviation and control of toxic effects. Toxicology is one of the several multidisciplinary fields of Environmental Science. Many of these fields are overlapping, as many of the things that they derive from other disciplines are common to them. The present book, entitled 'Environment and toxicology', is the unique compilation of the most innovative research articles of eminent environmental scientists of India which will be helpful for post-graduate students, research scholars, academicians, and also for other people who are engaged in the field of Environmental Toxicology.

Kumar A (Ed.) (2006)
Heavy Metal Pollution Research: Recent Advances
New Delhi: Daya Publishing House
ISBN: 8170353855

Some 65 of the known 92 elements are metallic in nature. The term 'metal' designates an element that is a good conductor of electricity whose electrical resistance is directly proportion to absolute 0 T. In addition, metals share some distinctive characteristics such as high thermal conductivity and high density. Metallic elements are intrinsic components of the environment. Some 19 heavy metals of the known 65 metals are toxic in nature and are a great threat to the living as well as non-living world, and so man is no exception. Actually toxic heavy metals are present at $<0.1\%$ levels in the earth's crust but anthropogenic activities such as smelting and mining of ores, releasing industrial wastes, use of metallic compounds in industries and in the production of vehicles and airplanes have released a large number of toxic metals and their salts into the environment. So, dispersion of heavy metals into the environment has become a most challenging problem. If proper management and mass awakening right from grass-root level to top policy makers have not been considered inevitable within time, no force on this earth can check the propagation of carcinogenic characters of the heavy metals. This book will be helpful in solving the crux of heavy metal pollution; as it is a compilation of the most advanced research articles of the scientists of repute in the concerned field. Besides, the book will be very helpful for the students, research scholars, professors, scientists as well as for those who have an interest in toxicology.

Kumar A (Ed.) (2006)
Industrial Pollution: Problems and Solutions
New Delhi: Daya Publishing House
ISBN: 8170353750

The storm of modernization and industrialization has not only uprooted man but has also destroyed his habitat and environment. The increase in discharge of carbon dioxide and other pollutants from various industries is as sharp as the decrease in release of oxygen by plants as a result of which the bioequilibrium maintained since time immemorial has been affected. So, industrial pollution has become a great threat for the generations to come. So, it is the prime duty of we scientists to explore the quantum of pollution load as well as to devise certain strategies and technologies so that our sustainable development would not be jeopardized otherwise our long-cherished dream of establishing eco-socialism on this watery planet could not come true. The present book entitled 'Industrial Pollution: Problems and Solutions' is a unique collection of advanced research papers of eminent environmental scientists which will be very helpful for students, research scholars, professors, scientists, and policy makers for assessment of industrial pollution load and to devise the know-how by which it can be solved.

Malhotra S (2004)
Air Pollution and Its Control
Jaipur: Pointer Publishers
ISBN: 8171323871

Air pollution has been growing since the Industrial Revolution. Rapid industrialization, burgeoning cities, and greater dependence on fossil fuels have brought in their wake increased production of harmful pollutants, making life more and more unpleasant and unhealthy. Among the most common and virulent of air pollutants are sulfur dioxide, suspended particulate matter, nitrogen oxides, carbon monoxide and lead. In addition, there is evidence of a growing threat to human health from even indoor pollutants such as radons, formaldehyde, mercury and organic substances. To this end, this book is timely and appropriate as it focuses attention on most of the factors that are causing havoc in the present day to the sustainability of Earth. Various methods and techniques of air pollution and its control are also discussed. This book will be useful for students of Environmental Sciences, Life Sciences, Environmental Engineering and also researchers and teachers.

Markandva A, Murty MN (2000)
Cleaning-Up the Ganges: A Cost–Benefit Analysis of the Ganga Action Plan
Oxford University Press: New Delhi
ISBN 019564945-1

Mishra KD (2003)
Ecology of Polluted Waters and Toxicology
Jaipur: ABD Publication
ISBN 81-85771-60-X

This book contains 25 research articles and reviews on different aspects of ecology of polluted waters, both lentic and lotic water bodies, and toxicity of pollutants to fish and other aquatic organisms. Keeping in view the multidisciplinary nature of the subject, diverse areas of research have been covered including environmental impact assessment, river pollution, plankton diversity, impact of pollution on aquatic macrophytes and bank vegetation, heavy metal pollution, toxicity of insecticides, herbicides, fungicides, metals, etc. to fish, tadpoles, prawn, and other aquatic organisms.

'The book shall be of great help to the teachers, researchers, and post graduate students in the field of limnology, ichthyology, environmental science, botany, zoology, environmental chemistry and toxicology as a reference book.' (jacket).

Pande GC, Pande DC (Eds.) (1999)
Environmental Development and Management: Strategies and Policies
New Delhi: Anmol Publications Pvt. Ltd
ISBN: 812610211X

'Environmental Development and Management: Strategies and Policies' is indeed a novel addition to the existing literature on the wider dimensions of the burning problem. It is an outcome of extensive research work by many collaborating experts in this field; and gathering, examining and analyzing the data of observations on varying dimensions from different parts of the globe. It is a timely, up-to-date and rigorously selective collection of precisely relevant original and field-based observations, analytical conceptual discussions, and well-documented scientific papers of experts, veterans in academics and scientists of wider recognition. A really vast profile of the extensive subject matter is spread over the broad five parts. The first part, 'Environmental Concepts: Options and Strategies' consists of a few chosen and nicely edited papers on nature, dimensions, depth of crisis, consciousness, awareness, space informatics and condensed backdrop of the environmental debate during 20th century and its status at the beginning of 21st century. Part Two and Part Three constitute the heart of the volume wherein scientists have investigated the levels of pollution and scaled the threat to human survival. Each major aspect of ecological deterioration and source of pollution has been carefully examined and every dimension has received a very lucid treatment. Similarly different strategies and methods of agro-forest resource management in different parts of the globe have been discussed at length, dressed with facts and palpitating with life. Parts Four and Five comprise very interesting discussions on diagnosis of the impact of ecological degradation on habitat, society and the economy. These parts present the prognostic and prescriptive options of environmental management.

Pillay VV (2003)
Comprehensive Medical Toxicology
Hyderabad: Paras Medical Publisher
ISBN: 81-88129-86-0

Pillay VV (2004)
Textbook of Forensic Medicine and Toxicology, 2nd Edition
Hyderabad: Paras Publishing
ISBN: 8181910311

Prabhakar VK (2001)
Toxic and Hazardous Chemicals
New Delhi: Anmol Publications Pvt. Ltd
ISBN: 8126109327

Raghavan S (2005)
India's Environmental Policy
New Delhi: Omsons Publications
ISBN: 8171172261

The book tries to analyze India's reference to marine environment. India with its long coastline and 25% of its population living in the coastal areas has been a party to many international conventions to protect the marine and coastal environment over the past two decades. India has attempted to provide some constructive leadership on international environment policy. Among South Asian nations, India, particularly has taken the cognizance of the dangers inherent in growing ecological deterioration and has taken steps to initiate measures at national as well as international levels to arrest, reduce, and rectify marine pollution.

Ramamoorthy S, Ramamoorthy R (1995)
Handbook of Chemical Toxicity Profiles of Biological Species
CRC Press
ISBN: 1566700140

The two volumes comprising this new handbook provide a unique resource for studies involving toxicity profiles in aquatic, avian, and mammalian species. The arrangement of material in alphabetical order by species allows the reader straightforward access to information on the effects of chemicals on various life forms. For each group of species, the acute and chronic (short- and long-term) toxicity data are arranged in descending order, enabling the reader to evaluate the relative toxicity of chemicals for any given species.

This arrangement of data also indicates the relative importance of exposure routes. Toxicity profiles include LC_{50} values, cancer indices, and Virtually Safe Doses (VSDs) and are provided for each organ. In addition, the Handbook provides important comparisons of identical toxicity testing methods and duration of exposure (e.g., LC5096h) to arrive at a ratio. The ambient concentration and its ratio to the toxic level will assist in selecting the cut-off chemical. This approach helps the reader to maximize the use of resources and to generate data that are specifically relevant to the species and ecosystem under study. The species-specific approach in the 'Handbook of Chemical Toxicity Profiles of Biological Species' makes it a powerful tool for a wide range of studies. It may be used, for example, in evaluating the status of endangered or other species, making impact assessments, developing regulatory controls, and determining important areas for future research.

Satake M (1997)
Environmental Toxicology
New Delhi: Discovery Publishing House

Shafi SM (2005)
Environmental Pollution
New Delhi: Atlantic Publishers & Distributors
ISBN: 812690366X

This book is the outcome of intensive efforts made by the author for more than 7 years in collection of materials, their recasting to suit own scheme of requirement and also incorporating new research findings from reputed researchers on environmental pollution in the book. The book has been styled to cover the requirements of University syllabus for the graduate (Honours) and postgraduate students of various universities. The book covers major aspects of the environment: air pollution, water pollution by physical agents (causing radioactive pollution, thermal pollution, sound pollution). Under the umbrella of these four major aspects a great deal of valuable information has been given on many topics including particulate pollutants, problems of aerosol accumulation, role of aerosol in photochemical pollution, phenomenon of acid rain and its effects, problem of ozone depletion, uses and destructive role of chlorofluorocarbons, causes of global warming, and role of some air-borne organisms as biopollutants. These items represent the main segments of atmospheric pollution. Likewise, matters on industrial pollutions, particularly sewage and some other biodegradable wastes, role of infectious agents in water to spread diseases, production of excess of plant nutrients in water, organic chemicals of exotic sources, inorganic chemicals in water, agricultural solid wastes, sediments, coastal pollution/oil pollutions, etc., represent main instances of water pollution. The information on the effects of pollutants on human health, animal health, plants, materials and properties are of general public interest and introduction of legal steps for controlling pollution carry additional significance.

Shrivastava AK (2004)
Encyclopaedia of Environmental Pollution, Agriculture and Health Hazards
New Delhi
ISBN 81-7648-594-2.

Singh VP (2005)
Metal Toxicity and Tolerance in Plants and Animals
New Delhi: Sarup & Sons
ISBN: 8176255874

Many heavy metals are essential for plants and animals when present in growing medium in low concentrations; they become toxic only when a concentration limit is exceeded. The toxic metal phytotoxicity has been known for more than a century. However, the interest in this field has been developed only recently. The capacity of the plants to survive on soils that contain high concentrations of certain toxic metals has fascinated ecologists and plant physiologists for decades. This book is very useful to those who are interested in toxic metals and their interaction with plants, particularly students and teachers of plant physiology, ecophysiology, molecular biology, and environmental science.

Singh VP (2005)
Toxic Metals and Environmental Issues
New Delhi: Sarup & Sons
ISBN: 8176255491

The book is the outcome of the work that has been done during the last three decades on toxic metals in soil–plant systems. Toxic metal problems are universal and the situation in developing countries is worse and unimaginable. In this book the author has taken some important toxic metals of the environment, which are of more concern to humans. Their occurrence, contaminations, effects on health hazards, and environmental issues are very well described. The book gives a very concise, integrated, and updated account of phytotoxicity, tolerance, detoxification, and phytoremediation of toxic metals in soil–plant–animal system. The book provides the most comprehensive information to readers, students, and researchers who are working in environment.

Sinha PC (1998)
Environmental Policies
New Delhi: Anmol Publications Pvt. Ltd.
ISBN: 8174889531

Sinha PC (2004)
Toxic and Hazardous Wastes
New Delhi: Anmol Publications Pvt. Ltd.
ISBN: 8174889655

Sinha PC (Ed.) (2006)
Hazardous Wastes, Organic Pollutants and Prior Informed Consent: Global Environmental Law, Policy and Action Plan Series
New Delhi: SBS Publishing
ISBN 81-89741-35-7

This book deals with the international guidelines related to hazardous wasted, organic pollutants and their movements to various areas by different ways and means, provides readers with an integrated understanding of the global environmental regimes for hazardous wastes and organic pollutants. The basal convention on the control of transboundary moments of hazardous wastes and their disposal, which aims to prevent the unauthorized dumping of toxic waste in developing countries, has been covered in detail with sufficient case studies. The Rotterdam convention on prior informed consent hazardous chemicals in international trade is discussed to elaborate upon the mechanism for the import of such chemicals. In addition, the Stockholm convention on persistent organic pollutants is presented to elaborate upon the guidelines to eliminate the global use of such nominated chemicals. The agenda 21 action plan in this regard is also elaborately covered.

Sood A (1999)
Toxicology
ISBN 81-7625-078-3

In the recent past the field of 'Toxicology' has undergone a veritable revolution. The present title is being compiled to include the numerous new concepts on this field. Each concept included in this book is self-sufficient. Further, a sincere effort has been made to represent each concept in this book in a clear and explanatory straightforward style. This approach combined with an extensive cross-referencing system helps the reader to place each concept into a broader modern scientific context. Many structural formulae have been included whenever the meaning of a concept can be best conveyed by means of a structural formula. It is presumed that the reader is readily familiar with the basic concepts in chemistry, biology, science, etc.

Talwar P (Ed.) (2006)
Environmental Management
New Delhi: Isha Books
ISBN: 8182053412

The objective of environmental management is improved human life quality. It involves the mobilization of resources and the use of government to administer the use of both natural and economic goods and services. It is based on the principles of ecology. In the complex and interdependent world that we have been given, environmental management is required because the activities of development in one sector affect in both positive and negative ways the quality of life in others. Designed as a guide to hands-on, day-to-day environmental management, this book covers the nuts and bolts of effective environmental management. It provides a through introduction to those new to the field or to the environmental specialists who need a thought-provoking refresher. It will enable the students to gain a practical understanding of environmental hazards, controlling air and water pollution, managing hazardous wastes, implementing pollution prevention programs, dealing with compliance audits and regulatory inspections, and much more.

Thukral AK, Virk GS (2000)
Environmental Protection
Jodhpur: Scientific Publishers
ISBN 81-7233-258-0

'Environmental Protection' presents articles on the state of environment, pollution control, and biodiversity conservation by eminent teachers and scientists. The book will be useful for postgraduate students in life sciences, botany, zoology, microbiology, genetics, and environmental sciences. The researchers will find information on recent trends in environmental research.

Vohora SB, Agrawal VP (Eds.) (1999)
Toxicology and Environmental Health, Proceedings of a National Symposium
New Delhi: Asiatic Publishing House

Journals

Abstracts on Current Literature in Toxicology
Library & TIC, ITRC

Acta Ecologica
International Society for Environmental Science
594-A Talvandi
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Anil Aggrawal's Internet Journal of Forensic Medicine and Toxicology
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New Delhi-110 062

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Society of Natural Science
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DAV College
Gorakhpur-273 001

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Indian Drugs is a well-known Scientific and Research journal published by IDMA on the 28th day of every month for the past 39 years. IDMA seeks to promote original research in India in pharmaceutical sciences and in all major fields that fall within its ambit, through this reputed publication. Original Research Papers, Review Articles, Short Notes in five broad disciplines: Pharmaceutics, Pharmacology, Pharmaceutical Analysis, Pharmaceutical Chemistry, and Pharmacognosy & Phytochemistry are published from all over India and from many countries abroad after scrutiny by the Editorial Advisory Board.

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60, Nehru Place
New Delhi-110 019

Indian Journal of Chemical Technology
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Indian Journal of Chemical Technology has established itself as the leading journal in the exciting field of chemical engineering and technology. It is intended for rapid communication of knowledge and experience to engineers and scientists working in the area of research development or practical application of chemical technology. This bimonthly journal includes novel and original research findings as well as reviews in the areas related to – Chemical Engineering, Catalysis, Leather Processing, Polymerization, Membrane Separation, Pharmaceuticals and Drugs, Agrochemicals, Reaction Engineering, Biochemical Engineering, Petroleum Technology, Corrosion & Metallurgy and Applied Chemistry. Educator & Chem-Tech Scan are two recent additions to the journal. Chem-Tech scan highlights new researches and technology developments, patents granted and technology offers in the field of chemical technology.

Indian Journal of Chemistry
ISSN: 0376-4699

Indian Journal of Chemistry (Section B) is a leading monthly journal in Organic and Medicinal Chemistry started publishing from 1976. It publishes papers on organic reaction mechanisms, theoretical organic chemistry, structure–activity relationships, medicinal chemistry, synthesis of chiral compounds, bio-organic chemistry, enzymes in organic synthesis, reagents in organic synthesis, heterocyclic compounds, phytochemistry (natural products), amino acids, peptides and proteins, spectroscopy in characterization of organic compounds, chemoenzymatic and enantioselective synthesis of organic compounds, synthesis of fullerenes, metal-catalyzed asymmetric reactions, bioactive plant products and combinatorial chemistry. Apart from full-length papers, notes and communications, the journal publishes short reviews on frontline areas under the column 'Advances in Contemporary Research'.

Indian Journal of Clinical Biochemistry (IJCB)
ISSN (printed): 0970-1915
Published by Association of Clinical Biochemistry of India

Indian Journal of Clinical Biochemistry (IJCB) is a biannual (January and July) publication of the Association of Clinical Biochemistry of India (ACBI). It covers the research areas in the fields of Clinical Biochemistry, Pathological, Microbiological, Molecular, Cellular, Genetic and Bioinformatic concepts and other advanced techniques. The journal primary mission is to serve the public interest in health care by providing leadership in clinical laboratory science to national professional societies, the diagnostics industry, government and non-government organizations. This journal also acts as a bridge in various interdisciplinary areas of medicine. It covers laboratory accrediation programs pertaining to health and disease.

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IJCM is a peer-reviewed journal, which covers a broad range of disciplines related to Community Medicine. It is published four times a year and includes invited editorial commentaries on topical issues; state of the art reviews, original research articles, brief reports, letters to editor, and book reviews.

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Indian Journal of Experimental Biology
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This journal, started in 1963, publishes full papers, notes and reviews in cell biology, molecular biology, genetic engineering, endocrinology, reproductive biology, immunology, developmental biology, comparative physiology, radiation biology, chronobiology, microbiology, pharmacology, toxicology and other biological fields including instrumentation and methodology. The papers having experimental design involving alteration and/or manipulation in biological system(s) providing insight into their functioning are considered for publication. Studies involving higher animals, human beings and of clinical nature are not encouraged for publication in the journal. Review articles in frontier areas of contemporary relevance are also published.

Indian Journal of Experimental Biology website (full text articles not currently available online)
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Indian Journal of Medical Ethics (formerly *Issues in Medical Ethics*) is a platform for discussion on healthcare ethics with special reference to the problems of developing countries like India. It hopes to involve all cadres of, and beneficiaries from, this system, and

strengthen the hands of those with ethical values and concern for the under-privileged.

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The *Indian Journal of Medical Research* (IJMR) is a biomedical journal with international circulation. It publishes original communications of biomedical research that advances or illuminates medical science or that educates the journal readers. It is issued monthly, in two volumes per year.

Indian Journal of Medical Research website (full text articles available online)
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Indian Journal of Medical Sciences is a monthly journal published as a medium for the advancement of scientific knowledge in all the branches of medicine and allied sciences and publication of scientific investigation in these fields. It is also indented to present this as a form suitable to the general practitioner and primary care physician. The journal is owned by the Indian Journal of Medical Sciences Trust, a registered charitable organization and published by Medknow Publications, Mumbai, India.

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November 2004 – The AIMS Department of Analytical Toxicology has initiated the creation of the Indian Society of Toxicology, registered under the Travancore-Kochi Literacy, Scientific & Charitable Societies. The aim of the society is to encourage the study, improve the practice, elevate the standard, and advance the cause of Toxicology. In January 2005, the society released the inaugural issue of its journal, *The Journal of the Indian Society of Toxicology*. It is a high-caliber peer-reviewed journal dedicated to toxicology. Articles will be accepted for publication only from members of IST (article submission guidelines).

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The *Journal, Indian Academy of Clinical Medicine* (JIACM) is the official publication of academic wing of Indian Association of Clinical Medicine. The Journal has been published regularly since 1998. The Journal is striving hard to keep the art and science of clinical medicine alive and kicking. The Journal has various sections such as review articles, update articles, PG clinics, editor's choice, original articles, short communications, etc. However, they encourage the inclusion of as many case reports as possible. The emphasis is on is on pictorial CME, PG clinics and articles on different clinical signs.

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Medical Journal Armed Forces India
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This journal was conceived in 1945 as the *Journal of Indian Army Medical Corps*. Col Dr. Thapar was the first Editor who published it on behalf of Lt. Gen Gordon Wilson, the then Director of Medical Services in India. Over the years the journal has achieved various milestones. Presently it is published in Vancouver style, printed on offset, and has a distribution exceeding 5000 per issue. It is published in January, April, July, and October each year. MJAFI is now indexed/abstracted by ExtraMED, Index Medicus for South East Asia, International Abstracts of Biological Sciences, Abstracts of World Medicine, IndMED, Hygiene and Tropical Disease Abstracts and EMBASE and is exchanged with Armed Forces Medical Publications of nine countries. The journal accepts original articles, contemporary issues, review articles, drug update, quizzes, case reports, letters, journal scans, and book reviews for publication. Approximately 20 articles are published in each issue, besides permanent features like guest column, editorial, 25 MCQs, an article on medical emergency and medical philately. Both civilian and military personnel can contribute articles for publication.

Medical Journal Armed Forces India website (full text articles available online)
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Online Journal of Health and Allied Sciences
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Pesticide Information (new name *Crop Care*)
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Department of Agricultural Research and Education (DARE)
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Web: http://www.dare.gov.in/hindi.htm (Hindi)

Indian Council of Agricultural Research (ICAR)
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National Research Centre for Women in Agriculture (NRCWA)
Web: http://www.nrcwa.org
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Ministry of Coal and Mines
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Web: http://mines.nic.in

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Web: http://nimh.gov.in

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Ministry of Environment and Forest
Web: http://envfor.nic.in
Web: http://envfor.nic.in/hindi/hwelcome.html (Hindi)
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Biological Diversity (BD)
Web: http://sdnp.delhi.nic.in/resources/biodiv/biodiv-frame.html

Central Pollution Control Board (CPCB), Delhi
Web: http://www.cpcb.nic.in/
Web: http://www.cpcb.nic.in/hindi/index.htm (Hindi)

Control of Pollution (CP)
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Email: secy@menf.delhi.nic.in

Environment Education (EE)
Web: http://envfor.nic.in/divisions/ee/ee.html

Environment Research (RE)
Web: http://envfor.nic.in/divisions/re/rediv.htm

Environmental Impact Assessment (IA)
Web: http://envfor.nic.in/divisions/iass/iass.html
Email: secy@menf.delhi.nic.in

Environmental Information (EI)
Web: http://envfor.nic.in/divisions/eidivision.htm
Email: dbandyo@nic.in

Environmental Information System (ENVIS)
Web: http://envfor.nic.in/envis/envis.html

Hazardous Substances Management (HSM)
Web: http://envfor.nic.in/divisions/hsmd/hsmd.html
Phone: +91-11-2436 0060
Email: nhosabettu@yahoo.co.uk

National Hazardous Waste Information System (NHWIS)
Web: http://164.100.194.13/servlet/welcome

Policy & Law (PL)
Web: http://envfor.nic.in/divisions/policy.html
Email: secy@menf.delhi.nic.in

Protocol on Biosafety (PB)
Web: http://envfor.nic.in/mef/cpbio-div.html

Ministry of Health and Family Welfare
Web: http://mohfw.nic.in

Central Drug Research Institute (CDRI)
Web: http://www.cdriindia.org/home.asp

Department of Family Welfare
Web: http://mohfw.nic.in/dofw%20website/dofw.htm

Department of Health
Web: http://www.mohfw.nic.in/depth.htm

Desert Medicine Research Centre Jodhpur
Web: http://www.icmr.nic.in/pinstitute/jodhpur.htm

Indian Council of Medical Research
Web: http://www.icmr.nic.in
V. Ramalingaswami Bhawan
Ansari Nagar
New Delhi 110 029
Phone: 26588895, 26588980, 26589794, 26589336, 26588707
Fax: 26588662, 26588713
Email: headquarters@icmr.org.in/icmrhqds@sansad.nic.in

Associate institutes
Food and Drug Toxicology Research Centre (FDTRC)
Web: http://www.ninindia.org/fdtrc.htm

Genetic Research Centre
Web: http://icmr.nic.in/pinstitute/grc/grc.htm
Institute of Pathology (IOP)
Web: http://www.icmr.nic.in/pinstitute/iop.htm
Safdarjang Hospital Campus
P.O. Box 4909
New Delhi 110 029
Phone: 91-11-26198402, 26198405
Fax: 91-11-26198401

Institute of Research in Medical Statistics (IRMS)
Web: http://www.icmr.nic.in/000134/irms.htm

National Institute of Medical Statistics (Indian Council of Medical Research)
Ansari Nagar
New Delhi 110029
Phone: 26588900, 26588904

L.R.S. Institute of Tuberculosis and Respiratory Diseases
Web: http://lrsitbrd.nic.in/Index.htm
Sri Aurobindo Marg
New Delhi 110 030
Phone: 26517827, 26517829, 26517830, 26854929, 26854922, 26855094

National Institute of Malaria Research (formerly known as Malaria Research Centre)
Web: http://www.mrcindia.org
(ICMR) 22 Sham Nath Marg
Delhi 110 054

National Institute of Epidemiology (NIE) (Indian Council of Medical Research)
Web: http://www.nieicmr.org
P.O. Box 2577
Mayor V.R. Ramanathan Road
Chetput, Chennai 600 031
Phone: 91-44-283 61642, 2836 2308/2836 2285
Fax: 91-44-2836 0663

National Institute of Nutrition (NIN)
Web: http://www.ninindia.org/
Jamai-Osmania PO
Hyderabad 500 007

National Institute of Occupational Health (NIOH)
Web: http://www.nioh.org
Meghani Nagar
Ahmedabad 380016
Phone: 91-79-22686351-59, 22686359
Fax: 91-79-2266110, 22686361

National Institute for Research in Reproductive Health (NIRRH)
Web: http://www.icmr.nic.in/pinstitute/irr.htm
Jehangir Merwanji Street
Parel

Mumbai 400 012
Phone: 91-22-24137730,24164683
Fax: 91-22-24139412
E-mail address: vichin@bom4.vsnl.net.in
Email: dirirr@vsnl.com

Rajendra Memorial Research Institute of Medical Sciences (RMRIMS)
Web: http://www.rmrims.org.in
Agamkuan, Patna
Bihar 800 007
Phone: (0612) 2631565, 2631561, 2636651, 2635570, 2635456 Fax: (0612) 2634379
Email: rmrims@rmrims.org.in, dirrmris@sancharnet.in

National Institute of Health & Family Welfare (NIHFW)
Web: http://www.nihfw.org
Munirka
New Delhi 110 067
Phone: 91-11-2616 5959, 91-11-2616 6441, 91-11-2618 8485, 91-11-2610 7773
Fax: 91-11-2610 1623
Email: info@nihfw.org
Web: www.nihfw.org
Gram: SWASTH PARIVAR

Regional Medical Research Centre
Regional Medical Research Centre Belgaum
Web: http://www.icmr.nic.in/rmrc.htm#belgaum
National Highway No. 4
Belgaum 590010

Regional Medical Research Centre Bhubaneswar
Web: http://www.icmr.nic.in/rmrc.htm#bhubaneswar
Chandrasekharpur
Nandankanan Road
Bhubaneswar 751 016
Phone: 91-674-2301322
Fax: 91-674-2301351
Grams: Medicare
Email: icmrrcbh@ren.nic.in

Regional Medical Research Centre Dibrugarh
Web: http://www.icmr.nic.in/rmrc.htm#dibrugarh
P.O. Box 105
Dibrugarh 786 001
Phone: 91-373-2381494
Fax: 91-373-2381746
Gram: REMRES
Email: icmrrcdi@ren.nic.in

Regional Medical Research Centre Jabalpur
Web: http://www.icmr.nic.in/rmrc.htm#jabalpur
R.M.R.C. Complex
Nagpur Road
P.O. Garha
Jabalpur 482 003
Phone: 91-761-2370239
Fax: 91-761-2370935
Gram: TRIBHEALTH
Email: icmrrcja@ren.nic.in

Regional Medical Research Centre Port Blair
Web: http://www.icmr.nic.in/rmrcpb/index.htm
Post Bag No. 13
Port Blair 744 101
Andaman & Nicobar Islands

Desert Medical Research Centre
Web: http://www.icmr.nic.in/rmrc.htm#jodhpur
P.O. Box 122
New Pali Road
Jodhpur 342 005
Phone: 91-291-2721022
Fax: 91-291-2721022
Email: icmrdmrc@ren.nic.in, rcsharma@dmrcjodhpur.org

Ministry of Labour and Employment
Web: http://labour.gov.in

Central Labour Institute
Email: cli@dgfasli.nic.in

Directorate General Factory Advice Service & Labour Institute
Web: http://dgfasli.nic.in/welcome.html
Ministry of Labour, Government of India,
Sion
Mumbai 400 022
Phone: PABX 91-22-4092203
Fax: 91-22-4071986
Email: fasli@dgfasli.nic.in

Directorate General of Mines Safety, Dhanbad
Web: http://www.dgms.net
Dhanbad 826 001

Labour Bureau
Web: http://labourbureau.gov.in
Labour Bureau, Ministry of Labour and Employment
Government of India
SCO 28-31, Sector 17-A
Chandigarh 160 017
Phone: 91-172-2703038, 2702974,
Fax: 91-172-2703961, 2704611

Ministry of Science and Technology
Web: http://mst.nic.in

Department of Biotechnology (DBT)
Web: http://dbtindia.nic.in

Department of Biotechnology
Ministry of Science and Technology

Block 2, 7th Floor
CGO Complex
Lodhi Road
New Delhi 110 003
Email: madhan@dbt.nic.in

Department of Science and Technology (DST)
Web: http://dst.gov.in
New Delhi 110 016
Phone: +91-11-26567373, 26962819
Fax: +91-11-26864570, 26862418
Email: dstinfo@nic.in

Department of Scientific and Industrial Research (DSIR)
Web: http://dsir.nic.in
Ministry of Science & Technology
Government of India
Technology Bhavan, New Mehrauli Road
New Delhi 110 016
Phone: 23717063, 23710472
Fax: +91 11 23710618
Email: dgcsir@csir.res.in

Autonomous S & T Institutions
Web: http://dst.gov.in/autonomous/autonomous_index.htm

Professional Bodies
Web: http://dst.gov.in/professional_bodies/professional-index.htm

Autonomous Body
Council of Scientific and Industrial Research (CSIR)
Web: http://www.csir.res.in
Web: http://csirhrdg.res.in
Anusandhan Bhawan, 2 Rafi Marg
New Delhi 110 001

National Laboratories/Institutes of CSIR
Central Drug Research Institute (CDRI)
Web: http://www.cdriindia.org
Chattar Manzil Palace, Post Box No. 173
Lucknow 226 001

Central Mining Research Institute (CMRI)
Web: http://cmriindia.nic.in
Director
Central Mining Research Institute,
Barwa Road
Dhanbad 826001
Phone: 91-326-2202326, 2203043, 2203070, 2203090, 2203010
Fax: 91-326 2202429
Email: dcmrips@yahoo.co.in/ director@cmri.nic.in
Gram: MINSEARCH, DHANBAD

Centre for Cellular and Molecular Biology (CCMB)
Web: http://www.ccmb.res.in/
Uppal Road
Hyderabad 500 007

Indian Institute of Chemical Biology (IICB)
Web: http://www.iicb.res.in/
Kolkata 700 032

Indian Institute of Chemical Technology (IICT)
Web: http://www.iictindia.org/
Hyderabad 500 007

Indian National Scientific Documentation Centre, New Delhi
Web: http://sunsite.tus.ac.jp/asia/india/jitnet/flash/insdoc.html

Industrial Toxicology Research Centre (ITRC)
Web: http://www.itrcindia.org/
http://www.itrcindia.org/hindi.html (Hindi)
Post Box No. 80, Mahatma Gandhi Marg
Lucknow 226 001
Phone (Director's Office): +91-522-2621856, 2628227 2613357
Phone (EPBAX, M.G. Marg Campus): +91-522-2627586, 2613786
Phone (EPBAX, Gheru Campus): +91-522-2436144, 2436151
Fax: +91-522-2628227, 2611547
Email: director@itrcindia.org

Institute of Life Sciences
Web: www.ils.res.in
Nalco Square, Chandrasekharpur
Bhubaneswar 751 023
Phone: 91-0674-2301900, 2300137, 2301460, 2301476, 2300129
Fax: (0674) 2300728
Email: bbmishra3@yahoo.com

National Chemical Laboratory
Web: http://www.ncl-india.org
Web: http://www.ncl-india.org/nclhindi/index.htm (Hindi)
Dr. Homi Bhabha Road
Pune 411 008
EPABX: +91(0)20-25902000, 25893400;
Fax: +91(0)20-25902601
Gram: CHEMISTRY, PUNE

National Environmental Engineering Research Institute (NEERI)
Web: http://neeri.res.in
Nehru Marg
Nagpur 440 020
Phone: 091-0712-2249886-88, 2249970-72
Fax: 0712-2249900
Email: a_gupta@neeri.res.in

National Institute of Science Communication and Information Resources (NISCAIR)
Web: http://www.niscair.res.in
Web: http://www.niscair.res.in/niscairhindi/home.asp (Hindi)
Dr. K S Krishanan Marg
Pusa Campus
New Delhi 110 012
Phone: 25841647, 25846301
Fax: +11 25847062

Other Science Departments
All India Institute of Medical Sciences
Web: http://www.aiims.ac.in
New Delhi
Phone: 91-11-26588500, 91-11-26589900, 91-11-26588700
Fax: 91-11-26588663, 91-11-26588641

Birla Institute of Technology and Science
Web: http://discovery.bits-pilani.ac.in/index.htm
Vidhya Vihar Campus
Pilani
Rajasthan 333 031
Phone: +91-01596-245073/4
Fax: +91-01596-244183

Centre for DNA Fingerprinting and Diagnostics, Hyderabad
Web: http://www.cdfd.org.in
ECIL Road, Nacharam
Hyderabad 500 076
Phone: +91-40-27151344
Fax: +91-40-27155610

Centre for Scientific Industrial Consultancy
Web: http://www.csic.iisc.ernet.in/
Indian Institute of Science
Bangalore 12
Phone: 080-23340134, 22932516, 22932446
Fax: 080-23314845
Email: chairman@csic.iisc.ernet.in

CSIC provides the interface through which industries and organizations can quickly and effectively gain access to the expertise and facilities of the Institute in the fields of science, technology and management.

Department of Atomic Energy
Web: http://www.dae.gov.in
Government of India
Anushakti Bhavan, Chatrapathi Shivaji Maharaj Marg
Mumbai 400 001
Phone: +91-22-2202 6823/2202 8917/2202 8899/2286 2500
Fax: +91-22-22048476

Environment Protection Training and Research Institute (EPTRI)
Web: http://www.eptri.com
91/4, Gachibowli,
Hyderabad 500 032
Phone: +91-40-23001241, 23001242, 23000489
Fax: +91-40-23000361
Email: info@eptri.com

Environmental Training Institute
Web: http://www.tnpcb.gov.in/eti0.html
Tamilnadu Pollution Control Board
III Floor, 100, Mount Salai, Guindy
Chennai 600 032
Phone: Director's Office: 2235 3159
Exchange: 2235 3134-3141
Fax: 22353068
Email: etitnpcb@vsnl.net

Food and Drug Toxicology Research Centre (FDTRC)
Web: http://www.ninindia.org/fdtrc.htm

Indian Institute of Health Management Research (Jaipur)
Web: http://www.iihmr.org
IIHMR 1, Prabhu Dayal Marg, Sanganer Airport,
Jaipur 302 011
Phone: +91-141-2791431–34
Fax: +91-141-2792138
Email: iihmr@iihmr.org

Indian Institute of Remote Sensing
Web: www.iirs-nrsa.gov.in
National Remote Sensing Agency
Dept. of Space, Govt. of India
4, Kalidas Road
Dehradun 248 001
Phone: +91-(0)135-2744518
Fax: +91-(0)135-2741987
Email: tso@iirs.gov.in

Indian Institute of Science
Web: http://www.iisc.ernet.in
Web: http://www.iisc.ernet.in/hindi (Hindi)
The Registrar
Bangalore 560 012
Phone: +91-80-23600757
Telegram: SCIENCE BANGALORE 560 012
Fax: +91-80-2360 0683/0085
Email: regr@admin.iisc.ernet.in

International Institute for Population Sciences
Web: http://www.iipsindia.org/
Govandi Station Road, Deonar
Mumbai 400 088
Phone: 91-22-25563254/55/56 (Ext. 149), 255564883 (Direct)

Fax: 91-22-25563257, 25583778
Email: iipsnfhs@vsnl.com
Jawaharlal Nehru Centre for Advanced Scientific Research Bangalore
Web: http://www.jncasr.ac.in
Web: http://www.jncasr.ac.in/hindi (Hindi)
Jakkur
Bangalore 560 064
Phone: 91-80-22082750
Fax: 91-80-22082766

National Family Health Survey
Web: http://www.nfhsindia.org

National Institute of Communicable Diseases
Web: http://nicd.org
Directorate General of Health Services
Ministry of Health and Family Welfare (GOI)
22, Sham Nath Marg, New Delhi-110 054
Phone: +91-11-23913148, 23946893 (PS To Director)
91-11-23971 272/060/344/524/449/326 (Board Numbers)
Fax: +91-11-23922677
Email: dirnicd@bol.net.in, dirnicd@del3.vsnl.net.in

Science and Engineering Research Council (SERC)
Web: http://www.serc-dst.org
Department of Science & Technology, Technology Bhawan
New Mehrauli Road
New Delhi 110 016
Telefax: 011-6963695
Email: venktesh@alpha.nic.in

Organizations (Non-Government)

ASSIST Andhra Pradesh
Web: http://assist-india.org
J. Ranga Rao
ASSIST, G.T. Road, Chilakaluripet
Guntur 522 616
Andhra Pradesh
Phone: 91 8647 253971
Fax: 91 8647 254815
Email: assistjr@sancharnet.in

ASSIST started its involvement with the issue of child labor. Gradually the involvement broadened to address more fundamental problems in society which have been the root causes of the problem of child labor. Hence even though starting with a child labor rehabilitation program, the process entailed the generation of people's movements on some issues like social housing, sanitation, drinking water, community health, savings, credit, income generation, self-reliance, and ecology encompassing the whole community, region, and district. Disadvantaged social groups such as scheduled tribes, scheduled castes, fishermen, and weavers have emerged as the main target population. In all these target groups the poorest of the poor such as artisans, agricultural laborers, small and marginal farmers, and migratory workers have been a natural option for ASSIST's program intervention.

Bombay Environmental Action Group (BEAG)
Web: http://www.beag.net
Nhava House, 1st Floor, C/o Zoun Business Centre
65, M Karve Marg
Mumbai 400 002
Maharashtra
Phone: +91-22-25700638
Fax: +91-22-25701459

Center for Education, Awareness and Research on Chemicals and Health (CEARCH)
Web: http://www.cearch.in
Dr. Aruna Dewan
236, Supath II Complex
Vadaj
Ahmedabad 380013
Gujarat
Phone:+91-792562 1421,+91-932791 7833, +91-982404 7400
Email: adewan@cearch.in, dewanaruna@yahoo.com

CEARCH has been established to create awareness about the acute and chronic health effects of toxic chemicals (pesticides, industrial and household chemicals, air pollutants, persistent chemicals, etc.); to train medical personnel in managing chemical disasters and chemical exposure-related diseases; to promote environment free from toxic chemicals; to safeguard the health of children and future generations of India.

Center for Occupational and Environmental Health (COEH)
Web: http://health.delhigovt.nic.in/dental/coeh/content.html
Ground floor B L taneja block, Loknayak Hospitals
New Delhi 110002
Phone: 011-3232400 Extension 4395
After Office Hours. 011-5510392, 011-6914943, 011-2230245
Fax: 011-3232870, 011-5507920
Email: joshitk@giasdl01.vsnl.net.in; dr_jugalkishore@hotmail.com

Centre for Environment and Development
Web: http://www.cedindia.org/
Thozhuvankode, Vattiyoorkavu PO

Thiruvananthapuram 695 013
Phone: 0471-2369720, 2369721, 2369722
Fax: 0471-2369720
Email: ceddir@vsnl.com

The major activities include research, development, consultancy and training programs related with Remote Sensing Applications and GIS, Environmental Resource Planning, Water Supply Engineering, Sanitary Engineering, Wetland Ecosystem Management, Biodiversity Conservation and Eco-restoration Programs, Community Action Support Programs, Environmental Policy and Legal Studies, Environmental Impact Assessment Studies, Harbor Modeling Studies, etc.

Centre for Environment Education (CEE)
Web: education.vsnl.com/cee/index.html
Web: envfor.nic.in/cee/cee.html

Centre for Environmental Education (CEE) was set up in 1984 to spread awareness of environmental issues and to try to find solutions for them. It is based at Ahmedabad and they have offices all over the country. They mainly aim to create environmental awareness in the communities. They conduct widespread environmental education and training programs through a very vast network. They have also taken up projects related to conservation of biodiversity and eco-development. Publications and database: They have a vast range of publications – books, posters, educational packages, bibliographies, and directories. There is also a large computerized database – the Environment Education bank, which has a collection of more than 800 environment concepts, about 2500 environment-related activities and 100s of case studies.

Director
Thaltej Tekra
Ahmedabad 380 054
Gujarat

Centre for Science and Environment (CSE)
Web: www.oneworld.org/cse/

The Centre for Science and Environment (CSE) does research, investigative and educational work in the field of pollution, forest, wildlife, land, and water use. The activities are carried out through lectures, field trips, publications, exhibitions on the various issues they take up, meetings, and workshops. Publications: Down to Earth – a fortnightly environment magazine; Children's magazine The Gobar Times; books; reports; computer database; audio visuals, etc.

Director
Centre for Science and Environment (CSE)
41, Institutional Area
Tuglakhabad
New Delhi 110 062

Consumer Education and Research Centre (CERC)
Web: http://www.cercindia.org
'Suraksha Sankool', Thaltej, Sarkhej-Gandhinagar Highway
Ahmedabad-380 054
Phone: 27489945-46, 27450528, 30121001-2-3
Fax: 079 -27489947
Email: cerc@cercindia.org

C.P.R. Environmental Education Centre, MoEF. Govt. of India
Web: http://www.cpreec.org

CPR Environmental Education Centre (C.P.Ramaswami Aiyar Foundation) is based at Chennai and was set up in 1989 to promote environmental awareness, to produce and disseminate basic educational and reference material on environment and to take up environmental projects. It has carried out a study of the sacred groves of Tamilnadu and soil and water analysis; gives guidance on environmental laws, environmental impacts and management studies. It works in the field of environmental education and has promoted smokeless chulhas and other renewable sources of energy. Publications: Books on environment, posters, audio cassettes, website on environment education.

Director
C.R.P. Environment Education Centre
I A Eldams Road, Alwarpet
Chennai 600 018

Development Alternatives Group
Web: http://www.devalt.org
111/9-Z, Kishangarh
Vasant Kunj
New Delhi 110070
Phone: 91 (11) 2613-4103, 2689-0380
Fax: 91 (11) 2613-0817
Email: tara@devalt.org

Environment Society of India
Web: www.esind.org
Karuna Sadan, Sector 11-B
Chandigarh 160 011

Environmental Management Policy and Research Institute
Web: http://empri.kar.nic.in
DG, EMPRI
Urban Eco-Park, 100 Ft. Road
Peenya Industrial Area, 3rd Phase
Peenya
Bangalore 560 058

Phone: 28377744
Fax: 28372460, 28377745

Environmental Resources Research Centre (ERRC)
P.B. 1230, Peroorkada
Thiruvananthapuram 695 005
Kerala

Greentech Foundation
Web: http://www.greentech.org
811, Vishwadeep Tower
Dist. Centre, Janakpuri
New Delhi 110 058
Phone: 91-11-25593846, 25554739, 25540482
Fax: 41588564
Mobile: 9810061297
Email: mail@greentech.org

Greentech Foundation, based in New Delhi, India is a non-profit organization established to promote education, training, research, and dissemination of knowledge, advancing the scientific, technical and practical aspects of Industrial Safety, Environment Management, Climate Change, Pollution Control, Hazardous/Non-Hazardous Waste Management, Water Treatment, Water Pollution, Noise Pollution, Eco Tourism, and Occupational Health, Fire, Safety & Security.

ILSI India [food safety and nutrition]
Web: http://india.ilsi.org
Email: ilsiinda@nda.vsnl.net.in
Phone: 91-11-2 -696 8752
Fax: 91-11-2 652-3477
Y 40-B, 1st Floor
Hauz Khas
New Delhi 110016

ILSI India has been taking the lead in acquainting scientists in South Asia with the latest scientific development in the areas of food and water safety, nutrition, risk assessment, harmonization of food regulations, improvement in the health profile of malnourished children and women, and biotechnology. Special attention has been given to the importance of complementary foods and food fortification.

Indian Association for Environmental Management (IAEM)

Indian Association for Environmental Management (IAEM) was set up at Nagpur in 1963 to educate people on the environment, to encourage the conservation of the environment and to spread environmental knowledge. They conduct seminars, essay competitions, and exhibitions related to water and its pollution, they have carried out water pollution control activities and worked in the field of environmental management. Publication: Journal.

Indian Association for Environmental Management (IAEM)
c/o NEERI, Nehru Marg
Nagpur-440 020
Maharashtra

Indian Environmental Society
Web: http://www.iesglobal.org
U-112, Vidhata House (3rd Floor)
Vikas Marg, Shakarpur
Delhi 110 092
Phone: +91-11–22046823/22046824/22450749
Fax: +91-11–22523311
Email: iesenro@vsnl.com, deshbandhu@iesglobal.org
Web: www.iesglobal.org, www.iespanchayat.net.in, www.globeindia.org

Occupational Health and Safety Centre (OHSC)
Web: http://www.ohscmumbai.org/
c/o Blue Star Workers Union Office
6, Neelkant apartments, Gokuldas Pasta Road
Dadar (E)
Mumbai 400 014
Phone: 4150750
Fax: 410 2252
Clinic timings: Thursdays 11–1 pm
201, Shivasmruti
Curry Road
Mumbai
Wed/Thu/Fri 4–6 pm

The Occupational Health and Safety Centre (OHSC), Bombay is a voluntary organization formed in 1988 by a group of trade unionists, lawyers, safety engineers, social activists interested in the health of the workers and the employees and safety at their work-place. The OHSC aims to assist workers and employees in their efforts to bring in a safer and healthier work place. Nearly 2000 workers have been compensated for occupational diseases and injuries, many for the first time in Mumbai and some for the first time in India.

Orissa Environmental Society (OES)
Web: http://www.orissaenvironment.com/

The Orissa Environmental Society was established in 1982 at Bhubaneshwar. It was set up to encourage and organize study, research, understanding, and appreciation of nature; to formulate co-curricular courses in environmental sciences at all levels of education and advise the government. They conduct research, seminars, and workshops on forest and wildlife protection and organize eco-development camps. They are campaigning for a biosphere reserve forest area in the state. They are the resource agency for pollution control in Talcher industrial area. Publications: *The Journal of Environmental Science*, reports, proceedings, etc.

N-6/530 Nayapalli
Bhubaneshwar 751 015

Research in Environment, Education and Development Society (REEDS)
Web: http://www.reedsindia.org/
17-1-386/S/22, S.N. Reddy Nagar
P.O. Champapet
Hyderabad 500 660
Andhra Pradesh

Sheratgarh Environmental Society (SES)
Premkunj, Adarsh Colony
Shehratgarh
Siddarthnagar District 272 205

Society for Participatory Research in Asia (PRIA)
Web: http://www.pria.org/cgi-bin/index.htm
42, Tughlakabad Institutional Area
New Delhi 110 062
Phone: +91-11 29956908, 29960931/32/33
Fax: +91-11 2995 5183
Email: info@pria.org

Srishti
1001, Antariksh Bhavan
22, Kasturba Gandhi Marg
New Delhi 110 001

Srishti was set up in Delhi in 1988 to promote conservation and enrichment of the environment; to carry out research on all aspects of sustainable living; to foster concern for the environment among the people, making its preservation a shared responsibility. It has been working for the conservation of the Delhi Ridge by involving community participation; they have kept a bird count in the wetlands of Delhi. They have co-ordinated the Asian midwinter waterfowl census for northern India and have carried out tree plantation, conservation of biodiversity and waste management. They played a very active role in the drafting and finalization of the Biodegradable Waste (Management and Handling) Rules, 1998. They worked closely with the CPCB and the MOEF in the finalization of the rules. Now that the rules have been issued, they are propagating the cause of better bio-medical waste practices.

Tata Energy Research Insitute (TERI)
Web: http://new.teriin.org
Darbari Seth Block, IHC Complex, Lodhi Road
New Delhi-110 003
Tel. (+91 11) 2468 2100, 41504900
Fax (+91 11) 2468 2144, 2468 2145,
Email: mailbox@teri.res.in

Tata Institute of Fundamental Research (TIFR)
Web: http://www.tifr.res.in/scripts/homepage.php
Homi Bhabha Road
Mumbai 400 005
Phone:+91-22-2278-2000
Fax:+91-22-2280-4610, 2280-4611
Email: webmaster@tifr.res.in

Toxics Link
Web: http://www.toxicslink.org
H2 (Ground Floor), Jungpura Extension
New Delhi 110 014
Phone: 91-11-24328006, 24320711
Fax: 91-11-24321747
Email: tldelhi@toxicslink.org

Directory of NGOs in India
Web: http://edugreen.teri.res.in/explore/ngos.htm

Universities

Allahbad University
Allahbad Uttar Pradesh
Web: http://www.allduniv.edu
Email: webauthor@allduniv.edu
Post Graduate Programme – M Sc (Env Science)

Annamalai University
Annamalai Nagar Tamil Nadu
Web: http://www.annamalaiuniversity.ac.in
Annamalai
Nagar 608 002
Tamil Nadu
Phone: 91-4144-238248/263/796
Fax: 91-4144-238080
Email: info@annamalaiuniversity.ac.in
V: +91-4144–237356/237357
237358/237359 (Voice-net)
P G Diploma-P G Dip in Industrial Pollution Control
Post Graduate Programme – M Sc (Env Science)

A P S University
Rewa
Web: http://www.itrewa.com
For recent version of site visit: apsurewa.ernet.in
Rewa 486 003
Madhya Pradesh
Phone: +91-07662-231900
Fax: +91-07662-231900
Post Graduate programme – M Sc (Env Biology)
M Phil (Env Biology)
P G Diploma – Env Impact Assessment – D L P
P G Diploma in Pollution Management

Assam University
Silchar Assam
Web: http://assamuniversity.nic.in
Silchar 788 011
Assam

Vice Chancellor: 91-03842-270801
Registrar: 91-03842-270806
Finance Officer: 91-03842-270804
Email: auliba@sancharnet.in; asokesen@sancharnet.in
Fax: 91-03842-270802, 91-03842-270849
Post Graduate programme – M Sc (Ecology & Env Science)

Babasaheb Bhimrao Ambedkar University
Web: http://www.bbauindia.org

B B R A University
Lucknow
Uttar Pradesh
Post Graduate Programme – M Sc (Env Science)

Bharati Vidyapeeth Bhavan
Web: http://www.bharatividyapeeth.edu/html/about_bvdu.shtml
Bharati Vidyapeeth Bhavan
Lal Bahadur Shastri Marg
Pune 411 030
Maharastra
Phone: 24335701, 24335510, 24331317
Fax: 020-24339121
Email: bharati@vsnl.com
Email: intoffice@bharatividyapeeth.edu (International Students)
Post Graduate programme – M Sc (Env Science)

Bharthiar University
Coimbator, Tamil Nadu
Web: http://www.b-u.ac.in/index.asp
Coimbatore
Tamil Nadu 641 046
Telephone: +91-422-2422222/2422223/2422234/2422272/2422321/ 2422335
Fax: +91-422-2422387
Email: regr@bharathiaruni.org
Post Graduate Programme – M Sc (Env Science)

Bharti Vidyapeeth
Pune Maharashtra
Web: http://www.bharatividyapeeth.edu/home.htm
Lal Bahadur Shastri Marg
Pune 411 030
Maharashtra
Phone: +91-20-24335701/24335709/24335510/24331317
Fax: +91-20-24339121/24321910
Email: bharati@vsnl.com/bharatividyapeeth@yahoo.com
Post Graduate programme – M Sc (Env Science)

Bundelkhand University
Web: http://www.bundelkhanduniv.org
Kanpur Road
Jhansi 284 128
Uttar Pradesh
Cable: University, Jhansi
Phone: (0517) 320497/320307/320496/320491
Fax: (0517) 320 761, 320 762
Email: info@bundelkhanduniv.org
Post Graduate Programme – M Sc (Env Science/Env Biotechnology)
P G Diploma in Env Law

Chhatrapati Shahu Ji Maharaj University
Web: http://www.kanpuruniversity.org/
Kalyanpur
Kanpur 208 024
Uttar Pradesh
Phone: +91-512-2570450/2570263/2570301
Fax: +91-512-2570006
Official website/Institution home page: kanpuruniversity.org
Email: sskatiyar@yahoo.com
Post Graduate Programme – M Sc (Env Science)

Cochin University of Science and Technology
Web: http://www.cusat.ac.in
The Registrar, Cochin University of Science and Technology
Kochi 682 022
Phone: +91-0484-2575396/2577550
Post Graduate Programme – M Sc (Env Science), P hd (Env Studies)

Dr B R Ambedkar University (formerly known as Agra University)
Web: http://www.dbrau.com
Paliwal Park
Agra 282 004
Uttar Pradesh
Phone: +91-562-2852135/2852045/2852373/2852374/2521584
Fax: +91-562-2520051
Email: contact@dbrau.com
Post Graduate Programme – M Sc (Env Science/Env Toxicity)
Phd (Env Science/Env Toxicity)

Dr R M L Avadh University
Web: http://www.rmlau.ac.in
Post Graduate Programme – M Sc (Env Science)
Post Box No. 17
Faizabad
Uttar Pradesh

Dr. Babasaheb Ambedkar Marathwada University
Web: http://www.bamu.net
Aurangabad
Maharastra 431 004
Phone: +91-240-2400431-37/2400069/2400104

Fax: +91-240-2400291
Official website/Institution home page: bamuniversity.ac.in
Email: vc@bamuniversity.org/registrar@bamuniversity.org
Post Graduate programme – M Sc (Env Science)

Forest Research Inst
Web: http://fridu.icfre.org
P.O. IPE, Kaulagarh Road,
Dehradun 248 195
Uttaranchal
Phone: 0135-2751826
Fax: 0135-2751826/2756865
PBX Lines: 2757021-28/2753225-28
(Extension 4230)
Email: nautiyaltc@icfre.org
P G Diploma – P G Dip in Bio Diversity Conservation

G B Pant University of Agriculture & Tech
Web: http://www.gbpuat.ac.in
Pantnagar 263145
Dist. Udham Singh Nagar,
Uttaranchal
Phone: +91-5944-233320/233350
Fax: +91-5944-233473
Post Graduate Programme – M Sc (Env Science), Phd

Goa University
Web: http://www.goauniversity.org
Taleigao Plateau
Goa 403 206
Phone: 0832-2451345–48
Fax: 0832-2451184
Email: registra@unigoa.ac.in
M Phil (Env Science)

Gujarat University
Web: http://www.gujaratuniversity.org.in/web/index.asp
Navrangpura
Ahmedabad 380 009
Gujarat
Phone: +91-079-26301341/26300342/43
Fax: +91-079-26302654
Web: www.gujaratuniversity.org.in
Post Graduate programme – M Sc (Env Science)

Guru nanak dev University
Web: http://www.gnduonline.org
Web: http://punjabgovt.nic.in/Education/gnduuni.htm
Amritsar
Punjab
Post Graduate programme – M Sc (Hons) (Env Science)

Gurukul Knagra University
Web: http://www.gkvharidwar.org
Haridwar
Uttaranchal
Post Graduate Programme – M Sc (Env Science), Ph.D.

Indian Agricultural Research Institute (IARI)
Web: http://www.iari.res.in
Dr. H. Chandrasekharan
Unit of Simulation and Informatics
Phone: 25842490/25841255
Email: head_usi@iari.res.in
Post Graduate programme – M Sc (Agriculture)

Indian Institute of Ecology and Environment
Web: http://www.ecology.edu/iiee/index.htm
A-15, Paryavaran Complex, Saket-IGNOU Road
New Delhi 110 030
Phone: 91-11-29535081/29535079
Fax:91-11-29533514
Post Graduate programme – M Sc (Ecology & Environment)

Indian Institute of Science
Web: http://www.iisc.ernet.in
Web: http://www.iisc.ernet.in/hindi (Hindi)
Phone: 91-80-23600129/91-80-22932436
Fax: 91-80-23600221
Email: ad@admin.iisc.ernet.in
PhD (Ecological Science)

Indian Institute of Technology Bombay
Web: http://www.iitb.ac.in/
Powai
Mumbai 400 076
Phone: +91-22-2572-2545
Fax: +91-22-2572-3480
M Tech (Env Science & Eng), PhD

Indian Institute of Technology Chennai
Web: http://www.iitm.ac.in/
I.I.T Post Office
Chennai 600 036
Tamil Nadu
Registrar phone: 2257 8100
Fax: 2257 0509
Email: registrar@iitm.ac.in
Post Graduate Programme – M Sc (Env Science)

Indian Institute of Technology Delhi
Web: http://www.iitd.ac.in/
Hauz Khas
New Delhi 110 016
Fax: 91-011-2658 2037/91-011-2658 2277
Email: webmaster@admin.iitd.ac.in
M Tech (Env Science & Env Engg)

Indian Institute of Technology Guwahati (IITG)
Web: http://www.iitg.ernet.in/, http://www.iitg.ac.in
Indian Institute of Technology Guwahati
Guwahati 781039
Assam
Phone: +91-361-2583000
Fax: +91-361-2690762
Email: pro@iitg.ernet.in
Post Graduation Programme – M Tech (Env Science)

Indian Institute of Technology
Web: www.iitr.ernet.in
Roorkee
Uttaranchal
Post Graduate Programme – M Sc (Env Science)

Indira Gandhi National Open University (IGNOU)
Web: http://www.ignou.ac.in
Web: http://www.ignou.ac.in/webhindi/index.htm (Hindi)
Phone: 29532321
Fax: 29536588
Certificate in Environmental Studies – D L P

Jambeshwar University
Web: http://www.gju.ernet.in
Hissar Hariyana
Phone: 01662 276025(O)263228(R)
Fax: 276240/276025
EPABX: 275015-18
Email: gju_tech@yahoo.com
Registrar: Shri Y.P. Goswami
Post Graduate programme – M Sc (Env Science)

Jamia Humdard University
Web: http://www.jamiahamdard.edu
Hamdard Nagar
New Delhi 110 062
Phone: 26984685/26989686
Fax: 091-11-698 8874
Acting Registrar: 091-11-26059664
Post Graduate programme – M Sc (Env Botany)

Jamia Millia Islamia
Web: http://jmi.nic.in/
Jamia Nagar
New Delhi 110 025
Phone: +91(11)26981717
Fax: +91(11)26980229
M Tech (Env Science & Env Eng)

Jawaharlal Nehru University
Web: http://www.jnu.ac.in/
New Mehrauli Road
New Delhi 110 067
Phone: +91-11-26717676/26717557
Fax: 26717601
Post Graduate programme – M Sc, M Phil, PhD (Environmental Science)

Jiwaji University
Web: http://www.jiwaji.edu
Vidya Vihar
Gwalior 474 011
Madya Pradesh
Phone: +91-751-341450/341896/341095
Fax: +91-751-341450
Post Graduate programme – M Sc (Env Science)
Master of Global Biodiversity, PhD

M G University
Web: http://www.mguniversity.edu/home.htm
Priyadarshini Hills, P.O. Kottayam
Kerala 686 560
Phone: 91-481-2731050–68
Fax: 91-481-2731002, 9, 11
Email: mgu@md2.vsnl.net.in
Telex: 888-288 MGUKIN
Post Graduate programme – M Sc (Bio Chemistry)

M. J. P. Ruhelkhand University
Web: http://mjpru.ac.in/
Dori Lal Agarwal Marg
Bareilly 243 006
Uttar Pradesh
Phone: +91-581-2527282/2527263
Fax: +91-581-2528384/2523334
Email: zhz@rohuniv.ernet.in
Graduate Programme – B Sc (Env Science)

Marathwara University
Web: http://www.bamu.net/
Dr. Babasaheb Ambedkar Marathwada University
Aurangabad 431004
Maharashtra
Phone: 334431-37/334467-69
Fax: 0240-334291
Post Graduate programme – M Sc (Env Science)

MDS University
Web: http://www.mdsuajmer.org/
Ajmer
Diploma Programme – Dip in Environment

Mohanlal Sukhadia University
Web: http://www.mlsu.org
Udaipur 313 001
Rajasthan, India
Phone: +91-294-2471035
Fax: +91-294-2471150
Email: registrar@mlsu.org
Graduate Programme – B Sc (Env Science)
Post Graduate Programme – M Sc (Env Science)

North Eastern Hill University
Web: http://www.nehu.ac.in/

Web: http://www.nehu.ac.in/Hindi1/hindi.htm (Hindi)
Shillong
Meghalaya 793 022
M Tech (Env Science)

Osmania University
Web: http://www.osmania.ac.in/
Hyderabad 500 007
Andhra Pradesh
Department of Env Science M Sc (Env Science)

Ponicherry University
Web: http://www.pondiuni.org
Pondicherry
Post Graduate programme – M Sc (Ecology and Env Science)
PhD (Ecology and Env Science)

Punjab University
Web: http://www.puchd.ac.in/
Chandigarh 160 014
Vice-Chancellor: 91-172-253-4299/91-172-253-4297/91-172-253-4293
Fax: 91-172-254-1022
Email: vc@pu.ac.in
Post Graduate programme – M Sc (Env Eng)

Shivaji University
Web: http://www.unishivaji.ac.in/
Vidyanagar
Kolhapur 416 004
Maharashtra, India
Dr. D. T. Shirke,
I/c. Registrar
Phone: +91-0231-2691729
Fax: +91-0231-2692333
Email: registrar@shivajiuniversity.com
Post Graduate programme – M Sc (Env Science)

Tamil Nadu Agriculture University
Web: http://www.tnau.ac.in/
Coimbatore 641 003
Tamil Nadu
Phone: 91-422-6611210
Fax: 91-422-6611410
Email: registrar@tnau.ac.in
Post Graduate Programme – M Sc (Env Science)

TERI University (formerly known as Teri school of Advance Studies, Delhi)
Web: www.teriuniversity.ac.in
Habitat Place, Lodhi Road
New Delhi 110 003
Phone: +91-11-2468-2100/2468-2111
Fax: +91-11-2468-2144/2468-2145
Email: registrar@teri.res.in
Under Graduation Programme – B Sc (Env Science)
Post Graduate programme – M Sc (Env Biology)

Tezpur University
Web: http://www.tezu.ernet.in/
Napaam 784 028
Tezpur, Assam
Phone: +91-3712-267007/8/9
Fax: +91-3712-267006
Post Graduate programme – M Sc (Env Science)

Thapar Institute of Engineering and Technology
Web: http://tiet.ac.in/
P.O Box 32
Patiala 147 004
Phone: +91-175-2393021
Fax: +91-175-2364498/2393020
Telegram: THAPARINST
Email: registrar@tiet.ac.in
Post Graduate programme – M Sc (Env Science)

University of Calcutta
Web: http://www.caluniv.ac.in/
Kolkata 700073
West Bengal
Phone: +91-33-2413288/311537/2410071/2414984
Fax: +91-33-2413222
Email: admin@caluniv.ac.in
Post Graduate Programme – M Sc (Env Science)

University of Jammu, J & K
Web: http://www.jammuuniversity.in/
Ms. Taranum Khan,
Assistant Registrar
Academic Affairs/Public Relation & Information,
University of Jammu
Email: isp_ju@jammuuniversity.in
Email:tksheebakhan@rediffmail.com
Phone: 91-191-2456892 (O), 91-191-2461693 (R)
Fax: 91-1912456892
Post Graduate programme – M Sc (Env Science)

University of Kerala
Web: http://www.keralauniversity.edu/
Thiruvananthapuram
Kerala 695 034
Phone: +91-471-2306422
Fax: +91-471-2307158
Email: keralauniversity@vsnl.com
Post Graduate programme – M Sc (Env Science)

University of Madras
Web: http://www.unom.ac.in/
University Centenary
Building Chepauk
Chennai 600 005

Tamil Nadu
Telephone: +91-044-25368778/25393347/25393348/25393353/ 25393354/25393357
Fax: 91-44-5360865/5393368
Email: ice123@vsnl.net.in; icedirector@universityofmadras-ice.ac.in
Official website/Institution home page: unom.ac.in; universityofmadras-ice.ac.in
Post Graduate Programme – M Sc (Env Science)

University of Mysore
Web: http://www.inflibnet.ac.in/
Crawford Hall
Mysore 570 005
Karnataka
Phone: +91-821-2419666/2419361
Fax: +91-821-2419363/2419301
Email: vc@uni_mysore.ac.in; registrar@uni_mysore.ac.in; rigistrar@universityofmysore.com
Post Graduate programme – M Sc (Molecular Biology)

University of Pune
Web: http://www.unipune.ernet.in/indexout.html
Ganeshkhind Road
Pune
Maharashtra
Phone: 25601305
E-mail: regis@unipune.ernet.in
Post Graduate programme – M Sc (Env Science)

University of Rajasthan
Web: http://www.uniraj.ernet.in/
JLN Marg
Jaipur 302004
Rajasthan
Phone: 91-141-2711070/2706813
Fax: 91-141-2709582
Diploma Programme – Dip in Human Ecology

Vidya Vihar
Rai Bareilly Road
Lucknow 226 025
Phone: 91-522-2440826/2440827/2441515/2441615/2441888
Fax: 91-522-2440821
CABLE: Babversity
Email: info@bbauindia.org
Post Graduate Programme – M Sc (Env Science)

Vinoba Bhave University
Hazariabaug 825 301
Jharkhand
Phone: 06546-64279/62342/64628/52081
Fax: 06546-64279
Post Graduate programme – M Sc (Env Science)

India Study Centers
Web: http://www.indiastudycenter.com/index.htm

Professional Societies

Academy of Environmental Biology
Regd. Office: 1/206, Vikas Nagar
Lucknow 226 022

Environmental Mutagen Society of India (EMS)
Web: http://www.emsi-india.org/

Indian Academy of Neurosciences
Web: http://www.neuroscienceacademy.org.in/
Industrial Toxicology Research Centre
Lucknow 226 003
TeleFax: +91-522-2628227

Indian Academy of Sciences
Web: http://www.ias.ac.in/
Executive Secretary
C. V. Raman Avenue
Post Box No. 8005
Sadashivanagar
Bangalore 560 080
Phone: +91-80-2361-2546/2361-4592/2361-2943
Fax: +91-80-2361-6094
Email: office@ias.ernet.in

The Academy, founded in 1934, aims at promoting the progress and upholding the cause of science in pure and applied branches. Major activities include publication of scientific journals and special volumes, organizing meetings of the Fellowship and discussions on important topics, recognizing scientific talent, improvement of science education and taking up other issues of concern to the scientific community.

Indian Association for Environmental Management (IAEM)
c/o NEERI, Nehru Marg
Nagpur 440 020
Maharashtra

Educates people on the environment, to encourage the conservation of the environment and to spread environmental knowledge.

Indian Association of Preventive and Social Medicine
Web: http://www.iapsm.org.in/

The Indian Association of Preventive and Social Medicine, founded in 1974, is a non-profit professional organization of specialists in Epidemiology, Health Management, Health Promotion, and Family Medicine, which is dedicated to the promotion of public health by bringing its members' expertise to the development of public health policies, an advocate for education, research, and programs of Community Medicine and

providing a forum for the regular exchange of views and information.

Community Medicine Department, PGIMER
Chandigarh 160 012
Email: iapsm@iapsm.org.in
Phone/Fax: 91-172-2744993

Indian Chemical Society
Web: http://www.indianchemicalsociety.org/
92, Acharyya Prafulla Chandra Road
Calcutta 700 009
Email: indchemical@vsnl.net
Phone/Fax: 91-33-23503478

Indian Environmental Society (IES)
Web: http://www.iesglobal.org/
U– 112, Vidhata House (3rd Floor)
Vikas Marg, Shakarpur
Delhi 110 092
Phone: +91-11-22046823/22046824/22450749
Fax: +91-11–22523311
Email: iesenro@vsnl.com; deshbandhu@iesglobal.org
Web: www.iespanchayat.net.in; www.globeindia.org

The Indian Environmental Society (IES), a non-profit development organization that has been promoting Environmental Improvement Initiatives in India since 1972. IES is active in Environmental Education, Biodiversity Conservation, Information Dissemination, Solid Waste Management, Eco-Technology & Heritage Conservation. Environmental Education has been the centerpiece of all programs of the Society. The organization is meritoriously operating in different states of the country.

Indian Institute of Science
Web: http://www.iisc.ernet.in/
Web: http://www.iisc.ernet.in/hindi/ (Hindi)
Bangalore 560 012
Phone: +91-80-23600757
Fax: +91-80-2360 0683/0085
Email: regr@admin.iisc.ernet.in

Indian National Science Academy
Web: http://www.insa.ac.in/html/home.asp
Bahadur Shah Zafar Marg
New Delhi 110 002
Telephone: 91-11-23221931–1950
Fax: 23235648/23231095
Email: insa@giasdl01.vsnl.net.in; insa@delnet.ren.nic.in; insa1@ndf.vsnl.net.in

The Indian National Science Academy plays a crucial role in promoting, recognizing, and rewarding excellence. Another important task is to publish journals, organize scientific discussions, and bring out proceedings and monographs. The Academy promotes public awareness and understanding of science. Acting as links between the scientific community and the planners, they advise the governments on critical issues. Importantly they serve as forums for interaction among scientists within and outside the country.

Indian Pharmacological Society (IPS)
Web: http://www.gsips.org/

Indian Science Congress Association
Web: http://www.sciencecongress.org/html/index.html
14, Dr. Biresh Guha Street
Kolkata 700 017
Phone: (033) 2287-2551(O)
Phone: (033)2287-4530
Fax: 0091-33-22872551
Email: iscacal@vsnl.net; iscacal_2004@yahoo.com
Telegram: SCICONG:CALCUTTA

Indian Society of Toxicology (IST)
Web: http://www.aimshospital.org/toxicology/society.html
Amrita Institute of Medical Sciences and Research Centre
Amrita Lane, Elamakkara Post
Kochi
Kerala 682 026
Phone: +91 (0) 484-280-1234/280-4321/400-1234
Fax: +91 (0) 484-280-2020
Email: toxicology@aims.amrita.edu

National Academy of Medical Sciences (NAMS)
Web: http://www.nams-india.org/
NAMS House
Ansari Nagar, Mahatma Gandhi Marg
New Delhi 110 029
Phone: +91-11-26589289/26588718/26589326
Telegram: "MEDACADEMY" New Delhi
Fax: +91-11-26588992

National Academy of Sciences
Web: http://www.nasi.org.in/
5, Lajpatrai Road
Allahabad 211 002
For organizational, administrative and other enquiries:
Prof. V.P. Kamboj: (0532) 2640224, 2440278 (O)
President: (0522) 2334378(R), 9415157684(M)
Email: kambojvp@gmail.com; kambojvp@yahoo.com; kambojvp@rediffmail.com
Prof. P.K. Seth: (0532) 2640224, 2642095 (O)
General Secretary (HQ): (0522) 2786437, 2788024(R), 9839010166(M)
Email: info@biotechcitylucknow.org; prahladseth@gmail.com; pkseth@hotmail.com; pksethdr@yahoo.co.in

Neurological Society of India (NSI)
Web: http://www.neurosocietyindia.com/
Dr. B.S. Sharma
Hon. Secretary
Neurological Society of India, Professor of Neurosurgery
713, Department of Neurosurgery
Neurosciences Centre, All India Institute of Medical Sciences
New Delhi 110029
Phone: 91-11-26594573
Fax: 91-11-26569007/26862663
Email: drsharmabs@yahoo.com

Science for Society, Bihar
Web: www.science4societybihar.org

Society of Biological Chemists (India)
Web: http://www.iisc.ernet.in/sbci/index.htm
c/o Indian Institute of Science
Bangalore 560 012
Phone: 91-080-23601412
Fax: 91-080-23601412
Email: sbci@satyam.net.in

Society of Biosciences
Muzaffarnagar, India

Poison Information/Control Centers

Dept of Toxicology
(Incl. Poison Information & Laboratory Services)
Email: poisonunit@aimshospital.org
Amrita Institute of Medical Sciences & Research
Cochin 682026, South India
Web: http://www.aimshospital.org/toxicology/toxicology.html
Director: Dr V. V. Pillay
Phone: +91-484-2804852 (O), +91-484-2807055 (R), 9895282388 (Cell 24 hrs)
Fax: +91 484 2802051
Email: mailto:toxicology@medical.amrita.edu;

Industrial Toxicology Research Centre
Post Box 80, M. Marg
Lucknow 226 001
Email: itrc@itrcindia.org
Phone: +91-0522-227586
Fax: +91-0522-228227

National Poisons Information Centre
Web: http://www.aiims.ac.in/aiims/departments/spcenter/npic/poison.htm
All India Institute of Medical Sciences, Ansari Nagar
New Delhi 110 029
Phone: +91-11-26589391/26593677
Emergency telephone: +91-11-661123
Fax: +91-11-26850691/26862663

Poisons Information Centre
Web: http://www.nioh.org/niohdeptpic.htm
National Institute of Occupational Health, (NIOH)
Meghani Nagar
Ahmedabad 380 016
Director: Dr A. Dewan
Phone: +91-79-2268-6351/52/59
Emergency telephone: +91-79-25621400
M-9327917833
Fax: +91-79-2268-6110
Email: dewanaruna@yahoo.com

Toxicology & IMCU Unit
Web: http://www.chennaipic.com/
Government General Hospital
Chennai 600003
Director: Dr C.Rajendran MD
Phone: +91-44-536-3208/+91-44-536-3131 ext. 108
Fax: +91-44-538-8521
Email: ghpictn@vsnl.net
Information also at http://www.whoindia.org/ and go to Environment health/Poison Prevention/Helpline

Legislation

Bio-Medical Ethics
Ethical Guidelines for Biomedical Research on Human Subjects
ICMR, 2000
Web: http://icmr.nic.in/ethical.pdf

Environmental Impact Assessment Notification, 1994
Web: http://mines.nic.in/fcnot.html
Government of India
Ministry of Environment & Forest
New Delhi

Environmental Laws of India
Web: http://cpreec.org/09_env_law/env_laws_advanced.html

Labour and Safety in Mines
Web: http://mines.nic.in/lsmines.html

Legislations on Environment, Forests, and Wildlife
Web: http://envfor.nic.in/legis/legis.html

Miscellaneous Resources

An Assessment of Mercury Pollution Problem at Kothari Industries Ltd., Madras
Published by CPCB 1985

Bhopal Chemical Release
Bhopal Information Center
http://www.bhopal.com

BHOPAL GAS DISASTER

Surviving Bhopal – toxic present–toxic future: a report on human and environmental chemical contamination around the Bhopal disaster site 2002, Srishti, New Delhi.

Stringer, Ruth Labunska, Iryna Brigden, Kevin 2002, Chemical stockpiles at Union Carbide India Limited in Bhopal: an investigation, Greenpeace, ISBN: 90 73361 80 X

CLEAN-India

An Environmental Assessment, Awareness, Advocacy and Action Programme supported by CPCB and European Commission.

Web: http://www.cleanindia.org

Health India
Web: http://www.healthplusindia.com

Medindia.net
Web: http://www.medindia.net

Report on 'Mercury in India-Toxic Pathways'
Published by Toxics Link, 2004
Web: http://www.toxicslink.org/pub-view.php?pubnum=35

Saxena RN, Saxena S (2003)
The handbook of environment and forests legislations, guidelines and procedures in India (with special reference to mining)
New Delhi, Green Publishing Corporation
ISBN: 81 8058 000 8

CHAPTER

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Iran

MOHAMMAD ABDOLLAHI

TOXICOLOGY IN IRAN

History of Toxicology in Iran

The history of toxicology in Iran dates backs to the establishment of its Pharmacy and Medicine schools. Toxicology itself was one of the main courses in the Pharmacy curriculum while students of Medicine were familiar with toxicology during the course of Legal Medicine. The Faculties of Pharmacy and Medicine in University of Tehran were established nearly 90 years ago in 1920. When the Iran Legal Medicine was established in Tehran, new laboratories for the diagnosis of poisons in biological fluids were developed. Clinical toxicology in Iran was started by the efforts of several specialist physicians in the fields of toxicology, anesthesiology, and pediatrics in the Loghman-Hakim Hospital of Tehran, Imam-Reza Hospital of Mashhad, and later in Isfahan and other cities.

Poisoning in Iran

The exact number of patients suffering from poisonings per year in Iran is unknown but the rate of poisoning is likely similar to that in other countries. There are both acute and chronic cases of poisonings and the vast majority of them relate to drugs and pesticides. Human exposures to chemicals either as acute or chronic are common in Iran. Acute chemical poisonings particularly from pesticides and drugs, especially self-administered are a common cause of admission to Emergency Departments or Poisons Treatment Units. Acute household chemical poisonings, particularly in children, are also common. Chronic exposure to chemicals in the industries (occupational poisonings) and environmental pollutions that induce diseases are also health problems, especially in heavily air polluted cities such as Tehran. Almost all emergency units and the majority of intensive care units (ICU) treat intoxications but there are few ICUs in Iran with a primary focus on toxicological cases. Chronic poisonings are mostly missed because of the lack of awareness of the problem by most clinicians. Lack of adequate clinical toxicology teaching, particularly of chronic poisoning to all medical students is a problem for the medical management of chemicals.

Teaching of Toxicology

Basic and clinical toxicology are taught to undergraduate Pharmacy students and more recently to Medical students, postgraduate students in Clinical Medicine, and to MSc and PhD students of Toxicology. Clinical toxicology courses as part of Continuing Medical Education are also given to some general practitioners and specialists in clinical medicine. There are very strong departments of Toxicology in the Faculties of Pharmacy in the Medical Universities of Iran. These departments usually graduate Pharmacists and Physicians with a PhD in Toxicology. In 1987, Tehran University of Medical Sciences (TUMS) started the postgraduate training of Pharmacists and Physicians in Toxicology at the PhD level and five years later Shaheed Beheshti, followed by Mashhad University of Medical Science, and, more recently, Tabriz University of Medical Sciences joined in Toxicology education at the PhD level. In addition, the Department of Pharmacology from the School of Medicine in TUMS, and the Pharmacy Schools of Mashhad, Ahwaz, Kerman, and

Shiraz Universities of Medical Sciences, joined in toxicology education at the MSc levels. Medical Universities also train Physicians in residency programs of Legal Medicine. Recently, a residency program of Emergency Medicine has been established in Iran in which Physicians are trained to manage poisoning cases. In addition, a fellowship of Clinical Toxicology is being approved by authorities to train Toxicologists at higher fellowship levels. Added to these, there are pediatricians, anesthesiologists, internalists, and legal medicine specialists who are active in the management of poisonings in Iran in private and non-private hospitals. There is a National Board of Toxicology located within the Undersecretary of Education in the Ministry of Health and Medical Education that governs all toxicology matters in terms of teaching, study, and jobs.

RESOURCES

Drug and Poison Information Services

Address: Valiasre Ave., Daneshkian St., No.
Phone: +98 21 66419306, 98 21 88923195
Fax: 98 21 88890857
Email: irfda@yahoo.com

There are strong Drug and Poison Information Centers (DPICs) that are under the supervision of the Medical Universities and the Food and Drug Department of the Ministry of Health (MOH). The first official DPIC was established on 1995 at Tehran. The role of DPICs that are mainly supervised by Pharmacists trained in toxicology is to help both health professionals and the general public in reducing the risks of poisonings. These centers collect and distribute data on hazardous products and poisoning risks. DPICs in Iran are very active in Continuing Medical Education programs, especially in toxicology. Most DPICs are involved in scientific projects and document important intoxications in the medical literature. Almost all provinces of Iran have officially notified a DPIC. Some states have more than one center. In total, 29 active DPICs exist in Iran. Only Medical and Pharmacy doctors who are primarily educated and experienced in toxicology and drug information provide advice by telephone, email, and fax. Iran has very good cooperation with the World Health Organization's International Programme on Chemical Safety (WHO/IPCS) program and is one of the official collaborative centers of the INTOX project.

Toxicology Laboratories

There are few laboratories in Iran providing toxicology services and therapeutic drug monitoring. Some hospital laboratories provide analytical services for poisonings. Although there is no critical problem in this field, Iran needs to establish more special toxicology and therapeutic drug monitoring (TDM) laboratories to improve the present status.

National Committee on Chemical Safety

Web: http://www.mohme.gov.ir/health/index.htm

Since the Ministry of Health, Medical Care and Education is responsible for the health of the populace, the National Committee of Chemical Safety is located in the Department of Occupational and Environmental Health of the Ministry of Health. The national profile of chemical safety, prepared by this committee in the Persian language, includes information from various organizations and legislation dealing with toxic substances.

Address: 5th Floor, Building of MOH, Square of Hafez and Jomhouri, Tehran
Phone: 98 9123842076
Fax: 98 21 66707417
Email: webmaster@hbi.ir

The Iranian Society of Toxicology

Web: http://www.irantox.org/
Address: Medical Council, Tabriz St., North Sarparast St., West Taleghani Av., Tehran
Phone: 98 21 88972240
Fax: 98 21 88972239
Email: admin@irantox.org

The Iranian Society of Toxicology (IST) was established in 1989. Its main objectives include advancement of toxicology, scientific contacts between toxicologists and other scientific societies, study of the health effects of poisons and chemicals, and advice to the regulatory authorities. IST is a member of the International Union of Toxicology (IUTOX). IST supports the scientific and professional development of its members by organizing education courses that are well attended by Toxicologists, Physicians and Pharmacists. IST with the help of Iranian Universities of Medical Science has organized seven National and International Congresses with the proceedings of these congresses being sent to the Iranian authorities for their consideration. IST welcomes new members, even international members. Most Iranian toxicologists, who are primarily Pharmacists or Physicians with a specialty in toxicology, pharmacology, anesthesiology, pediatrics, internal medicine, or legal medicine, are members of IST.

Government Agencies

In total, there are four centers in Iran that control and manage issues related to poisons in terms of import, export, distribution, safety, efficacy, and environment. Each center has its own rules, acts, and policies.

Ministry of Industry
Web: http://www.mim.gov.ir/
Address: No. 250, Somaieh Av., Tehran
Phone: 98 21 88897590-9
Fax: 98 21 88808275
Email: mimwebmaster@mim.gov.ir

This ministry is responsible for importing any chemical into the country. Only chemicals that are not produced domestically are allowed to be imported.

Ministry of Health and Medical Education
Web: http://www.mohme.gov.ir/
Address: Nasr 5 Building, South Falamak, Shahrak Gharb, Tehran
Phone: 98 21 88463530
Fax: 98 21 88463530
Email: webmaster@mohme.gov.ir

Three undersecretaries of MOHME govern toxicological issues in Iran.

They include the following:
Undersecretary of Food & Drugs
Web: http://www.fdo.ir/
Address: Fakhr-Razi St., Enghelab Av.
Phone: 98 21 66405598
Fax: 98 21 66705868
Email: info@fdo.ir

Undersecretary of Health
Web: http://www.mohme.gov.ir/health/index.htm
Address: 5th Floor, Building of MOH, Square of Hafez and Jomhouri, Tehran
Phone: 98 9123842076
Fax: 98 21 66707417
Email: webmaster@hbi.ir

Undersecretary of Education
Web: http://www.mohme.gov.ir/education/index.htm
Address: Nasr 5 Building, South Falamak, Shahrak Gharb, Tehran
Phone: 98 21 88363560
Fax: 98 21 88363560
Email: webmaster@hbi.ir

The Department of Environmental and Occupational Health situated within the Undersecretary of Health is responsible for controlling health issues related to poisons and chemicals. The National Committee on Chemical Safety, mentioned above, has been established in this department. The Undersecretary of Food and Drug situated within the MOHME is responsible for registering pesticides that may be used in houses. Issues related to poisoning by drugs are also managed in this department. Within the Undersecretary of Education, there is a National Board of Toxicology that is composed of distinguished scientists of toxicology who establish rules, makes policies, and control all toxicology curricula in the universities.

Ministry of Jahad-E-Agriculture
Web: http://www.agri-jahad.org/English/Main/Default.asp
Address: Keshavarz Bulvd., Tehran
Phone: 98 21 81361
Fax: 98 21 81361

The Plant Protection Organization which is an affiliate of this ministry controls all issues related to pesticides that are used in agriculture within the country. Registration of new pesticides, permission to import or export pesticides, control of pesticide formulating factories and companies are duties of this ministry.

Iran Department of Environment
Web: http://www.irandoe.org/en/
Address: Pardisan Nature Park, Hakim Express way, Tehran
Phone: 98 21 88241720-9
Fax: 98 21 88241720-9
Email: info@irandoe.org

This department is responsible for protecting environment from all possible pollutants by issuing necessary acts and policies, and also by direct intervention.

Iran Legal Medicine Organization
Web: http://www.lmoportal.ir/en/
Address: Behesht Avenue, Tehran-11144
Phone: +98 215 5619096
Fax: +98 215 5613937

This organization is responsible for forensic matters of toxicology in the country. Interpretations of this organization are the basis of judgments in the courts.

Non-Government Organizations

Iran Green Mountain Group
Web: http://greenmountain.ir/en/
Address: No. 160, Azadi Av.
Phone: 98 21 66436089

Those interested in mountaineering and the beautiful nature of the country gathered in 1996 to establish a mountaineering group named OJE-SABZ (Green Soar).

The group was certified first by I.R.I Mountaineering Federation and then by Iran Department of Environment, as an NGO. OJE SABZ club consists of some sub groups as follows: Mountaineering group for men, Mountaineering group for women, Mountaineering group for youth. All are acting as semi-independent sub groups. This group has been active in maintaining a clean environment.

Universities

Ahwaz University of Medical Sciences
Web: http://ajums.ac.ir/
Department of Toxicology and Pharmacology, Faculty of Pharmacy Web: http://ajums.ac.ir/colleges/darosazi/default.aspx
Address:
Phone: 98 611 335200
Fax: 98 611 335024

Baqiyatallah University of Medical Sciences
Web: http://www.bmsu.ac.ir/
Military Medicine Institute
Web: http://www.bmsu.ac.ir/pajoheshkadeh2004/pajoheshkadeh2004.htm
Address: Baqiyatallah Hospital, Molasadra Av., Tehran
Email: info@bmsu.ac.ir

Isfahan University of Medical Sciences
Web: http://www.mui.ac.ir/
Department of Toxicology and Pharmacology, Faculty of Pharmacy
Web: http://pharm.mui.ac.ir/
Address: Hezar Jarib Ave., Isfahan
Phone: 98 311 6685154/6688864
Fax: 98 311 6685141/6685142

Kerman University of Medical Sciences
http://www.kmu.ac.ir
Department of Toxicology and Pharmacology, Faculty of Pharmacy
Web: http://www.kmu.ac.ir/sitewizard/admin/wizard/Default.Aspx?PageId=446
Address: Jomhouri Bulevard
Phone: 98 341 213514
Fax: 98 341 26-213025

Mashhad University of Medical Sciences
Web: http://www.mums.ac.ir/
Department of Toxicology and Pharmacology, Faculty of Pharmacy http://www.mums.ac.ir/pharmacy/index.html
Address: School of pharmacy, P.O. Box: 91775-1365, Mashhad, Iran
Phone: 98 511 8823255-66
Fax: 98 511 8823251
Email: school-pharmacy@mums.ac.ir

Pharmaceutical Research Center (Bu-Ali Research Institute)
Web: http://www.mums.ac.ir/bari/
Address: P.O.Box: 9196773117, Mashhad
Phone: 98 511 7112611-5
Fax: 98 511 7112596

Shaheed Beheshti University of Medical Sciences
Web: www.sbmu.ac.ir
Department of Toxicology and Pharmacology, Faculty of Pharmacy http://www.pharmacysbmu.com/ Web:
Address: In front of Tavanir, Valiasre Av., Tehran
Phone: 98 21 8774283
Fax: 98 21 8795008
Email: hvahidi@pharmacysbmu.net

Toxicological Research Center, Loghman-Hakim Hospital, School of Medicine
Web: http://trc.sbmu.ac.ir/index.htm
Address: South Kargar Ave., Kamali St., Tehran
Phone: 98 21 55418175
Fax: 98 21 55418175
Email: trc@sbmu.ac.ir

Shiraz University of Medical Sciences
Web: www.sums.ac.ir
Department of Toxicology and Pharmacology, Faculty of Pharmacy
Address: Karafarin St., Darvazeh Ghoran, Shiraz
Phone: 98 711 2426070-7
Fax: 98 711 2426070
Email: Niknahad@sums.ac.ir

Tehran University of Medical Science
Web: www.tums.ac.ir
Department of Toxicology and Pharmacology, Faculty of Pharmacy
Web: http://pharmacy.tums.ac.ir/
Address: Tehran University, Poursina St., Tehran
Phone: 98 21 66959090
Fax: 98 21 66461178
Email: admin@tums.ac.ir

Department of Legal Medicine, School of Medicine
Web: http://medicine.tums.ac.ir/fa/
Address: Tehran University, Poursina St., Tehran
Phone: 98 21 81631

Department of Pharmacology and Experimental Medicine, School of Medicine
Web: http://medicine.tums.ac.ir/fa/
Address: Tehran University, Poursina St., Tehran
Phone: 98 21 81631

Pharmaceutical Sciences Research Center
Web: http://psrc.tums.ac.ir/
Address: Tehran University, Poursina St., Tehran
Phone: 98 21 66482704
Fax: 98 21 66482704
Email: psrc@tums.ac.ir

Center for Environmental Research
Web: http://cer.tums.ac.ir/
Address: No.21, School of Public Health (Building No.2), Shafei St., Ghods. St, Keshavarz BLd.
Phone: 98 21 66954230
Fax: 98 21 66954231
Email: cenvres@sina.tums.ac.ir

Professional Societies and Institutes

Iranian Society of Toxicology
Web: www.irantox.org
Address: Medical Council, Tabriz St., North Sarparast, Taleghani, Tehran
Phone: 98 21 88972240
Fax: 98 21 88972239
Email: admin@irantox.org

Iranian Society of Physiology & Pharmacology
Web: www.irspp.hbi.ir
Address: Department of Pharmacology, Faculty of Medicine, Shaheed Beheshti University of Medical Sciences, Evin, Tehran

Iranian Society of Legal Medicine
Address: Medical Council, Tabriz St., North Sarparast, Taleghani, Tehran
Phone: 98 21 88972241
Fax: 98 21 88972241

Iran Health Education
Web: www.modares.ac.ir/fmed/lamyianmHealth
Address: P.O. Box 14115-11, Tarbiat Modares University, Tehran
Phone: 98 21 88011001
Email: webmaster@modares.ac.ir

Iranian Society of Pharmaceutical Scientists
Web: www.iranasp.net
Address: Medical Council, Tabriz St., North Sarparast, Taleghani, Tehran
Phone: 98 21 88972240
Fax: 98 21 88972239

Iranian Society of Pharmacognosy
Web: www.pharmacognosi.net
Address: Medical Council, Tabriz St., North Sarparast, Taleghani, Tehran
Phone: 98 21 88972240
Fax: 98 21 88972239

Study of Pain in Iran
Web: www.modares.ac.ir/Persian/otherlink/research.htm
Address: P.O. Box 14115-11, Tarbiat Modares University, Tehran
Phone: 98 21 88011001
Email: webmaster@modares.ac.ir

Razi Vaccine and Serum Research Institute
Web: www.rvsri.com
Address: P.O. Box 31975/148, Karaj
Phone: 98 261 4570038-46
Fax: 98 261 4552194
Email: razi_institute@rvsri.com

Pasteur Institute of Iran
Web: www.pasteur.ac.ir
Address: No. 69, Pasteur Ave., Tehran
Phone: 98 21 66953311-20
Fax: 98 21 66465132
Email: office@pasteur.ac.ir

Iranian Red Crescent Society
Web: http://www.rcs.ir
Address: Solh Building, Rashid Yasemi St., Valiasr Ave., Tehran
Phone: 98 21 88662700-2
Fax: 98 21 88662703
Email: info@rcs.ir

Drug and Poison Information Centers

Central division of DPIC
Web: http://www.hbi.ir/hosting/en_med_center.htm and http://www.fdo.ir
Address: No. 24, Danshkian St., Valiasr Av., Tehran
Phone: +98 21 88923195/09646
Email: dpic@fdo.ir

Ardebil University of Medical Sciences DPIC
Phone: +98 451 5518308/09646
Email: fdoa@arums.ac.ir

Babol University of Medical Sciences DPIC
Phone: +98 1112294745/09646
Email: ettelaresani_babol@yahoo.com

Birjand University of Medical Sciences DPIC
Phone: +98 561 4422590/09646

Bushehr University of Medical Sciences DPIC
Phone: +98 771 2520976/09646

Ghom University of Medical Sciences DPIC
Phone: +98 251 7758020 and 09646

Guilan University of Medical Sciences DPIC
Phone: +98 131 2231051 and 09646
Email: drug@gums.ac.ir, dpicguilan@yahoo.com

Gorgan University of Medical Sciences DPIC
Phone: +98 171 4424004 and 09646
Email: golestandrug@yahoo.com

Hamedan University of Medical Sciences DPIC
Phone: +98 811 2510711
Email: phdu@fdo.ir

Isfahan University of Medical Sciences DPIC
Phone: +98 311 6699615
Email: drug_info@mui.ac.ir

Kerman University of Medical Sciences DPIC
Phone: +98 3412114096

Kermanshah University of Medical Sciences DPIC
Phone: +98 831 8383700
Email: drug_kums@hotmail.com

Khouzestan University of Medical Sciences DPIC
Phone: +98 611 2232364
Email: ahvaz@fdo.ir

Kordestan University of Medical Sciences DPIC
Phone: +98 871 3289846
Email: drug_sananadaj@yahoo.com

Loghman-Hakim Hospital Poison Center, Tehran
Phone: +98 21 55422020

Lorestan University of Medical Sciences DPIC
Phone: +98 661 3203168
Email: dpic_lorestan@yahoo.com

Mashhad University of Medical Sciences DPIC
Phone: +98 511 7634014
Email: drug_dic_ad@mums.ac.ir

Mazandaran University of Medical Sciences DPIC
Phone: +98 151 2273697

Oroomie University of Medical Sciences DPIC
Phone: +98 441 2240060
Email: vch-food-pharm@umsu.ac.ir

Qazvin University of Medical Sciences DPIC
Phone: +98 281 3673213
Email: qaz_dpic@yahoo.com

Rafsanjan University of Medical Sciences DPIC
Phone: +98 391 8220045
Email: rafsanjan@fdo.ir

Sabzevar University of Medical Sciences DPIC
Phone: +98 571 2240015
Email: drug@medsab.ac.ir

Semnan University of Medical Sciences DPIC
Phone: +98 231 4440379

Shahid Beheshti University of Medical Sciences DPIC
Phone: +98 21 88662332; +98 21 88776028
Email: dpic-sbmu@yahoo.com

Shiraz University of Medical Sciences DPIC
Phone: +98 711 2331271
Email: fdodept@sums.ac.ir

Tabriz University of Medical Sciences DPIC
Phone: +98 411 4421841
Email: drug.vc@tbzmed.ac.ir

Yazd University of Medical Sciences DPIC
Phone: +98 351 6214191
Email: yfdo@ssu.ac.ir

Zahedan University of Medical Sciences DPIC
Phone: +98 541 3214575
Email: dpic-zahedan@yahoo.com

Zanjan University of Medical Sciences DPIC
Phone: +98 241 5250100 and 5250101
Email: zanjan@fdo.ir

Books

Abdollahi M, Moghadamnia M, Shafagi B (1992)
Analysis of Toxic Substances (Emergency and Practical)
Tehran: Tehran University of Medical Sciences

Abdollahi M (1993)
Teratology (Principles and Practices)
Tehran: Shafagh

Abdollahi M (1994)
Pesticides Toxicology; Diagnosis and Treatment
Tehran: Eshraghieh

Abdollahi M et al (1996)
Emergency Management of Poisoned Patients
Tehran: Soroush

Abedi MH (2007)
Methods of Sampling in Forensic Toxicology
Tehran: Payeme Edalat

Afshar M (1983)
Drug Poisoning and Treatment
Tehran: Darupakhsh Company

Afshari D (2003)
Multiple Choice Questions of Occupational and Industrial Toxicology
Tehran: Baraye Farad

Aghaie S (1988)
Anti-parasites Toxins
Tehran: Eksir

Ahmadizadeh M (1997)
Industrial Toxicology of Heavy Metals
Tehran: Hazaran

Aslani M (2004)
Poisonous Herbs in Iran and Poisoning in Animals
Mashhad: University of Ferdosi

Badrian R (2004)
Evaluation of Pesticide Producing From the Uranium Richen Process
Tehran: Morsal

Bagheri A (2007)
Information Database of Pesticides and Plant Diseases
Tehran: Payeme Moallef

Balali-Mood M (1999)
Diagnosis, Prevention, and Treatment of Poisonous Animal's Bite
Tehran: Tabib

Cember H (1992), Translated by Aboukazemi ME et al.
Introduction to Health Physics
Tehran: University of Tehran

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Diagnosis, Prevention and Treatment of Chemical Weapons Complications
Tehran: Golban

Complementary Examination Institute (2002)
Toxicology Lectures
Tehran: Sanjesh

Cultural-Artistic Institute of Tehran (2001)
Examination of Toxicology
Tehran: Dibagaran

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Natural Toxic Compounds of Foods Formation & Changes During Processing & Storage
Tehran: Institute of Nutritional Research and Food Industry

Ehteshami A (2000)
Crime Toxicology
Tehran: Naja University of Military Sciences

Excellence Center of Toxicology and Food Chemistry (2007)
Toxicology
Tehran: Tehran University of Medical Sciences

Fakhraian H (2003)
Chemical Factors
Tehran: Imam Hosein University Publishing Institute

Fattahpour S (2002)
How to Control Drug Poisoning
Kermanshah: Fattahpour & Sheikhi

Fekri M (2004)
Narcotics; Diagnosis and Extraction
Tehran: Jahad Daneshgahi

Ghazi-Khansari M (2004)
Manual of Pharmacology Toxicology Lab Medical Technology
Tehran: Ghashieh

Hajighasemkhan A (2007)
Industrial Toxicology
Tehran: Baraye Farda

Hajinasrollah E (2001)
Surgery in Burning Substances Poisoning
Tehran: Shahrab

Hall EJ (1990), Translated by Salabian MJ
Radiobiology for the Radiologist
Shiraz: Sadi Cultural Institution

Helferich W (2004), Translated by Chiani M and Gholokhani R
Food Toxicology
Tehran: Hayyan

Helmut-Fritz VM (2000) Translated by Radnia H
Beyond Silent Spring: Integrated Pest Management and Chemical Safety
Karaj: Agricultural Research Center

Hill TR (2004), Translated by Parsinia M
Pharmacotherapy in Lactation, Theory and Information
Tehran: Ghalamestan Honar

Hill TR (2004), Translated by Abedzadeh M and Sadat Z
Pharmacotherapy, Lactation, Theory and Practice
Kashan: Morsal

Hossieni MR (2003)
Confrontation with Chemical Substances Poisoning
Tehran: Daryasara

Imani S (2003)
Toxicology of Pesticides and Plants Diseases
Tehran: Dibagaran

Ioirish NP (1987), Translated by Kaveh SH
Bee Pharmacists
Tehran: Islamic Revolution Publication Co.

Karbassi A, Bayati A (2007)
Environmental Geochemistry
Tehran: Kavosh Ghalam

Marrs TC (2002), Translated by Pourheidari G
Chemical Warfare Agents: Toxicology and Treatment
Tehran: Teimourzadeh

Meraz C (2004), Translated by Kaviani B
Health & The Honey Bee
Tehran: Eshraghieh

Moghadamnia AA, Abdollahi M, Nikfar S (2000)
Pesticide's Chemical Safety and Control of Poisoning
Babol: Babol University of Medical Sciences

Modarresi MM (2003)
Enriched Uranium: Effects on Human and Environment
Tehran: Spand Honar

Mostashari M (1998)
A Chemical Viewpoint to the Imposed War
Rasht: Guilan University Press

Moztarzadeh F (1996)
Asbestos and Other Hazardous Mineral Fibers
Tehran: Materials and Energy Institute

Niakan M (1994)
Pharmacotherapy by Bee Products
Tehran: Tehran Azad University

Nikfar S, Abdollahi M, Falaki F (1999)
Hazards of Pesticides in the Workplaces
Tehran: Ministry of Health & Medical Education Publications

Nikfar S, Abdollahi M, Falaki F (1999)
Precautions and Guidelines for use of Pesticides in the Workplaces
Tehran: Tehran University of Medical Sciences

Opad-hiay R (2004), Translated by Teimourzadeh A and Ebadi A
Herb's Probable Anticarcinoogenesis Effects
Ardebil: Rahro Danesh

Pourahmad J (2007)
General Toxicology
Tehran: Samat

Rakhshani-Zabol E (2002)
Principles of Agricultural Toxicology
Tehran: Jameh Farhang

Ranjbarian M (2002)
Job Poisoning and Prevention
Tehran: Dibagaran

Ravindra FP (2003), Translated by Pourmirza AA
Management of Acute Poisoning
Uromieh: Jahad-E-Daneshgahi

Reid HA (1985), Translated
Snakebite
Tehran: Pakhsh-E-No

Sahebghadam-Lotfi A (1988)
Metabolism of Lead and its Poisoning
Tehran: University of Tarbiat Modarres

Sanaei GH (1996)
Industrial Toxicology
Tehran: University of Tehran

Schiefer BH (2000), Translated by Kouhi MK and Asadi F
Understanding Toxicology; Chemicals, Their Benefits and Risks
Tehran: Jahad Publication Center

Samsam-Shariat H (1992)
Poisonous Medical Plants
Isfahan: Mashal

Shahtaheri J (2007)
Occupational Toxicology
Tehran: Baraye Farda

Shahramain I (2004)
Narcotic in Children's Medicine
Tehran: Golban

Shama M (1983)
Toxic Effects on Animals
Tehran: University of Tehran

Shokrzadeh M (2007)
Toxicology in Veterinary
Tehran: Jahad-E-Keshavarzi Institute of Higher Scientific and Applied Education

Stevens JT (2003), Translated by Ebadollahi A
Principle & Methods of Toxicology
Tehran: Doost-E-Mehraban

Somani SM (1994), Translated by Hosseini G et al.
Chemical Warfare Agents
Tehran: Azad University Scientific Publishing Center

Tafakore Nab Researching Group (2004)
How to Select Toxicology in College
Tehran: First Sanjesh

Taghaddosinejad F (2007)
Clinical Toxicology; Diagnosis and Treatment
Tehran: Abnous

Timbrell JA (1997), Translated by Rahimi R and Rahimzadeh P
Introduction to Toxicology
Tehran: Ettelaat

Journals

Although, there is only one journal specifically dedicated to Toxicology (*Iranian Journal of Toxicology*), many contain relevant articles on the subject. They include the following.

Acta Medica Iranica
ISSN: 0044-6025
Publisher: TUMS
Web: http://diglib.tums.ac.ir/pub/

Archives of Iranian Medicine
ISSN: 1029-2977
Publisher: Academy of Medical Sciences of Iran
Web: http://razi.ams.ac.ir/AIM/

Archives of Razi Institute
ISSN: 0365-3439
Publisher: Razi Vaccine and Serum Research Institute
Web: www.rvsri.com

Baspar
ISSN: N/A
Publisher: Iran Polymer
Web: www.baspar.com

Behbood
ISSN: 1735-093X
Publisher: Kermanshah University of Medical Sciences
Web: www.kums.ac.ir/journal10/persian/indexfa.htm

Blood
ISSN: 1027-9520
Publisher: Iranian Blood Transfusion Organization-Research Center
Phone: (+9821) 88601501-20
Fax: (+9821) 88601599
Email: sjibto@ibto.ir

DARU
ISSN: 1560-8115
Publisher: TUMS
Web: http://diglib.tums.ac.ir/pub/

Feyz
ISSN: 1029-7855
Publisher: Kashan University of Medical Sciences
Web: www.kaums.ac.ir/magazine

International Journal of Environmental Science and Technology
ISSN: 1735-1472
Publisher: Iranian Society of Environmentalists and Center for Environment and Energy Research and Studies affiliated to Graduate School of the Environment and Energy, Science and Research Campus, Islamic Azad University
Web: http://www.ceers.org/ijest/

Iranian Biomedical Journal
ISSN: 1028852X
Publisher: Pasteur Institute of Iran
Web: www.doaj.org/goto/ibj.pasteur.ac

Iranian Journal of Allergy, Asthma and Immunology
ISSN: 1735-1502
Publisher: Iranian Society of Asthma and Allergy
Web: http://www.iaari.hbi.ir/journal/

Iranian Journal of Anesthesiology and Intensive Care
ISSN: 1027-2704
Publisher: Iranian Society of Anesthesiologists
Address: Tehran 15875-3595
Fax: 021-88046984

Iranian Journal of Basic Medical Sciences
ISSN: 1608-6015
Publisher: Mashhad University of Medical Sciences
Web: http://www.sid.ir/en/JournalList.asp?ID=3505&Name=IRANIAN+JOURNAL+OF+BASIC+MEDICAL+SCIENCES

Iranian Journal of Biotechnology
ISSN: 1728-3043
Publisher: National Institute Genetic Engineering and Biotechnology
Web: http://ijb.nrcgeb.ac.ir/

Iranian Journal of Dermatology
ISSN: 0021-082x
Publisher: Iranian Society of Dermatology
Address: Iranian Society of Dermatology, Tehran 14155-6157
Fax: 9821-88963804
Email: iranjderm@yahoo.com

Iranian Journal of Diabetes and Lipid Disorders
ISSN: 1726-7544
Publisher: TUMS
Web: http://diglib.tums.ac.ir/pub/

Iranian Journal of Endocrinology & Metabolism
ISSN: 1683-4844
Publisher: Center of Endocrinology and Metabolism
Web: www.Ijem.org

Iranian Journal of Environmental Health Science & Engineering
ISSN: 17351979
Publisher: TUMS
Web: http://diglib.tums.ac.ir/pub/

Iranian Journal of Infectious Diseases and Tropical Medicine
ISSN: 1680-0192
Publisher: Society of Infectious Diseases and Tropical Medicine
Web: www.iiccom.com

Iranian Journal of Medical Hypotheses and Ideas
ISSN: 1735-9104
Publisher: TUMS
Web: http://ijmhi.tums.ac.ir

Iranian Journal of Nuclear Medicine
ISSN: 1681-2824
Publisher: Tehran University of Medical Sciences
Web: http://diglib.tums.ac.ir/pub/

Iranian Journal of Pharmaceutical Research
ISSN: 1735-0328
Publisher: School of Pharmacy, Shaheed Beheshti University of Medical Sciences
Web: http://www.ijpr-online.com/

Iranian Journal of Pharmacology & Therapeutics
ISSN: N/A
Publisher: Razi Institute for Drug Research and Iran University of Medical Sciences
Web: http://ijpt.iums.ac.ir

Iranian Journal of Public Health
ISSN: 0304-4556
Publisher: Tehran University of Medical Sciences
Web: http://diglib.tums.ac.ir/pub/

Iranian Journal of Radiation Research
ISSN: 1728-4554
Publisher: Novin Medical Radiation Institute
Web: http://www.ijrr.com/

Iranian Journal of Reproductive Medicine
ISSN: 1680-6433
Publisher: Research and Clinical Center for Infertility, Yazd, Iran
Web: www.yazdivf.org

Iranian Journal of Toxicology
Publisher: Arak University of Medical Sciences
Web: www.ijt.ir

Iranian Polymer Journal
ISSN: 10261265
Publisher: Iran Polymer and Petrochemical Institute
Web: www.doaj.org

Journal of Babol University of Medical Sciences
ISSN: 1561-4107
Publisher: Babol University of Medical Sciences
Web: www.mubabol.ac.ir

Journal of Dentistry
ISSN: 1735-2150
Publisher: TUMS
Web: http://diglib.tums.ac.ir/pub/

Journal of Gorgan University of Medical Sciences
ISSN: 1562-4765
Publisher: Gorgan University of Medical Sciences
Web: http://www.sid.ir/En/JournalList.asp?ID=3861&Name=JOURNAL+OF+GORGAN+UNIVERSITY

Journal of Hygiene and Health
ISSN: 1735-2363
Publisher: Isfahan University of Medical Sciences and Health Services
Web: http://hlth.mui.ac.ir/

Journal of Kerman University of Medical Sciences
ISSN: 1023-9510
Publisher: Kerman University of Medical Sciences
Phone: 0341-2110744
Fax: 0341-2112794
Email: journal@kmu.ac.ir; dmsm.karmania.ir

Journal of Legal Medicine of Islamic Republic of Iran
ISSN: 1027-1457
Publisher: Legal Medicine Organization
Web: www.digestbank.com/MAIN/sources_jou.asp

Journal of Mazandaran University of Medical Sciences
ISSN: 1561-4123
Publisher: Mazandaran University of Medical Sciences
Phone: (+98151) 3261245-8
Fax: 3261244
Email: ala@mmsu.ac.ir

Journal of Medical Council of Iran
ISSN: 1562-1073
Publisher: Medical Council of Iran
Web: www.jmciri.irimc.org

Journal of Medical Faculty, Guilan University of Medical Sciences
ISSN: 1028-6055
Publisher: Guilan University of Medical Sciences
Web: www.gums.ac.ir/

Journal of Military Medicine
ISSN: N/A
Publisher: Baqiyatallah University of Medical Sciences, Military Medicine Research
Web: www.bmsu.ac.ir/pajouheshkadeh2004/M.T.N/home.html

Journal of Medicinal Plants
ISSN: 1684-0240
Publisher: Institute of Medicinal Plants
Web: www.imp.ac.ir

Journal of Research in Medical Sciences
ISSN: 1735-1995
Publisher: Isfahan University of Medical Sciences
Web: http://jrms.mui.ac.ir/

Koomesh
ISSN: 1608-7046
Publisher: Semnan University of Medical Sciences
Web: www.koomesh.sem-ums.com/farsi/index.html

Kowsar Medical Journal
ISSN: 1028-7868
Publisher: Baqiyatallah University of Medical Sciences
Web: www.sid.ir/en/JournalList.asp?ID=339&Name=KOWSAR+MEDICAL+JOURNAL

Medical Journal of the Islamic Republic of Iran
ISSN: 1016-1430
Publisher: National Research Center of Medical Sciences
Web: http://journalseek.net/cgi-bin/journalseek/journalsearch.cgi?

Medical Journal of the Iranian Red Crescent
ISSN: 1561-4395
Publisher: The Iranian Hospital (Dubai) of The Iranian Red Crescent
Web: http://www.rcs.ir

Medical Journal of Reproduction & Infertility
ISSN: 1726-7536
Publisher: Avesina Research Institute, Shaheed Beheshti University
Web: http://www.journal.avesina.ac.ir/english/home.htm

Medical Journal of Tabriz University of Medical Sciences
ISSN: 1608-5671
Publisher: Tabriz University of Medical Sciences
Web: www.medicaljournal.tbzmed.ac.ir

Medical Journal of Reproduction and Infertility
ISSN: 1726-7536
Publisher: Avesina Research Institute (ARI)
Web: http://www.journal.avesina.ac.ir/english/home.htm

Modarres Journal of Medical Sciences
ISSN: 9554-1562
Publisher: Tarbiat Modarres University
Web: www.modares.ac.ir/persian/researchcenter/journal/n2.htm

Pajouhandeh
ISSN: 1735-1022
Publisher: Shaheed Beheshti University of Medical Science
Web: www.sbmu.ac.ir/journal/pajouhandeh/page2.htm

Payesh
ISSN: 1680-7626
Publisher: Jahad-E-Daneshgahi
Web: www.ihsr.ac.ir

Physiology & Pharmacology Journal
ISSN: N/A
Publisher: Iranian Society of Physiology and Pharmacology (IRSPP)
Web: http://www.irspp.hbi.ir/journal.html#top

Quarterly Journal of Fundamentals of Mental Health
ISSN: 1028-6918
Publisher: Ebn-e-Sina Psychiatry Hospital
Web: http://www.divinepsychology.org/journal/index.htm

Rahavard Danesh
ISSN: N/A
Publisher: Arak University of Medical Sciences
Web: www.arakmu.ac.ir/

Scientific Journal of Kurdistan University of Medical Sciences
ISSN: 1560-652X
Publisher: Kurdistan University of Medical Sciences
Phone: (+98871)3232449/(+98871)3284530
Fax: (0871)3237490
Email: kumsj@muk.ac.ir

Shahrekord University of Medical Sciences Journal
ISSN: 1735-1448
Publisher: Shahrekord University of Medical Sciences
Phone: 0381-3338047
Fax: 0381-3334911
Email: majaleh@sksmu.ac.ir

Shiraz E-Medical Journal
ISSN: 1735-1391
Publisher: Department of Medicine, Shiraz University of Medical Sciences
Web: http://semj.sums.ac.ir/

The Journal of Qazvin University of Medical Sciences
ISSN: 1561-3666
Publisher: Qazvin University of Medical Sciences
Web: www.qums.ac.ir

Yakhteh Medical Journal
ISSN: 1561-4921
Publisher: Royan Institute
Web: www.royaninstitute.org

Databases

Iranmedex
Web: www.iranmedex.com

HBINET
Web: www.hbi.ir

IranScienceNet
Web: http://www.iranscience.net/

Core Documents

National Profile on Chemical Safety in Iran (2000)
Farshad AA, Balali-Mood M, Abdollahi M, Jalali N, Javadi I, Falaki F, Ezzatian R, Malekahmadi F, Sabzevari O

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Iran, Plant Protection Organization, and Ministry of Industry

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Fax: 98 21 66707417
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CHAPTER

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Israel

YEDIDIA BENTUR AND BIANCA RAIKHLIN-EISENKRAFT

INTRODUCTION

After the establishment of the State of Israel in 1948, the discipline of Toxicology received a tremendous uplift throughout the country.

The importance of the discipline has been increasingly recognized and Toxicology has been pursued and developed in university departments and governmental agencies. Attention is being drawn to the adverse effects of pollution. The marketing and utilization of pesticides are regulated by the Ministries of Agriculture and Environmental Protection. Air quality is closely monitored by the Ministry of Environmental Protection. Disposal of hazardous wastes is regulated and specific sites have been allocated. The Israel Institute of Standards has established standards which are being regularly updated for the protection of human health and the environment. The Ministry of Health regulates and controls the marketing and utilization of medications as well as of water and food quality.

The Israel Poison Information Center was established in 1964 and its main goal is to provide 24 hour/7 days/week telephone consultations in clinical and occupational toxicology, first aid and triage including laboratory services. Heathcare providers and the public receive online consultation on the management and follow-up of patients with acute poisonings. In addition to daily rounds, journal clubs and seminars, as well as participation in bi-annual national toxicology meetings, the staff of MDs and PhDs is engaged in updating the intentional commercial products database, as well as teaching, research, and regulatory activities.

The Center's databases are a reliable information source on the active ingredients of commercial products and on the epidemiology of poisonings in Israel.

RESOURCES

Books

Bentur Y (Ed.)
Medical Management Monographs on Hazardous Materials in Multicasualty Incidents: Hospital Guidelines, 3rd Edition
Emergency and Disaster Division, Israel Ministry of Health, in press (Hebrew).
(The two previous editions were published in December 2001 and 1996).

Journals

Harefuah, The Israel Medical Association Journal
in Hebrew
35 Jabotinsky Street, Ramat-Gan 52136
Phone: +972-3-6100430
Fax: +972-3-5751616

IMAJ, The Israel Medical Association Journal
in English
Email: imaj@ima.org.il

Israel Environment Bulletin
Ministry for Environmental Protection, Israel Web: http://www.environment.gov.il
P.O. Box 34033
Jerusalem 95464

Israel Journal of Emergency Medicine
Web: www.isrjem.org

Pharmaline
A professional journal for pharmacists.
Email: pharmaso@zahav.net.il

Safety
Bulletin of the Israel Institute for Occupational Safety and Hygiene, Ministry of Labour and Welfare, Israel
Web: www.osh.org.il

Databases

Databases of the Israel Poison Information Center
Toxicological medical records and commercial products database; proprietary databases not available for the general public.

The Israel Drug Registry
Pharmaceutical Administration, Ministry of Health
Web: http://www.health.gov.il/units/pharmacy/trufot/index.asp?safe=e (English)
Web: http://www.health.gov.il/pages/default.asp?maincat=11&catid=38&pageid=165 (Hebrew)

The Israel Cosmetics and Toiletry Registry
Pharmaceutical Administration, Ministry of Health
Web: http://www.health.gov.il/units/pharmacy/tamruk/tamruk_start.asp (Hebrew only)

Database of Homeopathic Preparations
Pharmaceutical Administration, Ministry of Health
Web: http://www.health.gov.il/pages/default.asp?maincat=11&catid=242&pageid=4161 (Hebrew only)

Pesticide Database
Ministry for Environmental Protection
Web: http://www1.sviva.gov.il/heterim/html/hip_tacshir.asp?search_type=hip_tacshir.asp (Hebrew only)

Pesticide Data Bank
Ministry of Agriculture and Rural Development
Web: http://www.moag.gov.il/ppis/english/ (English)
Web: http://www.moag.gov.il/ppis/Default.htm (Hebrew)

Organizations (Government)

Israel Ministry of Environmental Protection
Web: http://www.sviva.gov.il/bin/en.jsp?enPage=e_homePage (English)
Web: http://www.sviva.gov.il/bin/en.jsp?enPage=HomePage (Hebrew)
Phone: +972-2-6553777 (main office)
Phone: +972-2-6495803 (public service)
Fax: +972-26495892 (public service)
Email: pniot@sviva.gov.il (public service)

The goals of the Ministry for Environmental Protection are to formulate a comprehensive national environmental policy and to develop the tools necessary for implementing this policy. The Ministry seeks to incorporate environmental considerations into decision-making and planning processes; to promote sustainable development; to implement programs for pollution control, monitoring and research; to develop and update legislation and standards; to ensure effective enforcement and supervision; to improve environmental education and awareness; and to advance regional and global cooperation on the environment.

Air Quality Web: http://www.sviva.gov.il/bin/en.jsp?enPage=e_BlankPage&enDisplay=view&enDispWhat=Zone&enDispWho=Air_Qual&enZone=Air_Qual& (English)
Web: http://www.sviva.gov.il/bin/en.jsp?enPage=BlankPage&x=1&enDisplay=view&enDispWhat=Zone&enDispWho=echut_haavir&enZone=echut_haavir& (Hebrew)
Phone: +972-2-6553918 (department secretary)
Fax: +927-2-6553763
Email: gilam@sviva.gov.il

Air quality in Israel is impacted by rapid industrial development, growing vehicle use, rising standards of living and an ever-growing population. In recent years, measures have been initiated to reduce air pollution from all sources – transportation, electricity production, industry and quarrying operations. At the same time, efforts have been invested in implementing the provisions of international conventions on ozone depletion and climate change.

Hazardous substances
Web: http://www.sviva.gov.il/bin/en.jsp?enPage=e_BlankPage&enDisplay=view&enDispWhat=Zone&enDispWho=HAZARDOUS&enZone=HAZARDOUS (English)
Web: http://www.sviva.gov.il/bin/en.jsp?enPage=BlankPage&x=1&enDisplay=view&enDispWhat=Zone&enDispWho=chomarim_mesucanim&enZone=chomarim_mesucanim& (Hebrew)
Phone: +972-3-7634544 (National Center for Hazardous Substances)
Fax: +972-3-7634548
Email: zohary@sviva.gov.il

Hazardous substances, which are found in almost every sector, pose a grave risk to human health and the environment. Therefore, appropriate safety and control procedures for handling and treating hazardous substances and their wastes are integral elements in Israel's environmental management program. Several government ministries are responsible for the implementation of dozens of laws and regulations dealing with all aspects of hazardous substances. The Ministry of the Environment has instituted a host of administrative and legislative measures to control hazardous substances at every stage of production, transfer, maintenance, use, and disposal. At the same time, the Ministry is promoting a policy based on minimization, reuse, recycling, neutralization, and safe disposal of hazardous wastes.

Emergency Environmental Center
Web: http://sviva.gov.il/bin/en.jsp?enPage=e_BlankPage&enDisplay=view&enDispWhat=Zone&enDispWho=emergency&enZone=emergency (English)
Web: http://www.sviva.gov.il/bin/en.jsp?enPage=BlankPage&enDisplay=view&enDispWhat=Zone&enDispWho=information_center&enZone=information_center& (Hebrew)
Phone: 1222-6911, *6911

The Environmental Center operates within the framework of the Information and Response Center. The Center serves as the focal point for information and response on environmental accidents at the time of their occurrence, including: discharge of a hazardous material to the environment, leak from a container or moving truck, dispersal of sharp odors in the environment, leak of household gas from a central gas system, marine or coastal pollution, exceptional air pollution river or water source pollution, dumping of hazardous waste in the public domain animal abuse, miscellaneous environmental accidents.

Water
Web: http://www.sviva.gov.il/bin/en.jsp?enPage=e_BlankPage&enDisplay=view&enDispWhat=Zone&enDispWho=water_top&enZone=water_top& (English)
Web: http://www.sviva.gov.il/bin/en.jsp?enPage=BlankPage&x=1&enDisplay=view&enDispWhat=Zone&enDispWho=maim&enZone=maim& (Hebrew)
Phone: +972-2-6553840/1 (department secretary)
Fax: +972-26520552
Email: sigal@sviva.gov.il

Preservation of Israel's water resources is one of the major challenges confronting the country today. Israel entered the 21st century with one of its greatest water overdrafts ever. Today this cumulative deficit stands at some 1.5 billion cubic meters, an amount equal to the annual consumption of the country, in comparison to the average annual replenishment rate of major aquifers. Moreover, water scarcity is exacerbated by the deteriorating quality of water resources due to demographic, industrial, and agricultural pressures. Preservation of Israel's water resources is one of the major challenges confronting the country today. Israel entered the 21st century with one of its greatest water overdrafts ever.

Rivers
Web: http://www.sviva.gov.il/bin/en.jsp?enPage=e_BlankPage&enDisplay=view&enDispWhat=Zone&enDispWho=Rivers&enZone=Rivers& (English)
Web: http://www.sviva.gov.il/bin/en.jsp?enPage=BlankPage&x=1&enDisplay=view&enDispWhat=Zone&enDispWho=maim_venehalim&enZone=maim_venehalim& (Hebrew)

In Israel, there are 16 main rivers which flow into the Mediterranean Sea and 25 main rivers that flow to the Jordan River and Lake Kinneret (Sea of Galilee). All of them once supported rich aquatic and wetland ecosystems where fauna and flora thrived. With time, a rapidly expanding population, accelerated urbanization and industrialization, and growing agricultural needs led to the depletion and deterioration of the country's rivers. Water was diverted for drinking and agricultural irrigation, sewage was introduced and the natural habitats of plants and animals were destroyed. The Ministry of the Environment has long recognized the urgent need for action and placed river restoration high on its agenda. Over the past decade, it has invested major efforts in making sure that Israel's ailing rivers are restored and revitalized. Growing awareness has led to major governmental, public and private investments in pollution prevention and ecological restoration. Over the past decade, billions of dollars were invested in sewage facilities and wastewater treatment plants, in upgrading pretreatment facilities in the country's factories and in rehabilitating riverbanks, establishing riverside parks and restoring natural habitats.

Radiation
Web: http://www.sviva.gov.il/bin/en.jsp?enPage=e_BlankPage&enDisplay=view&enDispWhat=Zone&enDispWho=radiation_subject&enZone=radiation_subject (English)
Web: http://www.sviva.gov.il/bin/en.jsp?enPage=BlankPage&x=1&enDisplay=view&enDispWhat=Zone&enDispWho=btichut_krina&enZone=btichut_krina& (Hebrew)

Phone: +972-26495839 (public service)
Fax: +972-2-6495870 (public service)
Email: chanaig@sviva.gov.il

Radiation is energy that travels in the form of waves or high-speed particles. There are many different types of radiation that have a range of energy forming an electromagnetic spectrum. The spectrum has two major divisions: non-ionizing and ionizing radiation. The Radiation Abatement Division of the Ministry of the Environment is responsible for both ionizing and non-ionizing radiation, including the risks associated with the entire spectrum of electromagnetic radiation.

Israel Institute for Occupational Safety and Hygiene
Web: http://www.osh.org.il/site/english_main.html (English)
Web: http://osh.org.il/homepage.asp (Hebrew)
Phone: +972-3-5266444
Fax: +972-3-5266457
Email: mail@osh.org.il
22 Mazah Street, P.O. Box 1122, Tel Aviv, 61010, Israel

Israel Institute for Occupational Safety and Hygiene (IIOSH) is Israel's national public institution concerned with workplace safety and health. It was established in the 1950s on the basis of organizations and laws that came into existence during the period of the British Mandate, prior to the establishment of the State of Israel in 1948. These regulations reinforced the activity of organizations founded earlier (at the beginning of the 1930s) that dealt with occupational safety, such as: the General Trade Union, the Manufacturers' Association, and the Jewish Agency. However, the field of occupational safety obtained its formal and mandatory status, acknowledged by the Mandate authorities and the Jewish leaders, only in 1946.

Israel Ministry of Health
Web: http://www.health.gov.il/english/ (English)
Web: http://www.health.gov.il/ (Hebrew)
Phone: +972-2-5681318 (public service)
Fax: +972-2-6725836
Email: pniot@moh.health.gov.il
2 Ben-Tabay Street, Jerusalem 93461, Israel
Emergency and Disaster Management Division
Web: http://www.health.gov.il/english/Pages_E/default.asp?maincat=3&catId=15&PageId=42 (English)
Web: http://www.health.gov.il/pages/default.asp?maincat=27 (Hebrew)
Phone: +972-3-6932323/+972-3-6932312/+972-3-6932315
Fax: +972-3-6916379, +972-3-6917306
Email: ana_e@emergency.health.gov.il
119 Igal Alon Street, Tel Aviv, Israel

The Emergency and Disaster Management Division is responsible to assessment, evaluation and preparedness of the Israeli medical system for mass casualty incidents including trauma and terror attack victims, toxicological events and chemical warfare.

Pharmaceutical administration
Web: http://www.health.gov.il/english/Pages_E/default.asp?maincat=10 (English)
Web: http://www.health.gov.il/pages/default.asp?maincat=11 (Hebrew)
29 Rivka Street, Jerusalem 93461, Israel
Phone: +972-2-25681212/+972-2-5681213 (department secretary)
Fax: +972-2-6725820

The Pharmaceutical Administration is the responsible body in the Ministry of Health for regulation of pharmaceutical and medical products, cosmetics, medical devices and drug treatment; for the development of rational use of medications and other health products and development of a national drug policy. Its main objective is to ascertain that all medications, medical devices, and other health products on the Israeli health market meet appropriate standards of safety, efficacy, and quality and are consumed on an optimal cost–benefit basis. The departments of the Pharmaceutical Administration include the Department of Drug Registry, the Institute of Standards and Control of Medicinal Products, Pharmacoepidemiology and Pharmacoeconomics and the Department of Clinical Trials.

Department of Environmental Medicine
Web: http://www.health.gov.il/pages/default.asp?maincat=26 (Hebrew only)
Phone: +972-2-6228847 (department secretary)
Fax: +972-2-6258136
Email: zeeva.asayag@moh.health.gov.il

Topics dealt with by the department include drinking water, fluoridation of water, swimming pools, ritual baths, institutional sanitation, youth camps, sewage, irrigation with purified sewage water, business administration and food facilities.

Department of Laboratories
Web: http://www.health.gov.il/units/mahabadot/index.htm (Hebrew only)
Phone: +972-2-6551855/+972-2-6551856/+972-2-6551857
Fax: +972-2-6528079
9 Eliav Street, P.O. Box 34410, Jerusalem 91342, Israel
Email: labdept@eliav.health.gov.il

The Department of Laboratories deals with accreditation of medical laboratories and medical laboratory technicians.

Food and Diet Services
Web: http://www.health.gov.il/pages/default.asp?maincat=51&catId=330&PageId=2533 (Hebrew only)
Phone: +972-3-6270100
Fax: +972-3-6270126
Email: Pniot_hazibur@fcs.health.gov.il

Ministry of Industry, Trade and Labor
Web: http://www.tamas.gov.il/NR/exeres/B0B48981-357D-446F-AFAC-91A358E93C87.htm (English)
Web: http://www.tamas.gov.il/ (Hebrew)
Phone: +972-2-6662000/+972-2-667910
Fax: +972-2-6245110
30 Agron Street, Jerusalem 94142, Israel

The Ministry of Industry, Trade and Labor focuses on the promotion of economic growth in Israel. The Ministry is engaged in the encouragement and support of export and international commerce, in order to assist Israeli businesses in enhancing their exports and entering new markets abroad. Other activities and units include the Israel Laboratory Accreditation Authority, The Anti-Trust Authority, The Director of Consumer Protection, The Director of Standards, The Domestic Trade Administration, The Israel Consumer Council, The Israel Standards Institute and The National Physics Laboratory.

Surveillance of Work, Safety and Occupational Health
Web: http://www.moital.gov.il/NR/exeres/56284B38-36A0-4D46-B61F-698E0DBA1066.htm (Hebrew only)
Phone: +972-2-6662811
Fax: +972-2-6662973/+972-2-6662972
Email: pikuah.avoda.manage@moital.gov.il
5 Bank Israel Street, P.O. Box 3166, Jerusalem 91036, Israel

Chemistry and Environment Administration
Web: http://www.tamas.gov.il/NR/exeres/33D0AE32-C6EA-42F7-8D2B-F315E6C7B05B.htm (Hebrew only)
Phone: +972-2-6662427, +972-2-6662428 (director)
Fax: +972-2-6662922
Email: ohador@moital.gov.il
Israel Laboratory Accreditation Authority
Web: http://www.israc.gov.il/english/800×600.asp (English)
Web: http://www.israc.gov.il/800×600.asp (Hebrew)
Phone: +972-3-9702727
Fax: +972-3-9702413
Email: israc@israc.gov.il
P.O. Box 89, Lod, Airport 70150, Israel

Ministry of Agriculture and Rural Development
Web: http://www.moag.gov.il/english/ (English)
Web: http://www.moag.gov.il/ (Hebrew)
Phone: +972-3-9485544
Fax: +972-3-9485835
Email: sar@moag.gov.il
Derekh Hamacabim Street, Rishon Lezion, P.O. BOX, Bet Dagan 50250, Israel

Plant Protection and Inspection Services
Web: http://www.moag.gov.il/ppis/english/ (English)
Web: http://www.moag.gov.il/ppis/ (Hebrew)
Phone: +972-3-9681500 (director)
Fax: +972-3-9603005
Email: eldadl@moag.gov.il
Phone: +972-3-9681562 (pesticides)
Fax: +972-3-9681582
Email: rina@moag.gov.il
Phone: +972-3-9681563 (pesticide database)
Fax: +972-3-9681582
Email: leal@moag.gov.il

Pesticides represent an important component of Integrated Pest Management in Israeli agricultural production. However, reckless application of pesticides may cause serious damage to users, to treated crops, and to consumers of these crops. In order to assure efficient and safe usage of pesticides, the following regulations are implemented and enforced:

Plant Protection Act: regulating import and marketing of pesticides and approval of new formulations.

Labeling regulations: enforcing labeling with detailed instructions for use, potential hazards and ways to prevent them – written in Hebrew on all packages containing pesticides sold to customers. The manufacturers are held legally responsible for the contents of these instructions.

Veterinary Services and Animal Health
Web: http://www.vetserveng.moag.gov.il/vetserveng (English)
Web: http://www.vetserv.moag.gov.il/vetserv (Hebrew)
Phone: +972-3-9681600
Fax: +972-9505292
Email: dinar@moag.gov.il

Laboratory Services – Kimron Veterinary Institute
Web: http://www.vetserveng.moag.gov.il/VetServEng/Files/Fields/KimronVeterinaryInstitute/default.htm (English)
Web: http://www.vetserv.moag.gov.il/VetServ/Files/Fields/MachonVeterinary/default.htm (Hebrew)
Phone: +972-3-9681682 (director)
Fax: +972-3-9605293
Email: dir-kimron@moag.gov.il

Department of Toxicology
Phone: +972-3-9681672
Fax: +972-3-9681730
Email: alans@moag.gov.il

The Kimron Veterinary Institute is the diagnostic and research branch of the Veterinary Services and Animal Health. It is affiliated with the Hebrew University of Jerusalem and its Koret School of Veterinary Medicine which is located on the Bet Dagan campus. The Kimron Veterinary Institute receives samples from veterinarians and from the field.

Regulation of Veterinary Biologicals and Drugs
Web: http://www.vetserv.moag.gov.il/VetServ/Files/Fields/PikuachTachshitim/default.htm (Hebrew only)
Phone: +972-3-9681759 (department secretary)
Fax: +972-3-9688912
Email: sheilaw@moag.gov.il

Israel Institute for Occupational Safety and Health
Web: http://www.osh.org.il/site/english_main.html (English)
Web: http://osh.org.il/homepage.asp (Hebrew)
Phone: +972-3-5266444
Fax: +972-3-5266457
Email: mail@osh.org.il
22 Mazah Street, P.O. Box 1122, Tel Aviv 61010, Israel

The Israel Institute for Occupational Safety and Hygiene (IIOSH) is Israel's national public institution concerned with workplace safety and health. It was established in the 1950s on the basis of organizations and laws that came into existence during the period of the British Mandate, prior to the establishment of the State of Israel in 1947. These regulations reinforced the activity of organizations founded earlier (at the beginning of the 1930s) that dealt with occupational safety, such as: the General Trade Union, the Manufacturers' Association, and the Jewish Agency. However, the field of occupational safety obtained its formal and mandatory status, acknowledged by the Mandate authorities and the Jewish leaders, only in 1946. Following the establishment of the State of Israel, this field of activity received its semi-governmental status in 1950, with a special secretary appointed to coordinate the activity in the field of the occupational safety under supervision by one of the departments of the Ministry of Labour. IIOSH was founded as a statutory tripartite non-profit institution in accordance with the 'Labour Inspection (Organization) Law – 1954'.

The Standards Institution of Israel
Web: http://www.sii.org.il/siisite.nsf/EngHomePage?OpenForm (English)
Web: http://www.sii.org.il/siisite.nsf/HomePage?OpenForm (Hebrew)
Phone: +972-3-6465116 (public relations)
Email: vered@sii.org.il

The Israel Institution of Standards is a national corporation operating by the 1953 law of standards. The objectives of this institute are to prepare standards and to ensure quality of consumer products. Over the years its activities have expanded to various aspects of life and it kept its leading role in promoting quality while ensuring citizens' safety, welfare, and quality of life. Industry, business, consumer, governmental, academic, and research sectors are represented in the various committees of the institute. Its three main areas of activities include standards, testing, and quality assurance.

Non-Government Organizations

Greenpages Israel
Web: http://www.greenpages.co.il/web_eng/http://www.greenpages.co.il/web_eng/index.html (English)
Web: http://www.greenpages.co.il/ (Hebrew)
Phone: +972-077-4242395 (Eitan Amiel)
Email: info@Greenpages.co.il
27 Yakov Tsur Street, Jerusalem 96411, Israel

Greenpages Israel is a complete index of environmental technologies in Israel presenting the variety of manufacturers, service-suppliers, and organizations involved in the environmental developments in Israel. The issue of Environmental Technologies in Israel is quickly developing today. In Greenpages Israel updated information about companies and organizations in this intensively growing field is displayed. The website presents also information about start-up companies and studies discussing environmental problems

Life and Environment
Web: http://www.sviva.net/Info.php?docId=ourVision (English)
Web: http://www.sviva.net/ (Hebrew)
Phone: +972-3-5602256
Fax: +972-3-5602104
Email: sviva@sviva.net
85 Nahalat Binyamin Street, Tel Aviv 66102, Israel

Green Course – Students for the Environment
Web: http://www.green.org.il/eng/ (English)
Web: http://www.green.org.il/beta/index.php (Hebrew)
Phone: +972-3-6388671
Fax: +972-3-5374302
Email: gidon@greem.org.il
P.O.Box 472, Tel Aviv, Israel

Green Action Eco-Social Change
Web: http://www.greenaction.org.il/english/index.html (English)
Web: http://www.greenaction.org.il/index.php (Hebrew)
Phone: +972-3-5270477
Fax: +972-3-5222224
Email: info@greennaction.org.il
20 Mapu Street, P.O. Box 5118, Tel Aviv 61050, Israel

Macabi Healthcare Services – Occupational Medicine
Web: http://www.osh.org.il/site/mi_macabi.html (Hebrew)
Phone: 1-700-50-53-53. *3555 (customer service)

Clalit Health Services – Occupational Health
Web: http://www.clalit.org.il/HE-IL/MedicalService/clinics/ (Hebrew)
Phone: 12222700, *2700 (customer service)

Universities

Technion-Israel Institute of Technology
Web: http://www.technion.ac.il/_root/index.html (English)
Web: http://www.technion.ac.il/_root/index-heb.html (Hebrew)
Phone: +972-4-8292111
Email: pard@tx.technion.ac.il
Technicon City, Haifa 32000, Israel

Civil & Environmental Engineering
Web: http://www.technion.ac.il/~ceesite/ (English)
Web: http://cee.technion.ac.il/ (Hebrew)
Phone: +972-4-8293066, +972-4-8295887 (Dean's office)
Email: deansecr@cv.technion.ac.il

The Ruth & Bruce Rappaport Faculty of Medicine
Web: http://md.technion.ac.il/inner2/index_eng.php (English)
Web: http://md.technion.ac.il/inner2/index_heb.php (Hebrew)
Phone: +972-4-8295200
Fax: +972-4-8517008
Email: medicine@tx.technion.ac.il
1 Efron Street, P.O. Box 9649, Bat Galim, Haifa 31096, Israel

Biotechnology and Food Engineering
Web: http://www.technion.ac.il/biotech/ (English only)
Phone: +972-4-8293068, 972-4-8293069 (Dean's office)
Fax: +972-4-8320742
Email: biodean@techunix.technion.ac.il

Shulich Faculty of Chemistry
Web: http://chemistry.technion.ac.il/ (English only)
Phone: +972-4-8293664, 972-4-8293727 (Dean's office)
Fax: +972-4-8295860
Email: chemp-l@techunix.technion.ac.il

Environmental Health Engineering
Web: http://sviva.technion.ac.il/ (Hebrew only)
Phone: +972-4-8295886/+972-4-8295887
Fax: +972-4-8220133
Email: deancecr@tx.technion.ac.il

Department of Biomedical Engineering
Web: http://www.bm.technion.ac.il/ (English only)
Phone: +972-4-8292079/+972-4-8292084
Fax: +972-4-8295710
Email: medean@tx.technion.ac.il

Ben-Gurion University of the Negev
Web: http://cmsprod.bgu.ac.il/Eng/Home/ (English)
Web: http://cmsprod.bgu.ac.il/Home (Hebrew)
Phone: +972-8-6477408 (public relations)
Phone: +972-8-6461111 (operator)
Phone: +972-8-6422111
Fax: +972-8-6477659
Email: rtemes@bgumail.bgu.ac.il
P.O. Box 653, Beer-Sheva 84105, Israel

The Faculty of Health Sciences
Web: http://cmsprod.bgu.ac.il/eng/fohsbrew (English)
Web: http://cmsprod.bgu.ac.il/fohs (Hebrew)
Phone: +972-8-6477408 (public relations)
Fax: +972-8-647763
Email: rtemes@bgu.ac.il

The Faculty of Natural Sciences
Web: http://cmsprod.bgu.ac.il/Eng/Home/Academics/naturalsciences.htm (English)
Web: http://cmsprod.bgu.ac.il/Teva/ (Hebrew)
Phone: +972-8-6461633, +972-8-6461634 (Dean's office)
Phone: +972-8-6461632 (administration)
Fax: +972-8-6477946 (administration)
Email: nilis@bgu.ac.il

The Faculty of Engineering Sciences
Web: http://cmsprod.bgu.ac.il/Eng/engn/ (English)
Web: http://cmsprod.bgu.ac.il/engn (Hebrew)
Phone: +972-8-6461774
Fax: +972-8-6479401
Email: miriwiz@bgu.ac.il

The National Institute for Biotechnology in the Negev
Web: http://cmsprod.bgu.ac.il/Eng/Centers/nibn/ (English)
Phone: +972-8-6461963 (director)
Fax: +972-8-6472983
Email: vardasb@bgu.ac.il

Blaustein Institutes for Desert Research
Web: http://bidr.bgu.ac.il/bidr/ (English only)
Phone: +972-8-6596777
Fax: +972-8-6596703
Email: bidr@bgumail.bgu.ac.il

Ben-Gurion University of the Negev, Sede Boqer Campus, 84990 Israel
Department of Geological and Environmental Sciences
Web: http://cmsprod.bgu.ac.il/eng/teva/departments/geological (English)
Web: http://cmsprod.bgu.ac.il/Teva/departments/geological/ (Hebrew)
Phone: +972-8-6461288/+972-8-6461289
Fax: +972-8-6472997
Email: geology@bgu.ac.il

Tel Aviv University
Web: http://www.tau.ac.il/
Phone: +972-3-6408111
Fax: +972-3-6422752
Email: tauinfo@post.tua.ac.il
Tel Aviv University, P.O Box 39040, Ramat Aviv, Tel Aviv 69978, Israel

Sackler Faculty of Medicine
Web: http://www.tau.ac.il/medicine/
Phone: +972-3-6409796
Phone: +972-3-6409657 (Dean's office)
Fax: +972-3-6407673

The Porter School of Environmental Studies
Web: http://www.environment.tau.ac.il/Eng/ (English)
Web: http://www.environment.tau.ac.il/ (Hebrew)
Phone: +972-3-6405720
Fax: +972-3-6405723
Email: environ@post.tau.ac.il

The Hebrew University of Jerusalem
Web: http://www.huji.ac.il/huji/eng/index_e.htm (English)
Web: http://www.huji.ac.il/huji/index.htm (Hebrew)
Phone: +972-2-6585111
Fax: +972-2-5812738
Email: webmaster@savion.huji.ac.il
Givat Ram 2000. Jerusalem, Israel

Faculty of Medicine
Web: http://medicine.huji.ac.il/ (English only)
Phone: +972-2-6758111
Fax: +972-2-6416015
The Faculty of Medicine, P.O. Box 12272, Jerusalem 91120, Israel

Faculty of Agricultural, Food and Environmental Quality Sciences
Web: http://www.agri.huji.ac.il/index-eng.html (English)
Web: http://www.agri.huji.ac.il/index.html (Hebrew)
Phone: +972-8-9489111
Fax: +972-8-9462384
Email: deanagri@agri.huji.ac.il

School of Pharmacy – Faculty of Medicine
Web: http://pharmacy.huji.ac.il/eng/default.asp (English)
Web: http://pharmacy.huji.ac.il/default.asp (Hebrew)
Phone: +972-2-6757125
Fax +972-2-6757252
Email: taliah@savion.cc.huji.ac.il
P.O. Box 12065, Jerusalem 91120, Israel

Midreshet Sde Boker
Web: http://www.boker.org.il/english/ (English)
Web: http://www.boker.org.il/ (Hebrew)
A desert and environmental research center.
Phone: +972-8-6532801 (main office)
Fax +972-8-6558352
Email: midrasha@boker.org.il
7 Zogia Street, P.O. Box 146, Midreshet Ben Gurion 84990, Israel

The Arava Institute for Environmental Studies
Web: http://www.arava.org/new/ (English only)
Phone: +972-8-6356618
Fax: +972-8-6356634
Email: friendsofarava@arava.org
Kibbutz Ketura, D.N. Hevel Eilot 88840, Israel

Israel Oceanographic and Limnological Research
Web: http://www.ocean.org.il/MainPageEng.asp (English)
Web: http://www.ocean.org.il/MainPage.asp (Hebrew)
Phone: +972-4-8565200
Fax: +972-4-8511911
Email: ask-ioir@ocean.org.il
Tel Shikmona, P.O. Box 8030, Haifa 31080, Israel

Professional Societies

Israel Medical Association
Web: http://www.ima.org.il/EN/ (English)
Web: http://www.ima.org.il/ (Hebrew)
Phone: +972-3-6100444
Fax: +972-3-5751616
35 Jabotinsky Street, P.O. Box 3566, Ramat Gan 52136, Israel

Israel Society of Toxicology

The Israel Society of Toxicology is a professional and academic organization of expert physicians and laboratory personnel practicing clinical toxicology. The objectives of this society are to improve care of the

poisoned patient, promote the profession of Clinical Toxicology and to participate in poison prevention activities. The Society has two scientific meeting annually and it collaborates with the Israel Association of Emergency Medicine and 'Safe Kids' organization.

Chairman: Yedidia Bentur, MD, Israel Poison Information Center, Rambam Health Care Campus, P.O Box 9602, Haifa 31096, Israel
Email: ipic@rambam.health.gov.il

Israel Association of Occupational Medicine
Contact via Israel Medical Association

Israel Society for Physiology & Pharmacology – ISPP
Web: http://www.ispp.org.il/ (English only)
Email: secretary@ispp.org.il

The Pharmaceutical Society of Israel (PSI)
Web: http://www.psi.org.il/ (Hebrew only)
Fax: +972-3-7601111
Email: membership@psi.org.il
P.O. Box 25345, Tel Aviv 61253, Israel

National Poison Information Center

Israel Poison Information Center
Rambam Health Care Campus
The Rappaport Faculty of Medicine, Technion
Web: http://www.rambam.org.il/Home+Page/Departments+and+Clinics/Division+of+Laboratory+Services/Poison+Information/default.htm (English)
Web: http://www.rambam.org.il/default.htm מחלקות+ומרפאות/אגף+מעבדות/מידע+בהרעלות (Hebrew)
Phone: +972-4-8542725 (main office)
Phone: +972-4-8541900 (emergency line
Fax: +972-4-8542092
Email: ipic@rambam.health.gov.il

Laboratory of Clinical Toxicology and Pharmacology
Israel Poison Information Center
Rambam Health Care campus
Web: http://www.rambam.org.il/Home+Page/Departments+and+Clinics/Division + of + Laboratory + Services/Toxicology/default.htm (English)
Web: http://www.rambam.org.il/default.htm מחלקות+ומרפאות/אגף+מעבדות/טוקסיקולוגיה
Phone: +972-4-8542728
Fax: +972-4-8542092
Email: ipic@rambam.health.gov.il

Miscellaneous Resources

Israel Biotech News
Web: http://www.bioisrael.com/
Phone: +972-9-7409127
Email: info@bioisrael.com
BioIsrael Communications Ltd.
3/6 Kaplanski Street, Kfar Saba 44326. Israel

About Israel

The World Factbook – Israel
Web: http://www.cia.gov/cia/publications/factbook/geos/is.html

Israel Government Website
Web: http://gov.il/FirstGov/english (English)
Web: http://gov.il/FirstGov (Hebrew)

Israel Ministry of Foreign Affairs
Web: http://www.mfa.gov.il/mfa (English)
Web: http://www.mfa.gov.il/MFAHeb (Hebrew)
Phone: +972-2-5303111
Fax: +972-2-5303896

Israel News

The Jerusalem Post
Web: http://www.jpost.com/
Phone: +972-2-5315621
Fax: +972-2-5315622
P.O. Box 81, Jerusalem 91000, Israel

Haaretz
Web: http://www.haaretzdaily.com/ (English)
Web: http://www.haaretz.co.il/ (Hebrew)
Phone: +972-3-5121212
Fax: +972-3-6815857

Ha'aretz Daily Newspaper Ltd
21 Salman Schocken Street, Tel-Aviv 61001, Israel

Ynet
Web: http://www.ynetnews.com/home/0,7340,L-3083,00.html (English)
Web: http://www.ynet.co.il/home/0,7340,L-8,00.html (Hebrew)
(HEB) Phone: +972-3-6932424
Fax: +972-3-6932466
Email: sds@y-i.co.il

Globs
Web: http://new.globes.co.il/serveEN/ (English)
Web: http://www.globes.co.il/serve/ (Hebrew)
Phone: +972-3-9538777
Email: freedback@globes.co.il

Maariv
Web: http://www.nrg.co.il/online/HP_0.html (Hebrew only)
Phone: +972-3-5638795
Email: ads@maariv.co.il

CHAPTER

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Italy

MARINA MARINOVICH, MAURELLA DELLA SETA, PAOLO PREZIOSI, IDA MARCELLO, AND ROBERTO BINETTI

INTRODUCTION

The first information on toxic substances can be found in the works of Pietro d'Abano (1256–1315): *Liber de Veneni,* published posthumously 1402; Pietro Andrea Gregorio Mattioli (1500–1577), the father of modern botany: a textbook on herbs and a translation, with comments, of *De Pedacio Dioscoride Anarzabeo Libri Quinque* (1544); Francesco Redi (1626–1698); and Felice Fontana whose treatise on viper poison was published in 1781.

A more modern approach was done by Prof. Bernardo Ramazzini (1633–1714) of the University of Bologna, who, describing several cases of occupational intoxication and outlining the health hazards of irritating chemicals, dust metals and other abrasive agents, can be considered the father of industrial toxicology and occupational medicine in Italy.

In the latter half of the 19th century, eminent professors of pharmacology in Italian universities also turned their attention to mechanistic problems in toxicology: Pietro Albertoni (1849–1933), Luigi Sabbatani (1863–1928), and Pietro Giacosa (1853–1928). The latter was the author of a textbook on medicine, pharmacology, and toxicology.

The two branches of toxicology in Italy, forensic and industrial, developed in parallel, and in 1910 the first Department of Occupational Medicine was opened at the University of Milan by Prof. Luigi Devoto (1864–1936), one of the most highly respected figures in this field.

This was followed in 1917 by the creation, at the Pharmacology Institute of the University of Florence, of a Division of Toxicology, which was later directed by the famous pharmaco-toxicologist Mario Aiazzi Mancini (1887–1980).

In the present the history of toxicology in Italy is well represented by the activity of the Italian Society of Toxicology. The Italian Society of Toxicology (SITOX, formerly SIT) was founded in Pavia on October 20, 1967. The founding members were Prof. Pietro Mascherpa, Director of the Institute of Pharmacology of the University of Pavia School of Medicine, and Professors Gianmartino Benzi and Francantonio Bertè. The President of the Republic officially recognized the Society on May 16, 1972. It is actively engaged in promoting the value of scientific, professional and regulatory aspects of modern toxicology.

RESOURCES

Books

Annuario DEA delle Università e Istituti di Studio e di Ricerca in Italia 2001–2002
Roma: DEA Editrice

This publication contains updated information on Italian universities, centers for study and research, and academic and cultural institutes, with a 'Who's who?' section at the end. Useful for consultation by toxicologists and other scientists.

Bertol E (2000)
Trattato di tossicologia forense, 2nd Edition
Padova: CEDAM

A large volume covering all the most important aspects of forensic toxicology, including historical, diagnostic, pathological, and analytical aspects of toxicology in general as well as the dynamics, pathological effects, and analysis of individual toxicants and toxicant groups. There are also chapters on environmental toxicology and doping and detailed discussions of the various forms of drug abuse. Useful for in-depth study and consultation.

Gagliano Candela R (2001)
Tossicologia forense: in schemi, tabelle e testo. In allegato: doping, principali avvelenamenti, gas tossici, stupefacenti, alcaloidi delle piante, veleni animali, tecniche di tossicologia analitica
Milano: Giuffrè

Capuano A, Dugo G, Restani P (1999)
Tossicologia degli alimenti
Torino: UTET

Cerutti G (2006)
Residui, additivi e contaminanti degli alimenti
Milano: Tecniche Nuove

This new edition, updated with the new laws in force by the European Community, classifies and examines the harmful substances in the safety of food and describes the proper industrial transformation process to follow. Schemes and tables accompany the text and summarize the information and the technical indications to observe.

Dolara P (1997)
Tossicologia: generale e ambientale
Padova: Piccin

Dolara P (2006)
TOX. Lezioni di tossicologia
Firenze: Firenze University Press
Web: http://www.fupress.com/scheda.asp?IDV=725

TOX is a handbook addressed to the students of Toxicology of the Faculty of Pharmacy and Sciences, but it can usefully be used by students of other Faculties and Course of Bachelor (Medicine, Agrarian, Engineering) and by all those interested in a short, general organization of the toxicological subjects. TOX covers the main fields of general toxicology (acute and chronic toxicity, mutagenesis, teratogenesis, carcinogenesis, reproductive toxicity, oxidative damage, epidemiological methods), and of special toxicology (food toxicity, heterocyclic amines, aromatic amines, tobacco smoke, pesticides, nitro compounds, amines, aromatic amines) and of environmental toxicology (environmental estrogens, PAH, heavy metals, dioxins and polychlorinated benzofurans, water and air pollution).

Cantelli Forti G, Hrelia P, Marinovich M, Galli CL (2000)
Tossicologia molecolare e cellulare
Torino: UTET

Froldi R (2004)
Lezioni di tossicologia forense, 3rd Edition
Torino G Giappichelli (Ed.)

This volume, which contains information on the most important problems of modern-day forensic toxicology, is intended for medical students, but it is also useful for law students.

Galli CL, Corsini E, Marinovich M (2007)
Tossicologia, 2nd Edition
Padova: Piccin

This book was conceived primarily as a toxicology text for students enrolled in various faculties (medicine, sciences, pharmacy, agriculture, and veterinary medicine). Following discussion of the general principles of toxicodynamics and kinetics, there is in-depth coverage of specific toxic effects (such as mutagenesis, carcinogenesis, and teratogenesis) and the methods used to study them. Other topics discussed include toxic effects on specific target organs, problems related to nutritional and food toxicology, environmental toxicology, occupational exposure to toxicants, and risk assessment.

Ignesti G (1999)
Piante medicinali: botanica, chimica, farmacologia, tossicologia
Bologna: Pitagora

Italian Energy & Environment Directory (Annuario Nazionale dell'Energia e dell'Ambiente) (2001)
Roma: Inter-ed

This important two-volume publication (total 1210 pages) provides a wealth of useful information on energy and the environment in Italy, including much that pertains to the field of toxicology. The volumes contain a 'Who's who?' section with 400 biographies and accurate information on 13 000 figures, 3600 companies, 400 products and services, 200 ministerial bodies, 460 research centres, 370 associations, and 470 municipal agencies.

Manara L, Mannaioni P (1995)
Farmacologia e Doping
Milano: Masson

This volume examines the main pharmacodynamic and toxicological aspects of compounds related to the phenomenon of doping in the world of athletics. There

are useful discussions of nutritional factors and those affecting muscle work, anabolic steroids, stimulants, sedatives, tranquilizers, cardiovascular drugs and diuretics, analgesics, and anti-inflammatory agents.

Meneguzzi Marchi R (1999)
Patologie da solventi per gli addetti al restauro
Padova: Il Prato

Mannaioni P, Chiesara E, Marozzi E (2004)
Tossicologia medica
Torino: UTET

Toxicology medicine can be defined as a specialized medicine branch characterized by the acquaintance of the major adverse effects, caused to humans by chemical substances (primarily drugs) and from the capacity of treating the intoxication caused by such chemical substances. The work can be placed mainly on the diagnostic and therapeutic front of the acute and chronic intoxication, but without neglecting the traces of pathogenesis useful and necessary for diagnosis and treatment. It includes, in addition, the elements of etiology, pathogenesis, and symptomatology of acute and chronic intoxication and drug addiction, needed to perform an accurate diagnosis and a prompt treatment.

Mari F (2001)
Veleni: intrighi e delitti nei secoli
Firenze: Le lettere

Montuschi L (Ed.) (1997)
Ambiente, salute e sicurezza: per una gestione integrata dei rischi da lavoro
Torino: G Giappichelli

Silvestrini B (1995)
Malati di Droga. Le Sostanze d'Abuso: Danni Fisici e Psichici, Reazione Individuale, Difese
Milano: Sperling e Kupfer

A non-conventional and clearly written discussion of drug abuse with a great deal of useful information, specifications, and personal evaluations.

Vighi M, Bacci E (1998)
Ecotossicologia
Torino:UTET

A volume considering the most important aspects of environmental toxicology.

Journals

Advances in Occupational Medicine & Rehabilitation (Aggiornamenti in Medicina Occupazionale e Riabilitazione)
Pavia: Fondazione Salvatore Maugeri
Web: http://www.fsm.it/bs/advances_occ.html

Current toxicology and therapy
Parma: Casa editrice Maccari

Epidemiology and Prevention (Epidemiologia e Prevenzione)
Milano: Zadig
Web: http://www.zadig.it/eprev/

Bimonthly journal of the Italian Epidemiological Association (Associazione Italiana di Epidemiologia, AIE). The AIE website (www.epidemiologia.it) contains the English indexes of the issues. Original contributions on occupational and non-occupational epidemiology. Articles in Italian; occasional summaries in English and Italian.

Giornale Italiano di Medicina del lavoro e Ergonomia
Pavia: Fondazione Salvatore Maugeri
Web: http://gimle.fsm.it/

Industrial medicine quarterly journal (occupational medicine, workplace and environmental hygiene, occupational toxicology) and ergonomics (evaluation of the relationship between man/workplace, occupational rehabilitation, psychology in the workplace, bioengineering).

Chiesara E (Ed.) (1990)
Guidelines for the Evaluation of Toxic Effects of Chemicals. Second part. Other toxic effects [in Italian]
Roma: Istituto Superiore di Sanità, Serie Relazioni

Guidelines established by the Italian National Toxicological Advisory Committee for the evaluation of the general toxic effects of chemicals (i.e., excluding mutagenesis, carcinogenesis, and teratogenesis).

Journal of Applied Cosmetology
Rome: International Ediemme

Official journal (quarterly review) of the International Society of Cosmetic Dermatology. It contains original papers, review articles, and research on the skin and cosmetics (including toxicological aspects of the latter).

Journal of Experimental & Clinical Cancer Research

Official Journal of Regina Elena Institute for Cancer Research, published quarterly (http://www.ifo.it/). Original contributions dealing with basic and applied research in the field of experimental and clinical oncology.

La Medicina del Lavoro
Fidenza: Mattioli
Web: http://www.lamedicinadellavoro.it/

Bimonthly journal that contains original contributions, report, review and letters related to the field of occupational health and industrial hygiene in Italian or English.

Pharmacological Research
London: Academic Press

A monthly peer-reviewed journal containing articles dealing with experimental or clinical pharmacology and toxicology. The journal is published by Elsevier for the Italian Society of Pharmacology.

Prevenzione Oggi (Prevention Today)
Rome: ISPESL
Web: http://prevenzioneoggi.ispesl.it/nindex.asp

Prevention Today is the most widely distributed Italian bilingual journal in the field of occupational safety and health. Published quarterly by ISPESL, with an intended readership of researchers and people involved in company safety, it publishes original scientific papers in the following areas: safety technologies; occupational hygiene; occupational medicine; psychosocial factors; training; workplace health promotion; communications and safety culture; epidemiology; certification; corporate social responsibility; environmental impact of production plants.

Rivista di Tossicologia Sperimentale e Clinica (Experimental and Clinical Toxicology Journal)
Rome: Società Editrice Universo

A quarterly journal that publishes papers dealing with experimental and clinical toxicology in Italian (and sometimes in English).

Technical Reports and Other Documents

Carere A (Ed.) (2006)
Environmental carcinogens and primary prevention [in English]
Rome: Annali Istituto Superiore di Sanità
Vol. 42, No. 2
Web: http://www.iss.it/publ/annl/cont.php?id=1969&lang=1&tipo=3&anno=2006

Selected topics and articles referred to the research area 'Environmental carcinogens and primary prevention'.
Mucci N, Camoni I (1995)

Guidelines of the Italian CCTN for the Classification of Some Effects of Chemical Substances
Rome: Istituto Superiore di Sanità
Serie Relazioni 96/2 EN

Definitions of the categories and the criteria for the classification of chemical substances on the basis of their potential carcinogenic, mutagenic, and toxic-reproductive effects, elaborated by the Italian National Advisory Toxicological Committee (CCTN) in 1994. All the allocations effected by the CCTN in the period 1977–1995 are reported and updated according to these criteria.

Binetti R, Marcello I (Eds.) (2006)
Miglioramento della prevenzione e della gestione delle intossicazioni acute [in Italian]
Rome: Annali Istituto Superiore di Sanità
Vol. 42, No. 3
Web: http://www.iss.it/publ/annl/cont.php?id=1970&lang=1&tipo=3

Galli CL, Rossi L, Vines P, Zapponi GA (Eds.) (1991)
Risk Assessment of Chemical Carcinogens [the majority of contributions in English]
Rome: Annali Istituto Superiore di Sanità Vol. 27, No. 4

A monograph dedicated to the examination of the many aspects of carcinogenic risk assessment.

Carreri V, Maroni M (2001)
Salute e Ambiente in Lombardia. Quarto rapporto. Unità Organizzativa Prevenzione-Direzione Generale Sanità/Regione Lombardia e International Centre for Pesticide Safety
Milano: ICPS

Maroni M (1998)
Salute e qualità dell'aria negli uffici
Milano: Masson

Ceriani D, Visentin S, Basla R, Maroni M (1999)
Studio cooperativo interlaboratoriale. Residui di antiparassitari in acque potabili. Biennio 1997–1998
Milano: Regione Lombardia/Direzione generale sanità e International centre for pesticides and health risk prevention 1–229

Databases

Carcinogens Data Bank (Banca dati cancerogeni-BDC). Istituto Superiore di Sanità
Web: http://www.iss.it/site/bancadaticancerogeni/ (Italian only)

BDC is a factual, non-bibliographic database developed by the Environment and Primary Prevention Department in collaboration with the Data Management, Documentation, Library and Publishing Activities service of the ISS. BDC provides classifications and evaluations of carcinogenicity formulated by the European Union in the context of 67/548/EEC Directive and contained in *IARC Monographs on the Evaluation of Carcinogenic Risks to Humans* published by the International Agency for Research on Cancer (IARC) of the World Health Organization (WHO),

Report on Carcinogens published by the United States National Toxicology Program (NTP), Integrated Risk Information System (IRIS) databank of the United States Environmental Protection Agency (EPA). BDC does not classify carcinogenic agents but gives synthetically integrated classifications and carcinogenicity evaluations produced by Competent Authorities at national and international level (IARC, EU, US EPA, NTP, CCTN). Data are derived from primary sources. It is possible to search by CAS number, synonyms, or chemical name.

Chemical carcinogens: structures and experimental data. Istituto Superiore di Sanità. (Cancerogeni chimici: strutture e dati sperimentali (ISSCAN)

Web: http://www.iss.it/ampp/dati/cont.php?id=233&lang=1&tipo=7 (Italian and English)

This database is freely downloadable from the website of ISS, and contains experimental data on chemical compounds tested with the long-term carcinogenicity bioassay on rodents (rat, mouse). A portion of the chemicals has been the subject of carcinogenicity classification by various regulatory agencies and scientific bodies. The data have been checked for their quality, and are coded as to be directly usable for structure–activity relationships analyses. Out of the three downloadable files, the 'structure-data file' (.sdf) can be accessed with Chemical Relational Database software programs that permit the effective linkage of chemical toxicity with chemical structure, and facilitate and greatly enhance data gathering and hypothesis generation, by permitting: (a) exploration across both chemical and biological domains; and (b) structure-searchability through the data.

Dangerous preparation archive. (Archivio Preparati Pericolosi). Istituto Superiore di Sanità

Web: http://www.preparatipericolosi.iss.it/iss/index.phtml (Italian only)

In the year 2000 an archive of dangerous preparations was created at the ISS, following a principle included in the Directive 88/379/EEC on dangerous preparations, subsequently modified by the Directive 1999/45/EC, concerning the creation of a data bank on dangerous preparations in each European country. The information stored in the archive is useful for purposes of health consumers' and workers' protection and prevention, and particularly in case of acute poisonings. The archive is fully informatized, therefore the companies can send the information using the web and the authorized poison centers can find the information on the archive using the web as well. In each Member State different procedures are in place to comply with the 1999/45/EC Directive; therefore an international co-ordination could be useful in order to create a European network of national databanks on dangerous preparations.

EDCs (endocrine disrupting chemicals)-diet interaction database (EDID). Istituto Superiore di Sanità

Web: https://excmail.iss.it/exchweb/bin/redir.asp?URL=http://dspace.iss.it/dspace/handle/2198/35http://dspace.iss.it/dspace/handle/2198/35] is available within the ISS website, in the EDC dedicated area (http://www.iss.it/inte/)

Diet is a significant source of exposure to EDCs, however, food safety assessment must also consider the concurrent intake of natural food components (e.g., vitamins, trace elements, phytoestrogens) modulating the endocrine system, including possible protective effects towards contaminants. EDID is a database on international literature's studies, either on experimental systems and on animal populations and humans; relevant reports of international and national agencies are also included. Due to copyright issues, the majority of documents are presented as abstracts. EDID is periodically updated, easy to consult and it aims to stimulate further research in the food toxicology field. The database has been created as part of the ISS special project on EDCs as well as of the 6th FP Network of Excellence CASCADE (www.cascadenet.org).

List of identified and classified substances. [Base Dati Etichettatura Sostanze Pericolose]. Istituto Superiore di Sanità

Web: http://www.dbsp.iss.it/4DACTION/WebEntra

This database, developed by the Environment and Primary Prevention Department, contains more than 100 000 chemical substances with CAS numbers and chemical names. The database gives the identification for all substances listed in the European Inventory of Existing Commercial Chemical Substances (EINECS) and hazard classification for more than 3000 substances included in Annex I of Council Directive 67/548/EEC. Substances are searchable by CAS numbers and chemical names.

National Inventory of Chemical Substances. (Inventario Nazionale delle Sostanze Chimiche). Istituto Superiore di Sanità

Web: http://www.iss.it/spps/index.php?lang=1 (Italian only)

In 1978, the ISS established a computerized National Inventory of Chemical Substances, *Inventario Nazionale delle Sostanze Chimiche* (INSC: National Inventory of Chemical Substances), a factual data bank on chemicals

(in Italian) that can be consulted for routine and emergency needs. The INSC provides extensive information on chemical identification, toxicological and ecotoxicological data, occupational health and safety, environmental fate, standards, evaluation, and classification for over 3000 entries. In addition, for approximately 2000 other substances, raw data (consisting of bibliographic information and specific articles collected in the open and gray literature) are available. The INSC can be accessed via the telecommunication network by public administrators, regional agencies, and international organizations (email: inscweb@iss.it).

National Inventory for Emissions and their Sources (Inventario Nazionale delle Emissioni e loro Sorgenti -INES). APAT – Agency for Environmental Protection and Technical Services

Web: http://www.eper.sinanet.apat.it/site/it-IT/ (Italian only)

In 1999, Italy established a national register on pollutant releases and transfers, the INES register, through Legislative Decree 372/99. The INES register is an inventory containing qualitative and quantitative information on pollutants released into water and into air by specific facilities defined at the EU level. Those facilities listed in EC Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control (IPPC) and fulfilling the criteria set out in Ministerial Decree of 23 November 2001 must report under INES. The competent authorities validate the data and send the results to the National APAT, which analyses the data, draws up summary statistics and fills in the INES register, then sends these on to the Ministry of the Environment that submits these data to the relevant EU bodies. The National APAT is in charge of providing and disseminating environmental information related to the INES register. For this purpose a website was set up on 11th November 2004 and is available to the public. According to relevant by-laws adopted for the implementation of the INES register, three reporting cycles have already been completed.

National Environmental Informative System (Sistema informativo nazionale Ambientale) SINAnet APAT Agenzia per la Protezione dell'Ambiente e per i Servizi Tecnici

Web: http://www.sinanet.apat.it/it/sinanet (Italian only)

In 1998 the Minister of the Environment entrusted APAT (formerly ANPA) with the responsibility for the overall management of the SINA Program, a national initiative started in 1988 with the objective of designing, operating, and developing the national environmental information system. Since then, APAT and the Italian Environment Agencies System have dedicated significant resources to the development of an effective and integrated Environmental Information and Monitoring System (EIMS), with the following objectives: to improve the quality, relevance and timeliness of environmental data; to disseminate relevant data and information for supporting decision making processes; and to bridge the gap between scientific data and policy level.

Sensitizing Agents Data Bank (Banca Dati Sensibilizzanti – BDS). Istituto Superiore di Sanità

Web: http://www.iss.it/bdse/ (Italian only)

BDS is a factual and bibliographic database produced by the Infectious, Parasitic and Immuno-Mediated Diseases Department, Environment and Primary Prevention Department and Data Management, Documentation, Library in collaboration with Publishing Activities of the ISS. BDS gives controlled and updated information concerning agents that may cause sensitization. It is worthwhile that the main objective of the BDS is not the classification of sensitizing or potentially sensitizing agents within specific risk classes, but it is essentially to provide concise and non-confidential information related to this endpoint. For each entry are available: chemical identification; danger classification according to the Council Directive 67/548/EEC; sensitizing properties; occupational exposure limits based on international agencies (ACGIH, DFG and European Union) and peer-reviewed scientific literature data in this field. The substances are categorized in different groups regarding sensitizing properties. Data are derived from monographs, government documents, technical reports, and primary journal literature. References are identified for all data sources. At present, the BDS includes: all the substances officially classified by European Union, (Annex I to Directive 67/548/EEC); some substances listed in Annex I (directive 67/548/EEC) for endpoints different than 'sensitization' but indicated as sensitizers by other relevant institutions, all the substances indicated as sensitizers by relevant Agencies or Institutions (ACGIH, DFG); some substances indicated as sensitizers by Industry and other non-governmental organizations (ETAD and HERA); all the substances regarded as 'potentially sensitizing dyes' by the Commission of the European Community for the award of the Community eco-label to textile products; some substances for which, even in the absence of any categorization by European Union, ACGIH or DFG, it is not possible to

exclude a sensitizing potential on the basis of reliable documents.

Organizations (Government)

National Health Service

Central Structure

The Italian National Health Service (INHS) was established in 1978 (Law 833, 23.12.1978), it was largely revised in 1992–1993 (Legislative Decrees 502/92 and 517/93); this revision gave to each Italian Region more power, autonomy, and responsibility for the management of the Health Service at local level in comparison with the coordination and supervising role of the Central Government. The main task of the Italian Health Service is to provide health care uniformly throughout the Nation, trying to give equal access to the services regardless of the social and economic differences of the population. This task reflects a constitutional principle that is the safeguarding of each individual's health both physical and psychological (art. 32 of the Italian Constitution Law). In 1999 a new 'Reform' of the Service (Legge Delega 419/1998 and Legislative Decree 229/1999) strengthened the 'Regionalization' of the Italian Health Service and reorganized the structures of the INHS along business lines.

The Structural Organization of the Italian National Health Service

1. The Ministry of Health (MOH), supported by the Consiglio Superiore di Sanità (National Health Council), provides high-quality advisory services on technological and scientific issues. The MOH involves local health structures through the central bodies which ensure co-operation among the central and the regional administration, that is: the Permanent Conference State/Regions, which takes care of the relationships between the Central Government and the Governments of the 21 Regions and Self-governing Provinces; and the Agency for Regional Health Care Services (ASSR);
2. National Bodies: several scientific technical institutions that operate at the central level:
   - National Institute of Health (ISS);
   - National Institute of Occupational Safety and Prevention (ISPESL);
   - National Institutes for Care and Scientific Research (IRCCS);
   - Experimental Zooprophylactic Institutes (IIZZSS);
   - Italian Medicine Agency (AIFA)
3. Administrative/scientific/technical institutions operating at the regional, provincial, and municipal level:
   - Healthcare Offices of Regions and Self-governing Provinces
   - Local Healthcare Agencies, ASL;
   - Public Hospitals.

The institutions mainly involved in toxicology are the following.

Experimental Animal Prophylaxis Institutes (Istituti Zooprofilattici Sperimentali – II.ZZ.SS.)

Web: http://www.ministerosalute.it/alimenti/attivita/sezAttivita.jsp?lang=italiano&label=coo&id=112&area=ministero&colore=2&lang=it (Italian only)

The Experimental Animal Prophylaxis Institutes (Istituti Zooprofilattici Sperimentali – IIZZSS) are Health Institutes ruled according to public law, enjoying self-government as to the management and administration and providing a number of services. They act as the technical and operative support of the National Sanitary Service with regard to animal health, control of the wholesomeness of food of animal origin for human consumption, hygiene of breeding and zoo-technical productions. They are concerned as well about the correct relationship between the environment, animals, and human settlements. IIZZSS have addressed special attention to: Public Veterinary Health, zoonoses and consequently urban veterinary hygiene, to prevent some communicable pathologies between men and animals (bovine spongiform encephalopathy, brucellosis, tuberculosis, etc.). IIZZSS perform their tasks for the Ministry of Health, Istituto Superiore di Sanità, Regions, Local Health Units, breeders and producers of animal-origin food for human consumption and producers of zoo-technical services and goods, and for end-consumers. IIZZSS represent a network throughout the whole national territory consisting of 10 central sites and 90 diagnostic centers located in almost every Italian Province.

National Medicines Agency (Agenzia italiana del farmaco – AIFA)

Web: www.agenziafarmaco.it/ (Italian only)
AIFA – Agenzia italiana del farmaco
Via della Sierra Nevada, 60-00144 – ROMA (Italia)
Phone: +39 06 5978401

AIFA is the Italian Drug Agency. It authorizes the commercialization of medicines, according to National and European procedures; it monitors drug adverse effects, through a drug surveillance network; it takes care of the application of European and National directives for clinical trials; it promotes the Italian Ethical Committees Network and the National Monitoring Center for Clinical Trials (https://oss-sper-clin.agenziafarmaco.it/

index_ingl.htm (English); https://oss-sper-clin.agenziafarmaco.it/ (Italian)]; it controls the production of pharmaceutical firms; provides drug information and controls Italian pharmaceutical expenditure.

National Institutes for Care and Scientific Research (Istituti di Ricovero e Cura a Carattere Scientifico – IRCCS)

Web: http://www.ministerosalute.it/ricsan/organizzazione/sezorganizzazione.jsp?id=73&label=ir1 (Italian only)

The National Institutes for Care and Scientific Research, ruled by the art. 42 of the Law n. 33 of 2/12/1978, by the DPR 617/1980 and by the Legislative Decree 269/1993 are emerging hospitals that, besides providing health care in the context of the National Health System, carry out both scientific research and training in the healthcare sector. Moreover, they provide the National Health System with technical and operational support for delivering health assistance and pursuing the National Health Plan targets in the field of health research. They play, therefore, a crucial role within the National Health System in identifying particular needs and responding to them, by sharing their scientific knowledge and operational resources. This function not only obliges these Institutes to respect the provisions laid down by national and regional health planning, but also to be consistent in terms of their own specialization and disease prevention, diagnosis, therapy, and rehabilitation methods. At present there are 40 Institutes, operating in the following medical specialties: Oncology, Neurosciences, Paediatrics, Dermatology, Communicable diseases, Orthopedics, Biotechnologies, Organ transplantation, Cardiology, Human Growth and Development, Geriatrics, Psychiatry, Gastroenterology, Genetics, Rehabilitation, and Occupational Medicine.

National Institute of Health (Istituto Superiore di Sanità)

Web: http://www.iss.it/chis/?lang=2 (English)
Web: http://www.iss.it (Italian)
Istituto Superiore di Sanità
Viale Regina Elena, 299, Rome
Phone: +39/6/49901
Fax: +39/6/49387118
Email: presidenza@iss.it

The Istituto Superiore di Sanità (ISS) is the leading technical and scientific public body of the Italian National Health Service. Its health protection activities include biological, physical, and chemical research, control, training and consultation, hazard identification, and risk assessment. ISS is organized into Departments and National Centres. At present there are seven Departments (Department of Environment and Primary Prevention; Department of Food Safety and Veterinary Public Health; Department of Technology and Health; Department of Therapeutic Research and Medicines Evaluation; Department of Cell Biology and Neurosciences; Department of Haematology, Oncology and Molecular Biology; Department of Infectious, Parasitic and Immuno-Mediated Diseases;) and four National Centres (National Centre for Epidemiology, Surveillance and Health Promotion; National Centre for Food Quality; National AIDS Centre and Risk Assessment and National Italian Transplant Centre). The first above mentioned four Departments and two Centres are involved in toxicological studies, evaluations and controls. Its activities include research, clinical trials, control, training and consultation in the interest of public health protection. Since 1978, it has served as the technical and scientific body of the Italian National Health Service. It is under the authority of the Ministry of Health. The Institute conducts scientific research in a wide variety of fields, from cutting-edge molecular and genetic research to population-based studies of risk factors for disease and disability. Research priorities are based on those set forth in the National Health Plan. An important activity of the Institute, which is mandated by the Minister of Health or the Regions, is certification of the chemical and biological purity of drugs and vaccines, as well as inspection and quality control of medical and diagnostic devices and equipment, food products and packaging. It monitors trends in disease, mortality and other health factors and provides technical support for health-related environmental surveys and for investigations of epidemics and other public health problems at national, regional, and local level. It also supervises the laboratories engaged in the testing of prohibited substances in sport and the national veterinary institutes. It also serves as the national reference center for MEDLARS (MEDical Literature Analysis and Retrieval System), a comprehensive international set of databanks co-ordinated by the US National Library of Medicine (NLM). The Institute produces a number of publications, including a quarterly peer-reviewed journal, technical reports, a monthly newsletter describing the Institute's major research activities, and a national epidemiological bulletin. The Institute plans, implements, and evaluates training activities in a wide variety of areas, with courses designed to address the needs of the National Health Service. It develops and tests innovative training methods, including web-based distance learning. Training is provided for various categories of professionals; methods range from short courses and hands-on workshops to more structured and formal courses at national and international level. It actively promotes co-operation at three different levels of involvement: scientific partnerships with industrialised

countries (USA, European partners, Japan); scientific and development projects in partnership with economies in transition (including China, South Africa, the Central Asian Republics and countries in Latin America, the Balkans and the Middle East); development partnerships in Africa and countries in turmoil, where humanitarian and technical assistance are provided in close collaboration with the Italian Ministry of Foreign Affairs, various UN Agencies and the World Bank, as well as the Global Fund for AIDS, Tuberculosis and Malaria. Several members of the Institute serve on panels of experts for the Fund as well as on other international committees and commissions. There is growing interest and co-operation in the application of telematics to health issues, in keeping with the priorities recently established by the G8 and the Italian government. ISS contributes to IARC, UNEP, IPCS, and NATO-CCMS activities and programs.

A National Toxicological Advisory Committee (CCTN) (in Italian the Commissione Consultiva Tossicologica Nazionale) was established in 1977 and was active up to 2001, within the ISS and appointed by the Ministry of Health, with the mandate to classify and evaluate the potential risk of carcinogenic effects, mutagenic effects and reproductive toxicity and other toxic effects related to human exposure to chemicals and to identify specific areas for toxicological research.

Several data-banks concerning toxicological hazards and risks are present on the ISS website; most of them are in Italian (see databases section).

National Institute of Occupational Safety and Prevention (Istituto Superiore Prevenzione e Sicurezza sul Lavoro – ISPESL)

Web: http://www.ispesl.it/index.asp?language=0 (English)
Web: http://www.ispesl.it (Italian)
ISPESL
Via Urbana 167-00184 Roma (Italia)
Phone: +39-06-4827917
Fax +39-06-48906750
Email urp@ispesl.it

The National Institute of Occupational Safety and Prevention is a technical scientific body of the National Health Service under the supervision of Ministry of Health, but independent with regard to organization, management, and funding. It has six central technical–scientific departments (Occupational Medicine, Occupational Hygiene, Safety Technologies, Productive Plants and their Interaction with the Environment, Documentation, Information and Training, Certification) and 37 field departments at the local level spread over the country. It acts as a national center for information, documentation, research, and experimentation for safeguarding health and safety at work. ISPESL's scientific research programs are mainly focused on prevention of occupational accidents and diseases, with emphasis on technological safety, and on definition, measurement and assessment of risks (toxic substances, industrial plants, electromagnetic fields). The Institute also provides consultancy and technical assistance to public bodies and private companies. Moreover, it carries out training activities addressed to the National Health Service staff in the fields of prevention, health and safety at workplaces. The Institute's databases of Solutions (http://www.ispesl.it/soluzioni/index.htm) and Risk Profiles (http://www.ispesl.it/risk_profiles/index.htm), are aimed at small and medium-sized enterprises (SMEs), providing a basic information technology resource for the Italian accident-prevention system.

Other National Institutions

APAT (Agency for the Protection of the Environment and the Technical Services)

Web: http://www.apat.gov.it/site/en-GB/default.html (English)
Web: http://www.apat.gov.it/site/it-IT/ (Italian)
APAT
Via Vitaliano Brancati, 48
00144 ROMA (Italy)
Phone +39-06-50071
Fax +39-06-50072916

Further to the sweeping reorganization of the environmental controls in 1993, the agency that had been initially set up as the National Agency for Environmental Protection (ANPA) has been subjected to a thorough reform that has caused it to merge with the Department of the National Technical Services of the Prime Minister's Office, with which it had already co-operated, and to change its name into APAT (Agency for the Protection of the Environment and the Technical Services).

The APAT carries out technical-scientific tasks and activities of national interest for the protection of the environment, the conservation of the water resources and the soil. The agency has technical-scientific and financial autonomy and is subject to the policy-making and supervisory authority of the *Ministry for the Environment, Land and Sea* and to the control of the State Audit Court.

The APAT works based on a 3-year program – brought up to date on a yearly basis – that lays down objectives, priorities, and resources, with a view to enforcing the directives of the Ministry for the Environment, Land and Sea. In the sectors falling within its province, the APAT carries out co-operation,

consulting, service and support activities under special agreements with other public administrations. In particular, the website of the APAT National contains a vast bulk of documentation, divided into different environmental themes (such as water, air, environmental certification, emergencies, industries, technologies, and infrastructures). The APAT publishes a number of national reports (e.g. on waste management and the quality of the environment in urban areas) including the Environmental Data Yearbook, which is widely distributed in both Italian and English (http://www.apat.gov.it/site/en-GB/APAT/Publications/Environmental_Data_Yearbook/).

The National Agency for Environmental Protection also manages environmental databases and makes these available to the general public through its website. These include GELSO (Good practices for local sustainability); National air emissions inventory – CORINAIR-IPCC (http://www.apat.gov.it/site/enGB/Environmental_Services/National_air_emissions_inventory_(CORINAIR-IPCC)/default.html); INES (National register on pollutant releases and transfers; see databases section); BRACE (National Database on Air Quality (http://www.brace.sinanet.apat.it/web/struttura.html); Meteorological Marine Data (http://www.apat.gov.it/site/en-GB/Environmental_Services/Meteorological_Marine_Data/default.html).

ICPS – The International Centre for Pesticides and Health Risk Prevention

Web: http://www.icps.it/English/home-I.htm (English)
Web: http://www.icps.it/ITALIANO/home-I.htm (Italian)
Ospedale L. Sacco – Azienda Ospedaliera Polo Universitario
Via G. B. Grassi, 74-20157 Milano
Phone: +39 02 3568661
Fax: +39 02 38203163
Email: mail@icps.it

The International Centre for Pesticides and Health Risk Prevention (ICPS) was created by the Government of the Region of Lombardy on the proposal of the World Health Organization (WHO) – Regional Office for Europe, in co-operation with the University of Milan. ICPS was inaugurated on March 25, 1990.

The mandate of ICPS is to work as a Collaborating Centre on Occupational Health, specialized in the pesticide area, for the preventive and safety programmes of the WHO.

The activities of the Centre are organized into three major areas as follows.

- Information and documentation on pesticide toxicity to man and environment epidemiological, toxicological and clinical research on the effects of pesticides in man;
- Training and education of personnel involved in public health, occupational and community health, and agriculture laboratory research for development and standardisation of methods for biological monitoring and residue measurement in environmental and biological media;
- Support to the Region of Lombardy by providing information and documentation on pesticide toxicity and the adverse health risks that may derive.

Italian Ministry for the Environment, Land and Sea (Ministero dell'ambiente, e della tutela del territorio e del mare)

Web: www.minambiente.it (Italian only)
Ministero dell'Ambiente e della Tutela del Territorio e del Mare Via Cristoforo Colombo, n. 44 00147 Roma
Phone: +39 06 57221

The Italian Ministry for the Environment Land and Sea was established in 1986. Within its scope of competency lie responsibilities related to: sustainable development, protection of territory, pollution and industrial risks, international protection of the environment, appraisal of environmental impact, nature conservation, waste and cleanup, and protection of seas and inland waters. The Italian Ministry for the Environment Land and Sea is strongly committed to promoting and supporting international partnership and co-operation towards global sustainable development.

Italian National Agency for New Technologies Energy and the Environment (Ente per le Nuove Tecnologie, l'Energia e l'Ambiente – ENEA)

Web: http://www.enea.it/com/ingl/default.htm (English)
Web: http://www.enea.it (Italian)
ENEA – Rome Headquarters
Lungotevere Thaon di Revel, 76-00196 Roma
Phone:+39-06-36271
Fax:+39-06-36272591/2777

ENEA, the Italian National Agency for New Technologies, Energy and the Environment is a public undertaking operating in the fields of energy, the environment, and new technologies to support competitiveness and sustainable development.

ENEA is mainly called upon: to promote and carry out basic and applied research and innovation technology activities, also through prototypes and product industrialization; to disseminate and transfer technologies, encouraging their use in productive and social

sectors; to provide high-tech services, studies, tests and evaluations to both public and private bodies and enterprises.

To these aims and in the sectors falling within its areas of competence, ENEA: carries out complex research, development and demonstration projects, mainly technology- and engineering-based, sets up and operates major scientific apparatuses; assesses the level of advanced technologies development, as well as their economic and social impacts, also on demand by public administrations; promotes collaboration with foreign bodies and institutions, also for defining technical regulations and participation to major research programmes and international organizations, providing its (specific) expertise; promotes, fosters and supports innovation technology processes in the national production system, especially in small and medium-sized enterprises; collaborates with regions and local administrations to promote productive development of local resources, through joint actions; promotes technical and professional training and competency of researchers, also through ad-hoc agreements with national and international universities.

Italian National Research Council (Consiglio Nazionale delle Ricerche – CNR)

Web: http://www.cnr.it/sitocnr/Englishversion/CNR/AboutCNR/AboutCNR.html (English)
Web: http://www.cnr.it/sitocnr/home.html (Italian)
Consiglio Nazionale delle Ricerche
Piazzale Aldo Moro, 7-00185, Roma
Phone: +39-06-49931
Fax: +39-06-4461954

The National Research Council (CNR) is a public organization; its duty is to carry out, promote, spread, transfer, and improve research activities in the main sectors of knowledge growth and of its applications for the scientific, technological, economic, and social development of the country. To this end, the activities of the organization are divided into macro areas of interdisciplinary scientific and technological research, concerning several sectors: biotechnology, medicine, materials, environment and land, information and communications, advanced systems of production, judicial and socio-economic sciences, classical studies and arts. CNR is distributed all over Italy through a network of institutes aiming at promoting a wide diffusion of its competences throughout the national territory and at facilitating contacts and co-operation with local firms and organizations. From the financial point of view, the main resources come from the State, but also from the market: even 30% of its balance sheet, an extraordinary result, is the result of revenues coming from external job orders for studies and activities of technical advice as well as from agreements with firms, contracts with the European Union and with other international organizations. The CNR does not have laboratories specifically devoted to toxicological research, although it supports many toxicologically oriented research projects and many of its laboratories are involved in basic research projects with relevance to toxicology.

Co-operation with universities and industrial companies is a systematic choice with the general aim of 'creating value for the country by competences through scientific research'.

Milan University Research Center on Risk Characterization – MURCOR

Web: http://www.biodip.unimi.it/it/dipartimento/mucor.htm (Italian only)
University of Milan
Dept. of Biology, Via Celoria, 26, 20133, Milan
Phone:+39 02 50314753
Fax:+39 02 50314802
Email: marialuisa.broccia@unimi.it

The Center bases its activity on the broad experience of several scientists of the University of Milan who have worked or still are working as members of national and international toxicological committees. The important and different experience acquired will help to properly succeed in the prefixed aims of the Center:

- Qualitative/quantitative evaluation of environmental pollutants and the consequent assessment of the toxic potential effects, including genotoxicity, carcinogenicity, developmental, reproductive, and environmental toxicity;
- Risk characterization on human population, wildlife, and environment;
- Development of innovative researches for the potential effects and toxic risks knowledge integration.

The Center offers the competence of the member scientists. This expertise is meant to help public or private institutions for the management of problems connected to environmental disasters, industrial accidents, environmental or food chain pollution, proposing solutions based on recent knowledge as final goal.

Regional (ARPA) and Provincial (APPA) Environmental Protection Agencies

Web: http://www.reteambientale.it/arpa.asp (English)
Web: http://www.reteambientale.it/eng/arpa.asp (Italian)

The Regional Environmental Protection Agencies (ARPA) and Provincial Environmental Protection Agencies (APPA, merely for the autonomous provinces of Trento and Bolzano), set up in pursuance of

Law no. 61/1994, carry out for the most part control activities (accurate controls and monitoring of the environmental variables, supervising the actual compliance with the laws), providing also technical/scientific, technical/juridical and technical/analytical support to public administrations (basically Regions, Provinces and Muni-cipalities) that are entrusted with administrative control, environmental planning and authorization functions. ARPA and APPA are included in the National Network of Environmental Authorities and Programming Authorities.

Each agency has its own website, where a variety of activities on different environmental matrices and risks to the population are described in detail, such as plans for handling emergencies, industrial plants at risk for serious incidents, alerts regarding spills or leakages of toxic substances. Some sites also provide access to online journal searches, studies and research activities on topical environmental issues.

World Health Organization
Web: http://www.who.int
Regional Office for Europe
European Center for Environment and Health, Rome Division
Via Vincenzo Bona 67
00156 Rome
Phone: +39-06-487751
Fax: +39-06-4877599

The Rome Division of the Environment and Health Department of the WHO Regional Office for Europe was set up in 1991. Its attentions are focused on water pollution and wastewater disposal at an international level, food safety, radiation protection, and analytical epidemiology. Its advice and assistance are available to Member States of the WHO Regional Office for Europe.

Organizations (Non-Government)

Mario Negri Institute for Pharmacological Research (Istituto di Ricerche Farmacologiche Mario Negri)
Web: http://www.marionegri.it/mn/it/info/engWarn.html (English)
Web: http://www.marionegri.it/mn/it/index.html (Italian)
Via La Masa, 19, 20156 Milan
Phone: +39-02-390141
Fax: +39-02-3546277/39001918
Email: mnegri@irfmn.mnegri.it

The Mario Negri Institute for Pharmacological research is a scientific non-profit foundation for biomedical research and higher education that started its activity in 1963. The following lines of toxicological research are currently being pursued:

- Relations among toxic effects, metabolism, and disposition of xenobiotics in animals;
- Development of short-term toxicity tests using isolated perfused organs and cells as models of target organ toxicity;
- Evaluation of chemical composition and toxicity of urban waste incinerator emissions;
- Toxicokinetics.

In its 44 years of activity, the Institute has published approximately 9300 articles in international journals, 3700 transfer articles, and 200 books (monographs and Conference Proceedings).

Universities

In Italy there more than 40 university departments of pharmacology and toxicology. Since 1917, the Department of Pharmacology of the University of Florence has included a chair of toxicology with an associated clinical service. Toxicology services are also associated with the chairs of clinical pharmacology at the Universities of Modena (the service is mainly involved in problems of drug addiction), Padua, and Pavia (see Poison control centers). These centers, which are supervised by the Ministry of Health, are involved in cancer research, including toxicological studies of carcinogenic substances and anticancer drugs.

This section pertains exclusively to institutions offering officially approved courses related to the disciplines of toxicology, those offering postgraduate specialization courses in toxicology and those with PhD programs or Masters in pharmacotoxicology.

Currently (2007) there are ten universities offering a dedicated degree on toxicology: Milan (Lodi), Bologna, Florence, Pisa, Sassari, Novara, Catania, Arcavacata di Rende, Camerino, Cagliari.

Courses Pertaining to Toxicology held at Universities

In 1988, new rules were established for university studies that have significantly influenced the teaching of toxicology in Faculties of Medicine and Surgery, Pharmacy, Veterinary Medicine, and Biological Sciences. Courses in toxicology are generally taught by full or associate professors. However, they may also be assigned to university researchers who have obtained teaching certification (based on evaluation obtained after 3 years of employment as researchers). In some cases, the courses are assigned to faculty members from other universities or non-university scientists with particular

experience in the given field. In the latter cases, the assignments are based on yearly contracts that can be renewed if necessary.

In the Faculty of Medicine, toxicology is considered an obligatory part of the pharmacology course. Toxicology is also taught in the dentistry degree, in which it accounts for 10–20 of the teaching hours dedicated to pharmacology. The course concentrates on areas with specific relevance for dentistry, such as mercury toxicity.

In the Faculty of Pharmacy, the course of pharmacology is taught over a period of five semesters, one or two of which are dedicated to toxicology. The course covers the following subjects: principles and aims of toxicology; biotransformation of chemicals, mechanism of action, and toxicity testing; some topics in toxicology; toxicity of drugs of clinical interest, heavy metals, household products, and food toxicology; carcinogens, teratogens, and drugs of abuse; and topics in environmental toxicology and ecotoxicology. In the Faculty of Pharmacy there are also other courses dealing with topics in the fields of toxicology and toxicological analysis, e.g., complementary concepts in toxicological chemistry and analysis of drugs.

In the Faculty of Veterinary Medicine toxicology is taught for a total of 100 teaching hours/year. The degree of Biological Sciences has only optional courses in toxicology.

Research Doctorate (PhD) in Toxicology

In accordance with Law 380/80, research doctorate programs have been established in various subjects. The programs are proposed by individual professors of a given university and administered by the same university, although other universities may be involved in the student's learning experience.

Each year the Ministry of Universities and Scientific and Technological Research activates a cycle of doctorate programs and establishes the number of positions that will be offered. An entrance examination is held at the university that is administering the program. The Commission of Examiners is composed of two full professors and one associate professor; the names of the examiners are selected at random by the Ministry of Universities and Scientific and Technological Research.

The doctorate programs generally last 3 or 4 years, during which time the student will be involved in studies and research activities approved by the program coordinator. Research activities are carried out in a university institute approved by the coordinator. At the end of the course, the student is expected to present a complete dissertation regarding his or her research to a Commission of Examiners, which is composed of two full professors and one associate professor selected at random by the Ministry of Universities and Scientific and Technological Research. The student receives a monthly salary from the state during the entire period of study. This salary is increased by 50% for study periods abroad, which can last 1 or 2 years.

The following doctorate programs were offered in the area of toxicology for the academic year 2006–2007.

Doctorate Programs

Clinical Pharmacology, Chemotherapy and Toxicology
University of Milan (associated to Insubria)
Web: http://users.unimi.it/farmadot/intro.htm (Italian only)
Alberto Panerai
Phone: +39-02-503-16934
Fax: +39-02-503-16933
E-mail: alberto.panerai@unimi.it
Dipartimento di Farmacologia UNIMI – Via Vanvitelli, 32-20129 Milano

Molecular and Cellular Physiology, Pharmacology and Toxicology
Web: http://dottorati.unisi.it/en/ (English)
Web: http://dottorati.unisi.it/en/scuole.asp?Id=21 (Italian)
Faculty of Pharmacy
University of Siena

Pharmacology and Toxicology

It is present at the Universities of Florence, Milan (associated to Pisa), Sassari, Padua, Bologna, Modena, Parma, and Trieste), Turin (+Genoa, Pavia)

Pharmacological, Toxicological, Pharmacognostic Sciences and Pharmacological Biotechnology
University of Milan (associated to Pisa)
Web: http://www.unimi.it/ricerca/dottorati/22470.htm

Toxicology
Web: http://w3.uniroma1.it/fisiofarm/didatt/Dottorato_Tossicologia.pdf (Italian only)
University of Rome (La Sapienza)

Masters

International

European Master in Risk Assessment and Risk Analysis
Web: http://users.unimi.it/euma2312/english/home_inglese.htm

The Master aims to provide a special qualification, in accordance with the European legislation, in human and environmental risk assessment and risk analysis.

Dept. of Occupational Health University of Milan
Via G. B. Grassi, 74
20157 Milan
Phone: +39-02-3568-6604
Fax: +39-02-3568-6605
Email: european.master@unimi.it

Toxicologic Histopathology
Web: http://web.uniroma2.it/modules.php?name=Content&section_parent=2109 (Italian only)
Faculty of Medicine, University of Rome 2 Tor Vergata
Facolta' di Medicina e Chirurgia
Via Montpellier, 1
00133 Roma

National

Farmaco-tossicologia delle sostanze d'abuso, dell'alcolismo e delle patologie correlate
Web: http://www.unical.it/portale/strutture/facolta/farmacia/postlaurea/master/ (Italian only)
Università della Calabria
Facolta' di Farmacia e Scienze della Nutrizione e della Salute
Università della Calabria
Edificio Polifunzionale
87036 Arcavacata di Rende (CS)
Phone: +39-0984-493109–0984-493110
Fax +39-0984-493107
Email: pres.farmacia@unical.it

Rischio ambientale: analisi e monitoraggio per la bonifica dei siti contaminati
Web: http://www.unina.it/postlaurea/master/dettagli.jsp?cont=170 (Italian only)
University of Naples
Facoltà di Scienze Matematiche, Fisiche e Naturali
Via Cintia – Complesso Monte S.Angelo, 80126, Napoli
Via Mezzocannone, 16, 80134, Napoli

Valutazione e controllo del rischio tossicologico da inquinanti ambientali
Web: http://www.unipv.it/reumatologia-tossicologia/master-rischio-tossicologico/presentazione/index.html (Italian only)
Università degli Studi di Pavia – Facoltà di Medicina e Chirurgia
Dipartimento di Medicina Interna e Terapia Medica
Sezione di Reumatologia e Tossicologia Clinica
Piazza Botta, 10-27100 Pavia
Phone: +39-0382-592785
Fax: +39-0382-592782
Email: tossicologia@unipv.it

Specialization (Post Doctoral Degree) in Toxicological Disciplines

Postdoctoral Degree in Pharmacology (Option in Toxicology)

University of L'Aquila
Web:http://www.univaq.it/inglese/eg-index.html (English)
Web: http://www.univaq.it/index.html (Italian)
Piazza Vincenzo Rivera 1, (Palazzo Carli)-67100 L'Aquila
Phone: +39-0862-432032
Fax: +39-0862-432033
Email: dottorato.ricerca@cc.univaq.it

University of Milan – Faculty of Medicine
Dipartimento di Farmacologia, chemioterapia e tossicologia medica
Via Vanvitelli, 32, Milano

University of Naples Federico II– Faculty of Medicine
Web: http://www.unina.it/postlaurea/specializzazioni/dettagli.jsp?cont=74 (Italian only)
Facoltà di Medicina e Chirurgia
Via S. Maria di Costantinopoli, 104-80138 – Napoli
Phone: +39-081-566-6942
Fax: +39-081-298522

Postdoctoral Degree in Medical Toxicology

University of Cagliari ((Faculty of Medicine)
University of Catania (Faculty of Medicine)
Web: http://www.medicina.unict.it/Pagina/It/Didattica_1/Formazione_post_laurea/Scuole_di_Specializzazione/Scuole_di_specializzazione_3/Tossicologia_Medica.aspx (Italian only)

University of Florence (Faculty of Medicine)
Web: http://www.med.unifi.it/segreteria/didattica/specializzazione/tossicologia_medica.htm (Italian only)

University of Messina (Faculty of Medicine)
Web: http://www.unime.it/didattica/scuolespecializzazione/specialareamedica.html (Italian only)

University of Modena e Reggio Emilia (Faculty of Medicine)
Web: http://www.unimo.it/OffertaFormativa/scuolespecializzazione.html (Italian only)

University of Padua (Faculty of Medicine)
Web: http://www.medicina.unipd.it/Didattica.htm (Italian only)

University of Pavia (Faculty of Medicine)
Web: http://www.unipv.it/webspec/sito/ (Italian only)

Professional Societies

CellTox (The Italian Association of in Vitro Toxicology)
Web: http://www.celltox.it/ (Italian only)
President: Dr. Isabella De Angelis
Dipartimento Ambiente e Connessa Prevenzione Primaria
Istituto Superiore di Sanità
Viale Regina Elena 299
00161 Roma
Email: info@celltox.it

CellTox was founded in 1991 and currently has approximately 100 members. Its scope is to promote the use of in vitro systems in pharmacological and toxicological research and to develop methods and techniques for the study of toxic effects at cellular and molecular levels. Its activities include biennial congresses, continuing education courses, and scientific meetings.

Italian Society of Toxicology, SITOX
Web: http://pharmtox.org/sitox/ (Italian only)
Società Italiana di Tossicologia (SITOX)
Viale Abruzzi 32, 20131 Milano
Phone: +39-02-29520311
Fax: +39-02-29520179
Email: sitox@comm2000.it

The Italian Society of Toxicology (formerly SIT) was founded in Pavia on October 20, 1967. The founding members were Prof. Pietro Mascherpa, Director of the Institute of Pharmacology of the University of Pavia School of Medicine, and Professors Gianmartino Benzi and Francantonio Bertè. The President of the Republic officially recognized the Society on May 16, 1972. Article 1 of the Society's charter extended eligibility for membership to 'all those who are interested in scientific problems and applicative issues related to toxicology.' Indeed, IST members are scholars working in a variety of fields including pharmacology, occupational medicine, poison control, forensic toxicology, veterinary toxicology, and agriculture.

Presidents of the Society include Professors Pietro Mascherpa (1968–1974), Leonardo Donatelli (1974–1979), Paolo Preziosi (1980–1986), Luigi Ambrosi (1986–1992), Pierfrancesco Mannaioni (1992–1996), Rodolfo Paoletti (1996–2002), and Giorgio Cantelli Forti (2003–present). The Society sponsors an annual postgraduate course in toxicology and a national congress every 3 years. The Italian Society of Toxicology is a member of the Federation of the European Societies of Toxicology (EUROTOX) and the International Union of Toxicology (IUTOX). The latter was chaired over from 1989 through 1992 by Prof. Paolo Preziosi, Past President of the SITOX, and various SITOX members are on the Executive Board of the IUTOX (Professors R. Paoletti, C. L. Galli) or EUROTOX (Professors P. Preziosi, V. Cuomo, M. Marinovich).

The SITOX has also organized international conferences and congresses with the IUTOX (1st Joint IUTOX/IST Symposium on Behavioral Toxicology, 1986; VI International Congress of Toxicology 1992) and with the EST (XXIV Congress of European Society of Toxicology, 1983), and the 41st Congress of EUROTOX, held in Florence in September 2003. It has sponsored international conferences, congresses, and round-table discussions with other scientific societies. Its members have attended the Summer Schools organized by the IUTOX. At the European level, the IST took part in a Workshop (WHO/EURO/IPCS/CE/EUR 9618) on Health Aspects of Chemical Safety-Workshop on manpower development and training (WHO/EURO interim documents 18) with a presentation by Professors P. Preziosi, V. Silano, and A. Sampaolo entitled Changing need for Toxicologists in Italy resulting from European Community Legislation (28 Nov. through 2 Dec. 1983).

Numerous meetings have been held with other societies on various topics such as 'Methodological trends for a reduction in the use of laboratory animals in toxicological studies', held with the Italian Society of Applied Pharmacological Sciences.

The SITOX has contributed to reforms of the Italian university system with the establishment of a 4-year School for Specialization in Toxicology and one currently defined as the School for Specialization in Pharmacology. These have evolved from an earlier program established on 15 Sept. 1984, which involved a School for Specialization with three directions: Pharmacology, Chemotherapy, and Medical Toxicology.

Finally, based on Article 67 of Decree 382 of the President of the Republic, the IST established a national research project that involved 28 operative units from various Italian university departments, and this project has evolved into another project entitled 'New Evaluation Approaches in Toxicology.'

The Society has also established a program that awards €150 000 to a scholar who has conducted particularly important research in the field of toxicology over the past 3 years.

Currently the society includes over 450 members. Fifty-five percent are pharmacologists; the rest are professionals working in the fields of anesthesiology, toxicological and pharmaceutical chemistry, and occupational medicine.

RENTIC – National Register of Italian Certified Toxicologists

Web: http://www.pharmtox.org/sitox/rentic.php (Italian only)

In March 1999 the Italian Society of Toxicology created the Italian Register of Certified Toxicologists (RENTIC), due to the increasing need to emphasize the importance of toxicologists, and to institute a register with complete information about toxicology experts to be available for public and private organizations. The basis for registration in these societies is peer-review evaluation of the applicants. A key criterion for acceptance is theoretical training covering the main areas of toxicology. Furthermore, job experience is required. After reviewing the merits of the applicant, the register then accepts the applicant to the register usually for 5 years. The members of RENTIC are also members of ERT, the European Register of Toxicologists, officially inaugurated in 1997.

Poison Control Centers

The poison centers in bold are those which have been acknowledged by the Ministry of Health as suitable for having granted the online access 24 h/day to the National Data Bank on Dangerous Preparations, located in the ISS.

Poison center	Hospital, address
Centro Antiveleni [Italian only — http://www.policlinicoumberto1.it]	Dipartimento Scienze Anestesiologiche, Medicina Critica e Terapia del Dolore V.le Policlinico 155 00161 Roma (Italia)
[a]**Centro Antiveleni** [Italian only: — http://www.policlinicogemelli.it/area/?s=210] +39 06 49978000 +39 06 3054343	Servizio di Tossicologia Clinica, Policlinico Universitario "A. Gemelli", Largo Agostino Gemelli 8, 00168 Roma (Italia)
Centro Antiveleni di Bergamo. Tossicologia Clinica [Italian only — http://www.ospedaliriuniti.bergamo.it/] +39 035 269469	Dipartimento Funzionale Interaziendale di Farmacologia Clinica Ospedali Riuniti Bergamo Largo Barozzi 24128 Bergamo (Italia)
[b]**Centro Antiveleni di Milano** [Italian only — http://www.centroantiveleni.org/] +39 02 66101029	Ospedale Niguarda Ca' Granda Piazza Ospedale Maggiore 20162 Milano (Italia)
[c]**Centro Antiveleni di Napoli** [Italian only — http://www.ospedalecardarelli.it/osp/default.asp?hw=1&osp=23&osp2=0&idp=0] +39 081 7472870 +39 081 5453333	III Unità Operativa di Anestesia e Rianimazione Ospedale Cardarelli Via Cardarelli, 9 80131 Napoli (Italia)
[d]**Centro Antiveleni di Pavia e Centro Nazionale di Informazione** Tossicologica Servizio di Tossicologia [Italian only: http://www.fsm.it/] +39 0382 24444	IRCCS Istituto Scientifico di Pavia Fondazione Salvatore Maugeri e Università degli Studi di Pavia Via S. Maugeri, 10 27100 Pavia (Italia)
Centro Antiveleni Unità Operativa di Tossicologia Medica [Italian only — http://www.ao-careggi.toscana.it/tossicologia/] +39 055 7947819	Azienda Ospedaliera Universitaria Careggi Viale G.B. Morgagni, 85 50134 Firenze (Italia)
Servizio Antiveleni Servizio di Pronto Soccorso, Accettazione e Osservazione (Emergency Department Approved for Pediatrics) [English — http://www.gaslini.org/eng/schedauo.asp?liv=1_4&dir=&id=95 Italian — http://www.gaslini.org/schedauo.asp?liv=4_1&dir=2&id=36] +39 010 5636245	IRCCS Istituto Scientifico G. Gaslini Largo G. Gaslini, 5 16147 Genova (Italia)
Centro Antiveleni Dipartimento di Emergenza. Unità Operativa di Rianimazione, Terapia Intensiva e Centro Antiveleni [Italian only — http://www.aopn.sanita.fvg.it/stc/azienda/reparti/med_urgenza.asp?Style=1] +39 0434 550301	Ospedale Civile. Azienda Ospedaliera S. Maria degli Angeli Via Montereale, 24 33170 Pordenone

Poison center	Hospital, address
Centro Antiveleni Unità Operativa di Anestesia, Rianimazione e Terapia Antalgica [Italian only — http://www.rianimazione.org/Cav/servizi3.asp] +39 095 7594120	Ospedale Garibaldi Centro Piazza S. Maria di Gesù 95124 Catania

[a] ***Centro Antiveleni***
Policlinico A. Gemelli
Largo Agostino Gemelli, 8
00168 Roma (Italia)
Phone: +39-06-3054343
This center, opened in 1971, has developed a computerized system based on the utilization of three databanks: the first databank stores all the information on toxic products (9000 documents), the second contains clinical information on all cases treated in the center (49 000 to date), and the third, interfaced with analytical laboratory instruments, allows immediate chemical-analytical identification of poisons. The service is operative 24 hours a day.

[b] ***Ospedale Niguarda Ca' Grande***
Piazza Ospedale Maggiore
20162 Milan
Phone: +39/2/66101029
This center, which works in close collaborations with the Ministry of Civil Defence, has developed a program for early warning in cases of large-scale toxic disasters. A registry is kept of the main industrial structures in the Lombardy Region that are at risk for such disasters, with information on the substances and materials used and stored on site.

[c] ***Ospedale Cardarelli***
Via Cardarelli, 9
80131 Napoli
Phone: +39/81/7472870
This center serves the regions of southern Italy (Campania, Calabria, Puglia, Lucania, and Sicily – total population, approximately 18 million). Chemical and toxicological studies are performed in the laboratories of the Azienda Ospedaliera 'A. Cardarelli' and the Laboratory of the Institute of Forensic Medicine, II Faculty of Medicine, University of Naples.

[d] ***Centro Nazionale di Informazione Tossicologica***
Fondazione Salvatore Maugeri
Clinica del Lavoro e della Riabilitazione I.R.C.C.S.
Via S. Boezio, 26
27100 Pavia
Phone: +39-0382-24444
This center was established in 1992 at the Pavia Medical Institute as part of a convention reached between the University of Pavia and the 'Salvatore Maugeri' Foundation, a national non-profit organization dedicated to clinical care and research in rehabilitation and environmental medicine. It forms a part of the university's Toxicology Division. The NTCI function as a poison control center and also carries out academic and research activities related to the management of illnesses related to chemical exposure. It serves as the co-ordinating center for a nationwide network of hospitals that provide training in clinical toxicology. Its staff includes physicians and research scientists working in the fields of emergency medicine, toxicology, pharmacology, and occupational and environmental health. Teaching activities are carried out within the University of Pavia postgraduate schools of medical toxicology, occupational medicine, and anesthesiology and intensive care. The NTCI laboratory is involved in many research activities based on animal models and/or in vitro methods that are being conducted in conjunction with research institutes in Europe and the United States. Studies include new therapeutic methods in clinical toxicology and neurotoxicity biomarkers.

Centro di Documentazione Tossicologica
Centro Interdipartimentale sulle Intossicazione Acute
Dipartimento di Farmacologia
'E. Meneghetti'
Università degli Studi di Padova
Largo E. Meneghetti, 2
35131 Padova
Phone: +39-049-8275078

Previously known as the 'Centro di studio dei tossici – Servizio antiveleni,' this poison control service now operates within the Inter-Departmental Centre for Research on Acute Intoxication (CIRIA), which includes the Department of Pharmacology (Chair of Toxicology, Toxicology Laboratory, and Chair of Neuropsychopharmacology) and the Institute of Anaesthesiology and Resuscitation of the University of Padua. It serves the regions of northwest Italy (Friuli-Venezia, Veneto, and Trentino Alto-Adige; total population, 7 million).

Legislation

Italy joined the European Economic Community (EEC) in 1957 following the treaty of Rome and, since

then, Italian legislation on control of chemical substances is guided largely, like in the other Member States, by European Community legislation.

Specific and extensive legislation has been developed, by European community and in consequence on a national level, for different categories of substances dealing with industrial chemicals, pesticides, biocides, food and feed additives, and cosmetics.

At legislative level in Italy there are, first of all, Acts that are adoption of European Union Directives as mentioned above, and also national Acts independent from the European legislation. In addition to EU Directives and national Acts, Italy is driven by a number of international treaties, like the Convention on Long-Range Transboundary Air Pollution (LRTAP), adopted in 1979 under the auspices of the United Nations Economic Commission for Europe (UNECE) and the voluntary Prior Informed Consent (PIC) procedure developed by UNEP and the Food and Agriculture Organization (FAO) of the United Nations.

Moreover, Italy is a Member country of the OECD and participates in its activities in the field of chemicals even if volunteers. The web page of OECD (Organisation for Economic Co-operation and Development) in the section of activities related to Chemical Safety of Environment Department (http://www.oecd.org/department/) makes available information, documents, and publications concerning work of Member countries on specific categories of chemicals (e.g. new and existing chemicals; endocrine disrupters; pesticides; biocides) and production and use of chemicals (e.g. chemical accidents; pollutant release and transfer registers).

The Italian Legislation may be summarized as falling in the framework of hazard identification, risk assessment and risk management of specific substances according to well-known European Union criteria.

Hazard Identification (The Dangerous Properties of Chemicals)

The key directive in this field is Council Directive 67/548/EEC (O.J. L. 196, 16/8/1967) and its subsequent amendments on the approximation of laws, regulations, and administrative provisions relating to the classification, packaging, and labeling of dangerous substances that established a common system for this purpose. Directive does not apply to medicinal products, biocides, pesticides, foodstuffs, cosmetics, wastes and radioactive substances covered by specific rules. The basic Dangerous Substances Directive, implemented in Italy by Law no. 256 of 29 May 1974, is continually updated to take account of scientific and technical progress. To date (March 2007) it has been amended nine times and adapted to technical progress 29 times. The 7th amendment (Council Directive 92/32/EEC), the most innovative, was adopted by Legislative Decree No. 52 of 3 Feb. 1997. The 29th Adaptation to Technical progress (Directive 2004/73/EC) was implemented in Italy by Ministerial Decree of 28 February 2006 and an Italian version of Annex I of Council Directive 67/548/EEC can be accessed at the ISS website: (see List of Identified and Classified Substances in the section Databases).

National Competent Authority responsible for dangerous substances and preparations is the Ministry of Health, with technical/scientific support of Istituto Superiore di Sanità. Coordination of the notification procedures for new chemicals is under the responsibility of the Ministry of Health. A Notification Unit, which is in charge of the technical and scientific aspects of the procedure, has been operating in the Istituto Superiore di Sanità since 1981.

Another key directive is the 1999/45/EC one, regarding the classification, packaging and labeling of dangerous preparations that replaced directive 88/379 as from 30 July 2002 for most preparations and as from 30 July 2004 for plant protection products and biocides. Directive 1999/45/EC in fact extends the scope of basic Dangerous Preparation Directive (88/379/EEC) to include plant protection products and biocides. Directive 1999/45 has been adapted to technical progress by Directive 2001/60/EC and both the Directives were incorporated into Italian legislation by Legislative Decree No. 65 of 15 March 2003. National authority responsible for dangerous preparations is the Ministry of Health, with the technical cooperation of the Istituto Superiore di Sanità (see Dangerous Preparation Archive in the section Databases).

The two previously mentioned key directives (67/548/EEC and 1999/45/EEC) give the basis for a cascade of legislative actions (downstream legislation) which, at the Italian level, provide risk management instruments in order to define the intrinsic dangerous properties of substances and/or preparations. In particular there are links between these Directives and other areas of European legislation concerning:

- export and import of certain dangerous chemicals;
- worker protection (e.g. lead, asbestos, carcinogens, or chemical agents as such);
- biocidal products;
- pesticides;
- pharmaceutical products;
- cosmetic products;
- the restriction of marketing and use of certain dangerous substances and preparations;
- animal testing; or

- the risk assessment of existing substances.

In 1994 an OECD Task Force established a Globally Harmonised System (GHS) aimed to harmonize Classification and Risk Communication of dangerous substances and mixtures. The GHS criteria, subsequently adopted at UN level and published in March 2003, will be implemented in the near future in the European legislation through a regulation, and after a transitional period will replace the current legislation on classification and labeling (Council Directive 67/548/EEC for substances and Directive 1999/45/EC for preparations).

Risk Assessment (Health Risks Represented by Exposure to Chemicals)

At the present time, there is still a separation between 'new' and 'existing' chemicals. Existing chemicals (100 106 substances included in the EINECS Inventory) are chemicals introduced on the European Union market before 1981. Risk assessments available of existing chemical are very limited and public authorities hold the burden of proof. New chemicals are chemicals introduced into the market after 1981, they have to be notified and for them the control is instead very stringent.

The evaluation and control of the risks related to exposure to existing chemicals are defined by EEC Council Regulation N. 793/93 of March 23, 1993, O.J. L. 84, 5/4/1993. It requires industry to provide a data package to Commission for European Communities for all existing substances placed on the market of the European Union in quantities greater than 1000 tonnes per annum/producer or importer. A limited set of data was also requested for substances put on the market in quantities between 10 and 1000 tons. These data were included in an EU database. A non-confidential version is available called IUCLID (International Uniform Chemical Information Database). Four priority lists have been published as Commission Regulations [1179/94 (O. J. N. 131, 26.5.1994), 2268/95 (O.J. N. 231, 28.9.1995) 143/97 (O.J. N. 25, 28.1.1997) and 2364/2000 (O. J. N. 273, 26.10.2000)]. This program of activity is fully coordinated with the OECD HPV program on existing chemicals. Non-confidential data stored in the IUCLID and Risk Assessment Reports can be accessed through the website of the European Chemical Bureau (ECB) of the Commission's Joint Research Center (located at Ispra, Varese, Italy) (http://ecb.jrc.it/existing-chemicals/). Risk assessment required by the Council Regulation 93/793 is carried out according to the principles laid down in Commission Regulation 1488/94 of June 28, 1994 (O.J. L. 161). In Italy, the Ministry of Health, with the technical/scientific co-operation of the Istituto Superiore di Sanità, was appointed as national competent authority responsible for the application of Regulation 93/793 for existing chemicals by the Decree of November 29, 1994. Italy was rapporteur Member State for four substances present in the first three lists. Risk assessment required for new chemicals by Directive 92/32/EC is carried out in accordance with the principles set out by the Commission Directive 93/67/EEC (O.J. N. L. 227 8.9.1993). Directive 93/67/EEC was incorporated into Italian legislation by the Legislative Decree n. 52 of 3.2.1997. A detailed Technical Guidance Document was issued by the European Commission in support of Directive 93/67/EEC. In Italy, the Ministry of Health and Istituto Superiore di Sanità are the designated national authorities responsible also for the risk assessment of new chemicals.

Risk Management

There are specific requirements for some dangerous substances. Italy follows Council Directive 76/769/EEC (O.J. L. 262, 27/9/1976) and subsequent amendment relating to restriction on the marketing and use of certain dangerous substances and preparations. Products covered by this directive include the chemicals PCB and PCT, certain lead compounds, mercury, arsenic, benzene, substances classified as carcinogenic, mutagenic or toxic for reproduction (category 1 or 2) and other very dangerous chemicals like all forms of asbestos, nickel (which is restricted in jewelry and metal objects such as buttons on clothing), certain types of creosote.

In Italy substances and preparations are regulated by the above-mentioned Legislative Decree 52/1997, the Legislative Decree 65/2003, and EEC Regulation no. 793/93. Marketing and use of substances and preparations must be controlled by competent institutions at the national, regional, and local levels. Sites of production, storage, and sales may be inspected at any time, and specimens and information may be collected. Violations ascertained during such inspections are subject to sanctions (including imprisonment). Like other Member States, Italy is required to present an annual report on these controls to the EC Commission.

Laws, rules, regulations, and all official acts concerning toxic substances are published in the *Gazzetta Ufficiale della Repubblica Italiana*, issued daily and accessible in full text format and freely for the last 60 days (http://www.gazzettaufficiale.it/). Information concerning European Community Directives enacted into Italian legislation can be found on the website of Parlamento Italiano (Italian Parliament) (http://www.parlamento.it/parlam/leggi/deleghe/dlattcee.htm (Italian only)).

REACH

The current above-mentioned legislation has been greatly modified by the new REACH regulation (regulation n. 1907/2006 published in the European OJ n. L396 of 30.12.2006) which entered into force on 1st June 2007. REACH is an acronym standing for Registration, Evaluation and Authorisation of CHemicals, and represents a new system aimed at ensuring a higher level of protection for human health and environment, first of all transferring the burden of the proof to industry. REACH prescribes the obligation for industry to collect relevant information for all chemicals put on the market in quantities $\geq$ 1 ton/year; such information has to be forwarded, in form of a registration, to a central European Agency on Chemicals (ECHA, recently settled in Helsinki). The principle 'no registration – no marketing' will be immediately applicable for new substances (i.e. those put for the first time on the European market after 1 June 2007), and within 11 years for substances already on the market prior to the entering into force of REACH. The regulation foresees also specific provisions for the evaluation of chemicals, and for the authorization of substances of very high concern (SVHC).

The European Chemical Agency (ECHA) will manage all the technical aspects related to the REACH regulation.

In Italy the Ministry of Health has been appointed as national Competent Authority, in co-operation other Ministries (Environment and Economic Development) for the more political issues, and with the technical co-operation of the National Agency for Environmental Protection (APAT), particularly for the environmental exposure assessment, and of the Istituto Superiore di Sanità (ISS) for all the other technical issues; within the ISS a National Centre for Chemical Substances is about to be created.

As soon as the new GHS system will be implemented in Europe through a new regulation, presently under co-decision procedure in the Council and the European Parlament, the REACH regulation will make reference to it for classification purposes. Also for GHS the national competent authority will probably be the Ministry of Health in cooperation with the ISS.

Plant Protection Products are those preparations containing one or more active substances, presented in the form in which they are supplied to the user and aimed to: (1) protect plants and plant products from all harmful organisms or to prevent the effects; (2) encourage or regulate the vital processes of plants, with the exclusion of fertilizers; (3) preserve plant products with the exclusion of preservatives governed by special provisions; (4) eliminate unwanted plants; (5) eliminate parts of plants, slow down or prevent undesired growth. In Italy the legislation regulating plant protection products is the Legislative Decree No. 194, of 17 March 1995, implementing Directive 91/414/EEC concerning the marketing of Plant Protection Products.

The directive sets up the criteria for a harmonized system of authorization for marketing the active substances used in plant protection products at the EU level. Member States may then approve products containing such substances for use on their own territory. Annex VI of Directive 91/414 provides uniform principles for the authorization of plant protection products. In Italy the Ministry of Health is responsible for the authorization of preparations containing pesticides and specifically:

- authorizes release on the market and the use of a phytosanitary product throughout Italy or in any parts of Italian territory;
- renews or modifies the authorizations already granted;
- re-examines, withdraws, or uses its powers to refuse renewal, or withdraws authorizations granted;
- establishes, by means of a decree of Ministry of Health, the maximum residue levels of active substances to be contained in products intended for human consumption. At present, the maximum residue levels were established by D.M. on 27 August 2004, containing a number of recent Community regulations, and which re-groups and unifies all national standards previously in force in this field.

Phytosanitary products may be put on the market and used only if they have been authorized by the Ministry of Health, in conformity with Legislative Decree No. 194, 17 March 1995, and Legislative Decree No. 290, 23 April 2001.

The home page of the website of Ministry of Health (Department for Veterinary Public Health, Nutrition and Food Safety) contains information on legislation concerning pesticides and instructions and forms for application of the licenses (most of section available also in English language) (http://www.ministerosalute.it/alimenti/sicurezza/sicApprofondimento.jsp?lang=english&label=pro&id=403&dad=s). Moreover, the website offers access to a database that includes all authorized phytosanitary products in Italy with a variety of information but not the review reports (http://www.ministerosalute.it/alimenti/sicurezza/fitosanitari/ricerca.jsp). The database is in Italian and can be searched by the pesticide name or product type (activity of the active substance).

Biocidal products are defined in Directive 98/8/EC as: 'Active substances and preparations containing one or more active substances, put up in the form in which they are supplied to the user, intended to destroy, deter, render harmless, prevent the actions of,

or otherwise exert a controlling influence on any harmful organism, by chemical or biological means'. The Biocide Directive covers a wide range of products across four main product categories: general biocidal products and disinfectants, preservatives, pest control and other biocidal products. More in detail, there are 23 specific Product Types described by the directive. It harmonizes the rules for placing on the market biocidal products by introducing common data requirements both for active substances and the biocidal products. This directive was implemented in Italy by Legislative Decree No. 174, of 25 February 2000. In Italy, some of the product types described in the biocide directive (insecticides, disinfectants and repellents) were already covered by a national registration procedure (Decree n. 392 of 6 October 1998), according to which the above-mentioned products can be marketed or utilized only with ministerial authorization. Such national registration procedure will be gradually repealed as far as the biocide directive will be progressively implemented. The final goal of the biocide directive is the authorization of the products: conditions that must be met for such authorization may vary according to the risk associated with the biocide and other factors. There is a system of reciprocal recognition between Member States, but it is not automatic. For example, a substance whose use will be authorized in Scandinavian countries might not be safe in another area with different climatic characteristics. The decree 174/2000 also provides guidelines on advertising of biocidal substances. The Ministry of Health and the Ministry of Environment, with the technical cooperation of the ISS, are the Institutions responsible for the implementation of the set of rules for biocidal products in Italy. From the web pages of the Ministry of Health it is possible to access all key legislation pertaining to biocides, and the basic principles are described in the site.

In particular, Ministry of Health, Directorate-General for Medicinal Products and Medical Devices co-ordinates the activities of the Competent Authority and is responsible for all activities foreseen by the Directive excluding the refusals of mutual recognition of authorizations for product types 15, 17, and 23. Ministry of Environment is competent authority for Evaluation of the effects on the environment including refusals of mutual recognition of authorizations for product types 15, 17, and 23. All the technical activities are performed in cooperation with the ISS.

Food Additives

The Ministry of Health is responsible for food safety in Italy. Direct food additives are regulated by a decree of the Ministry of Health No. 209 of February 27, 1996 concerning food additives permitted in the preparation and preservation of food. This decree is in accordance with EC council directives concerning food additives (94/34/EC), sweeteners (94/35/EC), coloring agents (94/36/EC), and other types of food additives (95/2/EC). The Italian decree includes a list of approved chemicals that may be used as food additives. New additives must be subjected to extensive toxicological testing in animals to demonstrate that they are safe for use in food, and their use must be shown to be absolutely necessary from a technological point of view.

Indirect food additives (chemicals used in food packaging materials) are regulated by the amended version of Council Directive 76/893/EEC. The Italian decree includes a positive list, of chemicals that may be used in food as indirect additives, compiled by the EU. The safety of new additives must be demonstrated by premarketing toxicological tests conducted according to suggested guidelines. Final decisions on approval are made by the European Food Safety Authority (EFSA). In Italy, the Ministry of Health, with the technical/scientific cooperation of the Istituto Superiore di Sanità, is the national competent authority responsible in this field. On the website of the Ministry of Health there is a large availability of documents, legislation for matters relating to food including drinking water (http://www.ministerosalute.it/alimenti/sicurezza/sicApprofondimento.jsp?lang=italiano&label=alip&id=251&dad=s) most of them in Italian.

Food Supplements

The products marketed as foods containing concentrated sources of nutrients or ingredients with physiological effect and presented for supplementing the intake of those substances from the normal diet are defined as 'food supplements'.

'Food supplements' means foodstuffs whose purpose is to supplement the normal diet and which are concentrated sources of nutrients or other substances with a nutritional or physiological effect, alone or in combination, marketed in dose form (such as capsules, pastilles, tablets, pills and other similar forms, sachets of powder, ampoules of liquids, drop-dispensing bottles, and other similar forms specifically designed to be taken in measured small unit quantities).

In order to ensure a high level of protection for consumers and facilitate their choice, the products that will be put on to the market must be demonstrated to be safe and must bear adequate and appropriate labeling.

There is a wide range of nutrients and other ingredients that might be present in food supplements

including, but not limited to, vitamins, minerals, amino acids, essential fatty acids, fiber, and various plants and herbal extracts.

As a first stage, the Directive should lay down specific rules for vitamins and minerals used as ingredients of food supplements. Food supplements containing vitamins or minerals as well as other ingredients should also be in conformity with the specific rules on vitamins and minerals laid down in the Directive or at national level in the case of lack of European measures.

At a later stage specific rules should be laid down concerning nutrients, other than vitamins and minerals, or other substances with a nutritional or physiological effect used as ingredients of food supplements, provided that adequate and appropriate scientific data about them become available. Until such specific Community rules are adopted and without prejudice to the provisions of the Treaty, national rules may be applicable concerning nutrients or other substances with nutritional or physiological effect used as ingredients of food supplements, for which no Community-specific rules have been adopted.

The chemical substances used as sources of vitamins and minerals in the manufacture of food supplements should be safe and also be available to be used by the body. For this reason, positive lists of those substances have been established. Such substances have been approved by the European Food Safety Authority (EFSA) (http://www.efsa.europa.eu/en.html), on the basis of the said criteria, for use in the manufacture of foods intended for infants and young children, and other foods for particular nutritional uses can also be used in the manufacture of food supplements. The Legislative decree 169/2004 implemented the Food supplements Directive in Italy with specific rules regarding the daily intake of the nutritional ingredients and the admitted plant extracts.

The Ministry of Health, with the technical cooperation of the Istituto Superiore di Sanità, is the national competent authority responsible in this field and on the website of the Ministry of Health is possible to consult the guidelines for producing and putting on the Italian market these products, the list of the nourishing ones and of the substances having physiological effects like plant extracts (http://www.ministerosalute.it/alimenti/dietetica/dieApprofondimento.jsp?lang=italiano&label=int&id=58&dad=s; Italian only).

Feed Additives

Since 18 October 2004, applications for authorizing the placing and use of feed additives in the market, are regulated in the European Union under Regulation (EC) No 1831/2003. The European Food Safety Authority (EFSA) is responsible for the scientific assessment of the feed additives. This legislation is under the jurisdiction of the Ministry of Agriculture (http://erclib.vet.unibo.it/jb/ud/22780/file/lgs-06.pdf; Italian only).

Cosmetics

Production and marketing of cosmetic products are regulated in Italy by the amended version of Council Directive 76/768/EEC within the Law no. 713 of 11 October 1986 and next updating decrees (Legislative Decrees No. 300 of 10 Sept.1991; n. 126 of 24 April 1997 and n. 50 of 15 Feb. 2005). Directive 76/768/EEC on the approximation of the laws of the Member States relating to cosmetic products ('Cosmetics Directive'), adopted in 1976, aims to guarantee the safety of cosmetic products for human use while encouraging commercial exchange and eliminating barriers to trade.

Official restrictions and prohibitions on specific ingredients that can be used in cosmetics are mainly regulated through the Annexes of Cosmetics Directive that include various lists (list of substances whose use is prohibited in the composition of cosmetic products (negative list); lists of ingredients subject to restrictions (restricted list); positive lists of cosmetic colorants, preservatives and ultraviolet (UV) filters that are permitted in cosmetic products). Where substances are subject to a positive list, the inclusion of a new substance on a positive list is preceded by a scientific risk evaluation of the substance by the Scientific Committee of Cosmetics and Non-Food Products Intended for Consumers (SCCNFP) an independent group of qualified scientists with significant experience in risk assessment, appointed by the European Commission. The SCCNFP also reviews the positive and prohibited/restricted lists in response to technical progress and/or concerns about the impacts of particular ingredients on safety. However, the final decision on addition (or removal) of substances from the lists is taken by the Commission and the Member States.

The EU Cosmetics Directive has to date undergone seven amendments and 31 adaptations (by the European Parliament and the Council) in order to reflect technical and scientific progresses concerning cosmetic products. For example, the 6th Amendment led to the adoption of the inventory of ingredients employed in cosmetic products and banned the marketing of cosmetic ingredients or their combinations tested on animals after 1 January 1998. The 7th Amendment introduced the 'period-after-opening labeling' concerning the durability and provided for more detailed provisions on the 'phasing out of animal testing' (for both the bans on animal testing of cosmetic products and of ingredients and on marketing the deadline for implementation is 2009. An exception is

made for the marketing of products tested for repeated-dose toxicity, reproductive toxicity and toxicokinetics that is extended until 2013).

The responsibility to ensure that cosmetic products are safe for consumer use is placed upon the manufacturer or their authorized agent or by any other person responsible for placing the product on the EU market. Guidelines to perform the risk assessment of the cosmetic ingredients were provided in 1997 and updated several times by the Communities Scientific Committee on Cosmetology. The Ministry of Health is the competent authority that enforces the cosmetics legislation in Italy. The website of Ministry of Health provides information concerning Italian implementations of community legislation and relevant documents (http://www.ministerosalute.it/cosmetici/cosmetici.jsp; Italian only).

Limitations Concerning Specific Chemicals

Italy follows Council Directive 76/769/EEC (O.J. L. 262, 27/9/1976) and subsequent amendment relating to restriction on the marketing and use of certain dangerous substances and preparations. Products covered by this directive include the chemicals PCBs and PCTs, certain lead compounds, mercury, arsenic, benzene, and other very dangerous chemicals. The basic Directive 76/769/EEC was put in force in Italy by the Decree of the President of the Republic No. 904 of 10/9/1982.

Miscellanous Reources

International Medlars Center

Italian National Medlars Centre
Web: http://www.iss.it/sdoc/cent/index.php?anno=2006&lang=1&tipo=7 (Italian only)

The National Medlars Centre was established at the Istituto Superiore di Sanità (ISS) in 1978. Before 1998, Italian users who wished to make an online search on files produced or distributed by the NLM could access the ELHILL or TOXNET computers using a password assigned by the ISS. After the institution by NLM of free websites TOXNET (http://Toxnet.nlm.nih.gov), and PubMed (pubmed.gov), the tasks of the ISS are now more oriented toward disseminating knowledge of NLM files in training courses, and distributing information and teaching material conceived for in-depth exploitation of toxicological resources on the Internet. Italian users are very interested in direct searching of toxicological information. An interlibrary loan documentation center has been established at the Documentation Service of the ISS for articles not available in Italy, within the activities of NLM DOCLINE (DOC on LINE) (email: documentazione@iss.it).

MATline, job-exposure matrix for carcinogenic chemicals. DoRS-Documentation Service for Health Promotion of Piedmont Region

Web: http://www.dors.it/matline/matline.php (Italian only)

MATline is a matrix developed by DoRS in collaboration with the Industrial Hygiene group from the Environmental Protection Agency. The matrix is a tool that can be used to predict which industrial processes can be expected to involve the use of a substance that is considered carcinogenic selected according to the method of classification adopted by the European Union (67/548/EEC Directive) and by the International Agency for Research on Cancer (IARC). Each agent is associated with a list of industrial processes coded according to the tariff headings used by the National Institute of Insurance against Occupational Injuries and Diseases (INAIL). Main toxicological data, target organs, uses and types of industry are reported for each agent. The matrix currently includes more then 600 carcinogenic agents, 23 classes of agents and some 7000 links between agents and industrial processes. The main sources of information are the IARC Monographs and databases available through the National Library of Medicine's TOXNET portal.

CHAPTER

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Japan

TETSUO SATOH AND TAKESHI MORITA

INTRODUCTION

Toxicology is a relatively new science compared with pharmacology and pathology. However, it is a multidisciplinary field encompassing these subjects as well as other related life and social sciences. In Japan, the study of modern toxicology originated in academic settings in the 1970s subsequent to severe health tragedies induced by chemicals in the 1960s. These included the congenital malformations induced by thalidomide, Minamata disease induced by methyl mercury, Itai-itai disease induced by cadmium, chinoform-induced SMON (subacute myelo-optico-neuropathy) disease, and Kanemi Oil Poisoning Case induced by Co-PCB (coplanar polychlorinated biphenyl) or PCDF (polychlorinated dibenzo furan). These events were driving forces in the formation of modern toxicology. The pharmaceutical and chemical industries joined in the pursuit of toxicological research in the 1980s. As GLP (Good Laboratory Practice) system was also introduced in the 1980s, industrial companies needed a platform for the exchange of information and for discussion. In the 1990s, further development of the GLP system and experiences in industry ensured high-quality testing and results. In addition, regulators became involved with the scientific sector. Their participation induced the development of regulatory sciences including toxicity test guidelines, e.g., OECD or ICH guidelines, for hazard identification, and subsequently industry recognized the significance of education/training. Subjects such as risk evaluation, mechanistic toxicology and cutting-edge research toxicology including the -omics disciplines are advancing among the academic, regulatory, and industrial sectors in the 2000s. High-throughput screening of chemicals is also an important issue, and food safety is of particularly high interest to the public. On the other hand, clinical toxicology including occupational safety and epidemiology, is not a major focus of toxicology in Japan. Toxicology should clearly play an important role in risk communication. Many future challenges to toxicology remain.

TOXICOLOGY IN JAPAN

History of the Japanese Society of Toxicology – Past, Present and Future

Origin of the Japanese Society of Toxicology

In Japan, the Toxicology Research Group and the Toxic Action Research Group were formed in 1975 and 1976, respectively. In 1981, the two groups merged to form the Japanese Society of Toxicological Sciences (JSTS) as a non-profit scientific society to promote the acquisition and utilization of knowledge in toxicology and to facilitate the exchange of information among its members as well as among investigators worldwide. The first membership list contained 943 names on June 1, 1981, and grew to nearly 2400 members in 25 years. Prior to the founding of the JSTS, the Toxicological Research Group joined the membership of the International Union of Toxicology in 1980. The JSTS was renamed the Japanese Society of Toxicology (JST) in 1997.

Mission

The mission of the JST is to advance health through understanding of toxicology, and to stimulate research in toxicology.

JST shall promote the following activities:

1. Convening the annual meeting.
2. Publication of the official Journal.
3. Education and certification of toxicologists.
4. Scientific and publicity activities for members and the public.
5. Other programs/projects necessary to accomplish the purpose of JST.

Members

JST has recognized five member categories: General members, Student members, honorary members, meritorious members, and Supporting members. Among its current members are 42 from across the world; Korea (15), USA (11), United Kingdom (9), Canada (3), China (1), and Denmark (1). JST currently has the second largest toxicology society membership in the world. Member affiliations are Contract Research Organization (CRO, 70%), Academia (22%), Government (6%) and others (2%).

Board of Directors, Council and General Meeting

JST's managing structure includes 20 Directors and 292 Councillors as of September 1, 2006. The Board of Directors meets twice a year to draft the action plans of JST. The Council Meeting and the General Meeting are held once a year to discuss the action plans proposed by the Board of Directors.

Committees

JST has five strategic Committees to accomplish the society activities – General Affairs, Editorial, Educational, Finance and Science and Publicity.

General Affairs Committee

The committee has two major responsibilities. One is to strategically draw up the general action plans of JST for the year by reviewing the plans proposed by the individual committees and preparing the subjects for discussion at the Board of Directors. Another is to manage JST membership, including nomination and approval of new councillors and members.

Editorial Committee

As an official journal, JST has published the 'Journal of Toxicological Sciences (JTS)' bimonthly (online ISSN: 1880-3989; print ISSN: 0388-1350). The journal contains invited review articles, peer-reviewed original papers, and Letter to the Editor. JTS has invited distinguished toxicologists from throughout the world to become Associate Editors and Editorial Board members. One of the society's top strategic priorities is the ongoing development of its journal. JST is in the process of developing a new look and feel for the journal. In addition, based on the judgment of the Educational Committee, JST provides Best Paper Awards (Tanabe Award) for the best scientific papers appearing in JTS. The recipients of the award are honored at a special awards ceremony at the JST annual meeting, and their names are listed in the JST publications. The Editorial Committee takes responsibilities for the publication of JTS and the determination of the candidates for the Best Paper Awards.

Educational Committee

To foster and improve the quality of toxicologists in Japan, the Education Committee has provided certification and recertification examinations, continuing education courses, and fundamental education courses every year.

Since 1995, the Board of Directors of JST has seriously discussed the accreditation and certification of toxicologists in Japan. After extensive deliberations, the certification program of toxicologists was newly launched in 1997 under the control of the Education Committee. The aspect of our certification examination is similar to that of the American Board of Toxicology. At the first certification examination in 1997, 99 toxicologists were certified by the JST as diplomates of the Japanese Society of Toxicology (D.J.S.T.). The written examination has been offered every year, and 289 toxicologists have been formally approved as diplomate. As of June, 2006, 78% of the diplomates are from industry, and 14% from academia, and 8% from national institutes, research institutes, and foundations. Diplomates can be recertified every 5 years based upon their active practice of toxicology and maintaining an expert knowledge in general toxicology.

An applicant must have had a principal involvement in the practice of toxicology, in addition to the appropriate background education. The examination covers all aspects of toxicology and toxicity testing. The certified toxicologist should have knowledge which encompasses all aspects of toxicology and should be able to conduct proper toxicological planning, testing, evaluation and risk assessment.

Financial Committee

The Financial Committee deals with all of the financial issues of JST. JST has continued to make progress in strengthening the financial foundation of the Society. Major steps are taken to set up and implement a system for monitoring ongoing financial actions and

develop future plans. In addition, the society has considered modernizing and upgrading the budget and expenditures management process. The society has 48 supporting members that are mainly private industries, and they have supported the achievement of the strategic plans of the society financially.

Science and Publicity Committee

JST has provided public education lectures on toxicology since 1995 at its annual meetings, and the JST website has been redesigned with links to other websites in 2006. The website also presents updated information in both Japanese and English for its worldwide membership. These activities fall under the auspices of the Science and Publicity Committee. Furthermore, in addition to the above-mentioned Best Paper Awards, JST presents prestigious awards such as the Toxicological Science Award and the Young Investigator Awards each year in recognition of distinguished toxicologists, based on the judgment of the Awards Subcommittee, organized under the control of the Science and Publicity Committee. The recipients of the awards are honored at a special awards ceremony at the JST annual meeting, and their names are listed in the JST publications.

National and International Activities

National Level

Annual Meeting

The scientific meeting of JST is held annually. The scientific program of the annual meeting contains the invited lectures of prestigious speakers from throughout the world, symposia, workshops, oral/poster presentations, luncheon seminars, and panel discussions. At the annual meeting in 2006, there were 1600 participants from five countries. This is the largest number of meeting registrants to date.

Public Education Lecture

To promote public education in toxicology, JST has organized a lecture for the public during each year's annual meeting. Scientific experts are invited to give a lecture on a popular and important topic related to clinical medicine and drug therapy.

International Level

International Congress of Toxicology

As one of its global activities, the IUTOX organizes the International Congress of Toxicology (ICT) every 3 years, and the ICTs have been hosted by an IUTOX member society, as elected by the IUTOX member societies in the world. The JST hosted the ICT-IV in 1986 in Yokohama, Japan. Professor Fuminori Sakai, Past Vice President of IUTOX, chaired the ICT-IV, and 1104 registrants from 39 different countries participated.

Asian Society of Toxicology

The JST and the Korean Society of Toxicology organized joint meetings of toxicology in 1987 (Seoul, Korea), 1990 (Nagoya, Japan) and 1993 (Seoul, Korea). In 1994, representatives of the toxicology societies in Japan, China, Korea, Taiwan, and Thailand met in Sapporo, Japan to promote the toxicological sciences in Asia. As a consequence of serious discussions, the establishment of the Asian Society of Toxicology (ASIATOX) (formerly The Asian Federation of the Toxicological Sciences) was officially approved at the meeting. ASIATOX joined the IUTOX membership in 1996. The first ASIATOX congress (ASIATOX-I) was hosted by JST in Yokohama, Japan in 1997. There were 474 participants from 13 countries. ASIATOX-II, III, and IV have been held in Korea, Thailand, and China respectively, spaced 3 years apart. The 4th Congress will be held in Taiwan in 2009.

Risk Assessment Summer School

IUTOX has sponsored the Risk Assessment Summer School (RASS) every other year. The purpose of RASS is to train young toxicologists by offering stimulating lectures by experts and discussing the topics under consideration. One or two young toxicologists representing JST have participated in every RASS meeting in the past.

Future Perspectives

The development of toxicology as a recognized scientific discipline has proceeded at a rapid pace for the last 10 years. Its genomic basis, in particular, has been of consequence, and its growth is likely to accelerate in the future. Over the years, JST has achieved exceptional success with its meetings, publications, and its member services and outreach activities. Two important tasks in JST activities include maintaining the high-quality certification program of toxicologists and considering ways to improve the society journal.

Concerning certification, the number of JST-certified toxicologists has increased every year and the certification program is now well recognized throughout Japan. The diplomates receive several benefits such as health promotion at the workplace. Another goal of the program is to expand it to toxicologists in other countries. Concerning its journal, the JTS editorial team envisions a publication with increased visibility and which enhances the scientific edge in the

field of toxicology. As JTS modernizes, it will provide a highly efficient web-based manuscript submission and review system in the near future. The system will facilitate all aspects of manuscript submission, including tracking and communication between authors, reviewers, and editor.

Finally, the ultimate aim of all the Committees of JST is to advise Council in developing an implementation plan that ensures a systematic and efficient expenditure of energies and resources, and that is most closely aligned with a carefully considered strategy for accomplishing its long-range plan.

For more details, contact the Japanese Society of Toxicology Headquarters:

International Medical Center, Shinanomachi Rengakan, 35 Shinano-machi, Shinjuku-ku, Tokyo 160-0016, Japan

Phone :+81-3-5361-7075
Fax: +81-3-5361-7091
Email: jst@imic.or.jp
Web: http://www.jsot.gr.jp/english/index.html (English)
Web: http://www.jsot.gr.jp/index.html (Japanese)

RESOURCES

Books

Education Committee of the Japanese Society of Toxicology (Ed.) (2002)
Toxicology
Tokyo: Asakura-shoten (Japanese)

Fujita S (Ed.) (1999)
Toxicology
Tokyo: Asakura-shoten (Japanese)

This is a textbook mainly for toxicology education in veterinary school.

Japan Poisoning Information Centre (Ed.) (1999)
First aid manual for acute poisoning, 3rd Edition
Tokyo: Jiho (Japanese)

Japanese Society of Toxicology (Ed.) (2003)
Dictionary of Toxicological Terms
Tokyo: Jiho (Japanese–English)

This is a Japanese–English and English–Japanese dictionary of terms which are frequently used in toxicology.

Kariya K, Satoh T, Takahashi M, Noguchi H (Eds.) (2004)
Japanese Edition of Casarett & Doull's Toxicology, 6th Edition
Tokyo: Scientist Publishers (Japanese)

One of the best-selling books in toxicology, 'Casarett & Doull's Toxicology' (6th ed.) (edited by C. Klaassen) was translated into Japanese. The book is extremely useful for the education and training of toxicologists in Japan.

Naitoh H, Yokote N (Japanese Translating Eds.) (2002/2003)
Clinical Toxicology
Ford et al (Eds.) Vols. 1/2
Tokyo: Maruzen (Japanese)

Nishi K (Ed.) (2003)
Emergency manual for drugs and poisoning, 7th Edition
Tokyo: Iyaku-Journal (Japanese)

National Profile on Chemicals Management JAPAN (2003)
Jiho Co. Ltd. (Japanese)
Web: http://www.mhlw.go.jp/houdou/2003/10/dl/h1029-1b.pdf (Japanese only)

Sakamoto T (Japanese Translating Ed.) (1999)
Poisoning and Drug Overdose, 2nd Edition
Kent R Olson (Ed.)
Tokyo: Medical Science International (Japanese)

Satoh T, Kariya K, Kitada K (Eds.) (2006)
Introduction to Clinical Toxicology (formerly Toxicology in Medicine), 3rd Edition
Tokyo: Nankodo (Japanese)

A textbook for advanced undergraduate and graduate students to use in the classroom setting. It provides a thorough, systematic introduction to toxicology. It describes the most current knowledge on toxicology from the viewpoint of clinical pharmacy rather than fundamental pharmaceutical sciences.

Satoh T, Ueno Y (Eds.) (1995)
Essential Toxicology, 3rd Edition
Tokyo: Nankodo (Japanese)

A basic textbook in toxicology for undergraduate and graduate students. Topics such as toxicokinetics, metabolism, excretion, mutagenesis, carcinogenesis, hepatotoxicity, and the natural toxins are covered.

Journals

Almost all journals are published as official journals of the professional societies. See Professional Society Section.

Foods & Food Ingredients Journal of Japan
Web: http://www.ffcr.or.jp/zaidan/FFCRHOME.nsf/pages/ffij-eindex (English Abstract)
Web: http://www.ffcr.or.jp/zaidan/FFCRHOME.nsf/pages/ffij-jindex (Japanese Abstract)

Health and Nutrition News
Web: http://www.nih.go.jp/eiken/english/info/info_news_e.html (English)
Web: http://www.nih.go.jp/eiken/info/info_news.html (Japanese)

Industrial Health
Web: http://www.niih.go.jp/en/indu_hel/index.html (English)
Web: http://www.niih.go.jp/jp/indu_hel/index.html (Japanese)

Industrial Health is an international academic journal published by the National Institute of Industrial Health (NIIH). Contributed papers are closely examined by professors in Japan and overseas. The journal covers fields in medicine, ergonomics, industrial hygiene engineering, and policy sciences.

The Tohoku Journal of Experimental Medicine
Web: http://journal.med.tohoku.ac.jp/ (English)

Tohoku University publishes *The Tohoku Journal of Experimental Medicine* (TJEM). The TJEM is one of the oldest and the most prestigious periodicals in Japan and the world. It is open to original articles in all branches of medical sciences from authors throughout the world.

Technical Reports and other Documents

Chemicals in the Environment; Report on Environmental Survey and Monitoring of Chemicals in FY2001–2005
Web: http://www.env.go.jp/chemi/kurohon/en/index.html (English)
Web: http://www.env.go.jp/chemi/kurohon/index.html (Japanese)

'Chemicals in the Environment' by the Ministry of the Environment (MOE) includes three types of surveys i.e., Initial Environmental Survey, Environmental Survey for Exposure Study, and Monitoring Investigation.

Chemical Hazard Evaluation Sheets
Web: http://www.safe.nite.go.jp/data/sougou/pk_list.html?table_name=hyoka&rank=sheet&sort=cas (Japanese only)

Chemical Substance Fact Sheets for Risk Communication
Web: http://www.env.go.jp/chemi/communication/factsheet.html (Japanese only)

The fact sheets provide general public with simplified and easy-to-understand information on chemical substances subjected to the Law Concerning Reporting, etc., of Release of Specific Chemical Substances to the Environment and Promotion of the Improvement of their Management (PRTR Law).

Information on PRTR chemicals
Web: http://www.env.go.jp/chemi/prtr/archive/target_chemi.html (Japanese only)

Information System on Safety and Effectiveness for 'Health Foods'
Web: http://hfnet.nih.go.jp/ (Japanese only)

Links to Chemical Safety Database for Chemical Management
Web: http://www.meti.go.jp/policy/chemical_management/06DB/index.htm (Japanese only)

Results of Eco-toxicity tests of chemicals conducted by Ministry of the Environment in Japan (2003 version)
Web: http://www.env.go.jp/chemi/sesaku/02e.pdf (English)
Web: http://www.env.go.jp/chemi/sesaku/02.pdf (Japanese)
Web: http://www.env.go.jp/chemi/sesaku/01.html (Japanese only)

Test results conducted based on the OECD-GLP standard and the OECD test guidelines are shown. However, because these data have not been evaluated by experts, confirmation of test result is needed if these data are to be used for assessment.

Databases

Chemical Database (WebKis-Plus)
Web: http://w-chemdb.nies.go.jp/index.html (English)
Web: http://w-chemdb.nies.go.jp/ (Japanese)

Chemical Hazard Evaluation Reports
Web: http://www.safe.nite.go.jp/data/sougou/pk_list.html?table_name=hyoka (Japanese only)

More than 100 hazard evaluation reports are presented.

Chemical Risk Information Platform (CHRIP)
Web: http://www.safe.nite.go.jp/english/db.html (English)

Web: http://www.safe.nite.go.jp/japan/db.html (Japanese)

The Platform includes Total Search System for Chemical Substances, PRTR Chemicals Database, and Biodegradation and Bioconcentration of the Existing Chemical Substances under the Chemical Substances Control Law.

Comprehensive Information Search Systems on Food Safety
Web: http://www.ifsis.fsc.go.jp/fsilv1/do/FSILogon (Japanese only)

Database for GHS Classification Results
Web: http://www.safe.nite.go.jp/ghs/ghsi.html (Japanese only)
Web: http://www.safe.nite.go.jp/ghs/index.html (Japanese only)

The results of GHS classification on about 1500 chemicals and the documents for classification are presented.

Environmental Risk Evaluation on Chemicals, Vols. 1–4
Web: http://www.env.go.jp/chemi/risk/index.html (Japanese only)

Evaluation Reports by the Food Safety Commission
Web: http://www.fsc.go.jp/english/index.html (English)
Web: http://www.fsc.go.jp/index.html (Japanese)

The Food Safety Commission is an organization that undertakes risk assessment. The Commission's primary goals can be summarized into three main tasks: (1) conducting risk assessment on food in a scientific, independent, and fair manner, and making recommendations to relevant ministries based upon the results from the risk assessment, (2) implementing risk communication among stakeholders such as consumers and food-related business operators, and (3) responding to food-borne accidents and emergencies.

Food additives:
Web: http://www.fsc.go.jp/english/evaluationreport/foodadditive.html (English)
Web: http://www.fsc.go.jp/senmon/tenkabutu/index.html (Japanese)

Pesticides:
Web: http://www.fsc.go.jp/english/evaluationreport/pesticide.html (English)
Web: http://www.fsc.go.jp/senmon/nouyaku/index.html (Japanese)

Information of area of expertise:
Web: http://www.fsc.go.jp/senmon/index.html (Japanese only)

Risk evaluation:
Web: http://www.fsc.go.jp/hyouka/index.html (Japanese only)

Global Information Network on Chemicals (GINC) Chemical substances toxicity database
Web: http://wwwdb.mhlw.go.jp/ginc/html/db1.html (English)
Web: http://wwwdb.mhlw.go.jp/ginc/html/db1-j.html (Japanese)

This database is for existing chemicals with high production volume (HPV). Several types of toxicity testing reports are included, e.g., in most cases, a single dose toxicity test, a 28-day repeat dose toxicity test, a reproductive/development toxicity test and mutagenicity tests. Each report consists of the nomenclature of the chemical, abstracts and summarized data from the studies in English, and toxicity test results in order.

Health and Nutrition Information Infrastructure Database System
Web: http://nihn-jst.nih.go.jp:8888/nns/owa/nns_main_e.hm01 (English)
Web: http://nihn-jst.nih.go.jp:8888/nns/owa/nns_main.hm01 (Japanese)

The Database covers the National Nutrition Survey (NNS). Data search functions include NNS information search, Nutrient contribution information search, Dish information search, and Nutrient requirement of each country search.

Information on Chemicals
Web: http://www.nihs.go.jp/hse/chemical/index-e.html (English)
Web: http://www.nihs.go.jp/hse/chemical/index.html (Japanese)

The database includes Legislation in Japan (English and Japanese), Summary of Environmental Health Criteria (Japanese), Concise International Chemical Assessment Documents (CICAD) (Japanese), and International Chemical Safety Cards (ICSC) (Japanese).

Primarily Evaluation Reports by the New Energy and Industrial Technology Development Organization (NEDO) Chemical Material Management R&D Program
Web: http://www.safe.nite.go.jp/risk/riskdoc2.html (Japanese only)

Primary evaluation reports for more than 50 chemicals are presented.

Risk Assessment Documents
Web: http://unit.aist.go.jp/crm/mainmenu/e_1.html (English for explanation)

Web: http://unit.aist.go.jp/crm/mainmenu/1.html (Japanese only)

Risk assessment documents developed based on the evaluation of the available scientific data for the chemicals with known or anticipated risks for human health and/or the environment. They provide the scientific basis for regulatory bodies, industries, and the public in the decision-making process of chemical risk management.

Summary of Pesticide Documents and Evaluation Reports
Web: http://www.acis.go.jp/syouroku/index.htm (Japanese only)
Web: http://www.acis.go.jp/eng/indexeng.htm (English for explanation)

Pesticide Documents prepared by applicants and Evaluation Reports prepared by the Food Safety Commission, Cabinet Office are presented.

Organizations (Government)

Food Safety Commission (FSC)
Web: http://www.fsc.go.jp/english/index.html (English)
Web: http://www.fsc.go.jp/ (Japanese)

Food Safety Commission Secretariat Postal Mailing Address:
2-13-10 Prudential Tower, 6th Floor, Nagata-cho, Chiyoda-ku, Tokyo 100-8989, Japan
Phone: +81-3-5251-9218
Fax: +81-3-3591-2237

Ministry of Agriculture, Forestry and Fisheries (MAFF)
Web: http://www.maff.go.jp/eindex.html (English)
Web: http://www.maff.go.jp/ (Japanese)
Information on Food Safety:
Web: http://www.maff.go.jp/syohi.html (Japanese only)
1-2-1 Kasumigaseki, Chiyoda-ku, Tokyo 100-8950, Japan
Phone: +81-3-3502-8111

Ministry of Economy, Trade and Industry (METI)
Web: http://www.meti.go.jp/english/index.html (English)
Web: http://www.meti.go.jp/ (Japanese)
Chemical Management:
Web: http://www.meti.go.jp/english/policy/c_main_environment.html#3 (English)
Web: http://www.meti.go.jp/policy/chemical_management/index.htm (Japanese)

Public Relations Office
1-3-1 Kasumigaseki, Chiyoda-ku, Tokyo 100-8901, Japan
Phone: +81-3-3501-1619
Fax: +81-3-3501-6942
Email: webmail@meti.go.jp
General METI Inquiries
Phone: +81-3-3501-1511

Ministry of Health, Labour and Welfare (MHLW)
Web: http://www.mhlw.go.jp/english/index.html (English)
Web: http://www.mhlw.go.jp/ (Japanese)
Chemical Safety:
Web: http://www.mhlw.go.jp/new-info/kobetu/seikatu/kagaku/index.html (Japanese only)
1-2-2 Kasumigaseki, Chiyoda-ku, Tokyo 100-8916, Japan
Phone: +81- 3-5253-1111

Ministry of the Environment (MOE)
Web: http://www.env.go.jp/en/index.html (English)
Web: http://www.env.go.jp/ (Japanese)
Health & Chemicals:
Web: http://www.env.go.jp/en/chemi/ (English)
Web: http://www.env.go.jp/chemi/ (Japanese)
Godochosha No. 5, 1-2-2 Kasumigaseki, Chiyoda-ku,
Tokyo 100-8975, Japan
Phone: +81-3-3581-3351
Email: MOE@env.go.jp

Organizations (Government Institutes)

Agricultural Chemicals Inspection Station (ACIS)
Web: http://www.acis.go.jp/eng/indexeng.htm (English)
Web: http://www.acis.go.jp (Japanese)

The Agricultural Chemicals Inspection Station (ACIS) inspects pesticide quality and ensures proper and safe use of pesticides. On-site inspection of pesticide manufacturers, distributors, and end users has been conducted by ACIS to prevent distribution/use of inappropriate pesticides.

2-772 Suzuki-cho, Kodaira-shi, Tokyo 187-0011, Japan
Phone: +81-42-383-2151
Fax: +81-42-385-3361

Japan National Institute of Occupational Safety and Health (JNIOSH)
Web: http://www.jniosh.go.jp/ (Japanese only)

The Japan National Institute of Occupational Safety and Health (JNIOSH) includes the following two Institutes, i.e., NIIH and NIIS.

1-4-6 Umezono, Kiyose-shi, Tokyo 204-0024, Japan
Phone: +81-42-491-4512
Fax: +81-42-491-7846

National Institute of Industrial Health (NIIH)
Web: http://www.h.jniosh.go.jp/en/index.html (English)
Web: http://www.h.jniosh.go.jp/jp/index.html (Japanese)

The National Institute of Industrial Health (NIIH) has the following three functions: (1) to provide scientific and technical support on occupational health administration, (2) to conduct original research on occupational health, and (3) to meet the needs of national and international scientific communities and the Japanese society based on the manpower, facilities, and achievements of the Institute. NIIH publishes an international academic journal 'The Industrial Health'.

6-21-1 Nagao, Tama-ku, Kawasaki-shi, Kanagawa 214-8585, Japan
Phone: +81-44-865-6111
Fax: +81-44-865-6166

National Institute of Industrial Safety (NIIS)
Web: http://www.jniosh.go.jp/old/anken/english/top.html (English)
Web: http://www.jniosh.go.jp/old/anken/index.html (Japanese)
1-4-6 Umezono, Kiyose-shi, Tokyo 204-0024, Japan
Phone: +81-42-491-4512
Fax: +81-42-491-7846

National Cancer Center (NCC)
Web: http://www.ncc.go.jp/index.html (English)
Web: http://www.ncc.go.jp/jp/ (Japanese)

The National Cancer Center is providing diagnosis, research, training and the like through cooperation between administrative departments, hospitals, and research institutes. It has thus served a central role in measures to prevent and treat cancer in Japan.

National Cancer Center: Tsukiji Campus
5-1-1 Tsukiji, Chuo-ku, Tokyo 104-0045, Japan
Phone: +81-3-3542-2511

National Cancer Center: Kashiwa Campus
6-5-1 Kashiwanoha, Kashiwa-shi, Chiba 277-8577, Japan
Phone: +81-4-7133-1111

National Food Research Institute (NFRI)
Web: http://nfri.naro.affrc.go.jp/english/ourroles/index.html (English)
Web: http://nfri.naro.affrc.go.jp/ (Japanese)

The National Food Research Institute (NFRI) is implementing wide-ranging research on food science and technology. The mission of the Institute is to provide society with a healthy and enriched life, and to assure the supply of safe food through conducting research. Its food research projects cover a wide range of scientific and technical fields and are aimed at developing technological systems.

2-1-12 Kannondai, Tsukuba-shi, Ibaraki 305-8642, Japan
Phone: +81-298-38-7991
Fax: +81-298-38-7996

National Institute for Environmental Studies (NIES)
Web: http://www.nies.go.jp/index.html (English)
Web: http://www.nies.go.jp/index-j.html (Japanese)

Environmental problems have been proliferating from the relatively localized problems, represented by industrial pollution, to global problems. Actually, these problems stem from long-term human activities, represented by global warming and ecosystem degradation. Many other environmental issues like management of wastes and hazardous substances have also become serious problems. To solve these issues, NIES is making use of the synergies within its institute, and paying attention to interdisciplinary collaboration.

16-2 Onogawa, Tsukuba-shi, Ibaraki 305-8506, Japan
Phone: +81-29-850-2314
Fax: +81-29-851-4732
Email: www@nies.go.jp

National Institute of Advanced Industrial Science and Technology (AIST)
Web: http://www.aist.go.jp/index_en.html (English)
Web: http://www.aist.go.jp/index_ja.html (Japanese)

The missions of National Institute of Advanced Industrial Science and Technology (AIST) are (1) contribution to a sustainable society, (2) contribution to industrial competitiveness, (3) contribution to local industrial development, and (4) contribution to industrial technology policies. Research fields are Life Science & Technology, Information Technology, Nanotechnology, Materials & Manufacturing, Environment & Energy, Geological Survey and Applied Geoscience, and Metrology and Measurement Technology.

AIST Tokyo Headquarters
1-3-1 Kasumigaseki, Chiyoda-ku, Tokyo 100-8916, Japan
Phone: +81-3-5501-0900

National Institute of Biomedical Innovation (NIBIO)
Web: http://www.nibio.go.jp/index.shtml# (Japanese only)

7-6-8 Saito-Asagi, Ibaraki-shi, Osaka 567-0085, Japan
Phone: +81-72-641-9811
Fax: +81-72-641-9812

National Institute of Genetics (NIG)
Web: http://www.nig.ac.jp/index-e.html (English)
Web: http://www.nig.ac.jp/ (Japanese)

This institute carries out comprehensive genetic research to advance the knowledge of basic and applied genetics as one of the inter-university institutes. NIG also serves as a center for various genetic resources such as mutant strains, clones and vectors, the DNA Data Bank of Japan, and a DNA sequencing center. Recent generation of massive information on biological systems and their environment calls for new directions in life sciences, such as bioinformatics, system-level analysis, and theoretical approaches to extract knowledge from databases.

1111 Yata, Mishima-shi, Shizuoka 411-8540, Japan
Phone: +81-55-981-6707
Fax: +81-55-981-6715

National Institute of Health and Nutrition (NIHN)
Web: http://www.nih.go.jp/eiken/english/index.html (English)
Web: http://www.nih.go.jp/eiken/index.html (Japanese)

The National Institute of Health and Nutrition (NIHN) is making numerous contributions to improve nutrition and dietary habit and to advance the knowledge of health and nutrition science for the public. NIHN provides leadership for the public by conducting surveys and research on health maintenance and promotion as well as nutrition and dietary habits.

1-23-1 Toyama, Shinjuku-ku, 162-8636 Tokyo, Japan
Phone: +81-3-3203-5721
Fax: +81-3-3202-3278

National Institute of Health Sciences (NIHS)
Web: http://www.nihs.go.jp/index.html (English)
Web: http://www.nihs.go.jp/index-j.html (Japanese)

The National Institute of Health Sciences (NIHS) is responsible for conducting basic research to ensure the quality, efficacy, and safety of a wide range of products that directly and indirectly affect the populace. The major activities of NIHS cover extensive testing and research to ensure the quality and safety of drugs, foods and other goods closely related to people's lives. Such activities include biological studies, information services, and co-operation with international organizations.

1-18-1 Kamiyoga, Setayaga-ku, Tokyo 158-8501, Japan
Phone: +81-3-3700-1141
Fax: +81-3-3707-6950

National Institute of Public Health (NIPH)
Web: http://www.niph.go.jp/English/index.html (English)
Web: http://www.niph.go.jp/ (Japanese)

The mission of the National Institute of Public Health is to carry out education and training of personnel engaging in public health, environmental hygiene and social welfare, and to conduct research in these areas.

2-3-6 Minami, Wako-shi, Saitama 351-0197, Japan
Phone: +81-48-458-6111
Fax: +81-48-469-1573
Email: webmaster@niph.go.jp

National Institute of Radiological Sciences (NIRS)
Web: http://www.nirs.go.jp/ENG/nirs.htm (English)
Web: http://www.nirs.go.jp/index.html (Japanese)

National Institute of Radiological Sciences (NIRS) is the only institution in Japan dedicated to comprehensive scientific research for radiation and health. Experts from many fields collaborate in research and development to enhance the levels of radiological sciences. NIRS has conducted various activities as an institution with advanced equipment and personnel with expertise in a wide range of professional fields including medical science, physics, engineering, chemistry and pharmaceutical science.

4-9-1 Anagawa, Inage-ku, Chiba-shi, Chiba 263-8555, Japan
Phone: +81-43-251-2111
Email: kokusai@nirs.go.jp

National Institute of Technology and Evaluation (NITE)
Web: http://www.nite.go.jp/index-e.html (English)
Web: http://www.nite.go.jp/ (Japanese)

The National Institute of Technology and Evaluation (NITE) is offering a vital contribution to society in the fields of: (1) biotechnology including the collection of micro-organisms; (2) chemical management including the integration of risk information of chemical substances; (3) accreditation including accreditation under international standards; (4) consumer product safety including the compilation of safety information of products used in daily life.

2-49-10 Nishihara, Shibuya-ku, Tokyo 151-0066, Japan
Phone: +81-3-3481-1921
Fax: +81-3-3481-1920
Email: koho@nite.go.jp

New Energy and Industrial Technology Development Organization (NEDO)
Web: http://www.nedo.go.jp/english/index.html (English)

Web: http://www.nedo.go.jp/index.html (Japanese)

NEDO's activities are industrial technology research and development (R&D), environmental technology R&D, and promote new energy and energy conservation technology. NEDO is also responsible for R&D project planning and formation, project management and post-project technology evaluation functions.

NEDO Kawasaki Head Office
MUZA Kawasaki Central Tower, 1310 Omiya-cho, Saiwai-ku
Kawasaki-shi, Kanagawa 212-8554, Japan
Phone: +81-44-520-5100
Fax: +81-44-520-5103
Email: inf-r6@nedo.go.jp

Radiation Effects Research Foundation (RERF)
Web: http://www.rerf.or.jp/ (Japanese & English)

The Radiation Effects Research Foundation is the scientific research institution focused on the study of health effects of radiation in the survivors of the atomic bombings of Hiroshima and Nagasaki. Careful analysis of the accurately recorded cancer incidence and mortality data for the large study population is contributing fundamental risk information for radiation protection standards worldwide.

Hiroshima Laboratory
5-2 Hijiyama Park, Minami-ku, Hiroshima-shi, Hiroshima 732-0815, Japan
Phone: +81-82-261-3131
Fax: +81-82-263-7279

Nagasaki Laboratory
1-8-6 Nakagawa, Nagasaki-shi, Nagasaki 850-0013, Japan
Phone: +81-95-823-1121
Fax: +81-95-825-7202

Research Center for Chemical Risk Management (CRM)
Web: http://unit.aist.go.jp/crm/index_e.html (English)
Web: http://unit.aist.go.jp/crm/ (Japanese)

Research Center for Chemical Risk Management (CRM) is a center in National Institute of Advanced Industrial Science and Technology (AIST). CRM conducts innovative research, works with government and industry to promote environmental safety through science-based and sustainable solutions, and disseminates research findings and recommendations about risk assessment and risk management to the general public and policymakers.

16-1 Onogawa, Tsukuba-shi, Ibaraki 305-8569, Japan
Phone: +81-29-861-8257
Fax: +81-29-861-8934
Email: crm_webmaster@m.aist.go.jp

Risk Analysis Research Center, The Institute of Statistical Mathematics
Web: http://www.ism.ac.jp/risk/ (Japanese only)
The Institute of Statistical Mathematics:
Web: http://www.ism.ac.jp/index_e.html (English)
Web: http://www.ism.ac.jp/index_j.html (Japanese)
4-6-7 Minami-Azabu, Minato-ku, Tokyo 106-8569, Japan
Phone: +81-3-3446-1501

Organizations (Non-Government)

Biosafety Research Center Foods, Drugs and Pesticides (An-pyo Center)
Web: http://www.anpyo.or.jp/ (Japanese only)
582-2 Shio-shinden, Iwata-shi, Shizuoka 437-1213, Japan
Phone: +81-538-58-1266
Fax: +81-538-58-1293

Central Institute for Experimental Animals (CIEA)
Web: http://www.ciea.or.jp/index.htm (Japanese only)
1430 Nogawa, Miyamae-ku, Kawasaki-shi, Kanagawa 216-0001, Japan
Phone: +81-44-754-4455
Fax: +81-44-754-4454

Chemicals Evaluation and Research Institute (CERI)
Web: http://www.cerij.or.jp/ceri_en/index_e4.shtml (English)
Web: http://www.cerij.or.jp/ceri_jp/index_j4.shtml (Japanese)

The Chemicals Evaluation and Research Institute, Japan (CERI) engages in a wide scope of activities related to chemicals, including experiments, testing, analysis, evaluations, and research and development. Its ultimate objective is to further the sound development of industry and enhance people's lifestyles by upgrading the quality of chemicals and assuring their safety while at the same time emphasizing environmental preservation and the protection of health. CERI carries out basic research, the development of testing methods, the development of techniques to assess risk, data collection and analysis, and other functions.

CERI Chemical Safety (Hazard) Evaluation Sheet:
Web: http://www.cerij.or.jp/db/date_sheet_list/list_sideindex_cot.html (Japanese only)

CERI Chemical Safety (Hazard) Evaluation Report:
Web: http://www.cerij.or.jp/db/sheet/yugai_03.htm (Japanese only)

Headquarters
1-4-25 Koraku, Bunkyo-ku, Tokyo 112-0004, Japan
Phone: +81-3-5804-6131
Fax: +81-3-5804-6139

Hatano Research Institute, Food and Drug Safety Center (FDSC)
Web: http://www.fdsc.or.jp/ (Japanese only)
729-5 Ochiai, Hadano-shi, Kanagawa 257-8523, Japan
Phone: +81-463-82-4751
Fax: +81-463-82-9627

The Institute of Environmental Toxicology (IET)
Web: http://www.iet.or.jp/ (Japanese only)
4321 Uchimoriya-machi, Jyoso-shi, Ibaraki, Japan
Phone: +81-297-27-4506
Fax: +81-297-27-1225
Email: info@iet.or.jp

Japan Advanced Information Centre of Safety and Health (JAISH)
Web: http://www.jaish.gr.jp/eng/index.html (English)
Web: http://www.jaish.gr.jp/menu.html OR http://www.jaish.gr.jp/menu2.html (Japanese)

Chemical information:
Web: http://www.jaish.gr.jp/user/anzen/kag/kag_main01.html (Japanese only)

Anzen Eisei Sogo Kaikan, 5-35-2 Shiba, Minato-ku
Tokyo 108-0014, Japan
Phone: +81-3-3452-3385

Japan Chemical Industry Association
Web: http://www.nikkakyo.org/English/index.php3 (English)
Web: http://www.nikkakyo.org/ (Japanese)

The objectives of JCIA are (1) investigation and research on the essentially important matters for the chemical industry such as production, distribution, and consumption of chemical products, (2) investigation and research on the various issues related to the chemical industry such as technology, labor, environment, and their policy planning and promotion, (3) commendation of the outstanding achievements that contributed to the technological development and safety of the chemical industry, (4) collection and supply of information related to the chemical industry and its publication, (5) advocacy, communication, and educational activities for the development of relations between the chemical industry and the public, (6) undertaking a workshop and seminar for the chemical industry, and (7) communication and co-operation with domestic and overseas organizations related to the chemical industry. JCIA is a member of the International Council of Chemical Associations (ICCA).

Chemical Product Database:
Web: http://61.204.48.89/jciadb/index_e.html (English)
Web: http://61.204.48.89/jciadb/ (Japanese)

The database provides information on chemical products produced, imported, and marketed by chemical companies. This includes components, composition, use, hazard, and toxicity of products and contact addresses. A Library of MSDS is also provided.

Sumitomo Fudosan Rokko Bldg. 7F, 1-4-1 Shinkawa, Chuo-ku Tokyo 104-0033, Japan
Phone: +81-3-3297-2550
Fax: +81-3-3297-2610
Email: chemical@jcia-net.or.jp

Japan Chemical Industry Ecology-Toxicology & Information Center (JETOC)
Web: http://www.jetoc.or.jp/english_index.html (English)
Web: http://www.jetoc.or.jp/ (Japanese)

The objectives of Japan Chemical Industry Ecology-Toxicology & Information Center (JETOC) are to collect and organize information related to safety of chemical substances and to enhance joint testing.

Japanese Translation version of OECD SIAP(SIDS Initial Assessment Profile):
Web: http://www.jetoc.or.jp/HP_SIDS/SIDSbase.htm (Japanese only)

Chemical Safety Information:
Web: http://www.jetoc.or.jp/indexanzensei.html (Japanese only)

Sumitomo Fudosan Rokko Bldg., 1-4-1 Shinkawa, Chuo-ku
Tokyo 104-0033, Japan
Phone: +81-3-3297-8051
Fax: +81-3-3297-8055

Japan Crop Protection Association
Web: http://www.jcpa.or.jp/english/index.htm (English)
Web: http://www.jcpa.or.jp/ (Japanese)

Japan Crop Protection Association (JCPA) is the nonprofit organization of Japanese manufacturers, formulators and distributors of agricultural crop protection products (CPPs). JCPA promotes mutual information exchange and cultivates mutual friendship among its members.

Data of Crop Protection Products:
Web: http://www.jcpa.or.jp/nouan/index.html (Japanese only)
1-5-8 Muromachi, Nihonbashi, Chuo-Ku, Tokyo 103-0022, Japan
Phone: +81-3-3241-0215
Fax: +81-3-3241-3149
Email: nouyaku-hp@jcpa.or.jp

Japanese Foundation for Cancer Research
Web: http://www.jfcr.or.jp/english/index.html (English)
Web: http://www.jfcr.or.jp/ (Japanese)

Japanese Foundation for Cancer Research (JFCR) was established in 1908 as the first institute in Japan specializing in cancer. Since the establishment of the Cancer Institute and its affiliated hospital, JFCR has been a leader in the research and treatment of cancer in Japan through its activities by encouraging close collaboration between basic and clinical researchers.

3-10-6 Ariake, Koto-ku, Tokyo 135-8550, Japan
Phone: +81-3-3520-0111
Fax:+81-3-3520-0141

Japan Industrial Safety and Health Association (JISHA)
Web: http://www.jisha.or.jp/english/index.html (English)
Web: http://www.jisha.or.jp/ (Japanese)

Japan Industrial Safety and Health Association (JISHA) supports the activities of business owners and business groups to prevent industrial accidents. JISHA's activities are public relations and publication, collection and release of information, research and surveys, technical support, safety and health education, promotion of zero-accident everyone participation campaigns, support to small and medium-sized enterprises, support to health programs, promotion of creating comfortable workplaces, international cooperation, and toxicity research on chemical substances.

Headquarters
Shiba 5-35-1, Minato-ku, Tokyo 108-0014, Japan
Phone: +81-3-3452-6841
Fax: +81-3-3453-8034

Japan International Center for Occupational Safety and Health (JICOSH)
Web: http://www.jicosh.gr.jp/english/ (English)
Web: http://www.jicosh.gr.jp/Japanese/index.html (Japanese)

Japanese firms are often placed in a difficult position in proceeding with effective and efficient safety and health management or taking appropriate countermeasures. In addition, although ensuring safety and maintaining and improving the health of workers are essential requirements that are commonly recognized throughout the world, there still are such problems as information or technologies relating to safety and health that are owned by specific countries are not commonly shared by all parties concerned. JICOSH works to help resolve these issues.

1-4-6 Umezono, Kiyose-shi, Tokyo 204-0024, Japan
Phone: +81-42-495-5931
Fax: +81-42-495-5936
Email: info@jicosh.gr.jp

The Japan Food Chemical Research Foundation
Web: http://www.ffcr.or.jp/zaidan/FFCRHOME.nsf/pages/eng.h-page (English)
Web: http://www.ffcr.or.jp/ (Japanese)

The Foundation collects and compiles domestic and overseas information about food additives, pesticide residues, apparatus and containers/packages for food and other topics related to the field of food chemistry on this website. The Foundation supports research activities aimed at developing safety evaluation methodologies for food additives, and at reducing the use of food additives.

Information on Food Safety Commission, Evaluation to Health Effects:

Web: http://www.ffcr.or.jp/zaidan/FFCRHOME.nsf/pages/info,cao (Japanese only)
1-11-1 Sanwa-cho, Toyonaka-shi, Osaka 561-0828, Japan
Phone: +81-6-6333-5680
Fax: +81-6-6333-5491
Email: admin@ffcr.or.jp

Universities

Few universities include 'toxicology' in name of their departments or laboratories. However, many universities with departments, schools, or faculties of medicine or pharmaceutical sciences have toxicology-related departments.

Aichi Medical University
Web: http://www.aichi-med-u.ac.jp/ (English)
Web: http://www.aichi-med-u.ac.jp/ (Japanese)
Nagakute, Aichi 480-1195, Japan
Phone: +81-561-62-3311

Asahikawa Medical College
Department of Pharmacology
Web: http://www.asahikawa-med.ac.jp/new04/en/index.html (English)
Web: http://www.asahikawa-med.ac.jp/ (Japanese)

1-1-1 Midrogaoka-Higashi-2-jyo, Asahikawa-shi, Hokkaido 078-8510, Japan
Phone: +81-166-68-2115
Email: sho-shomu@jimu.asahikawa-med.ac.jp

Azabu University
School of Veterinary Medicine, Department of Veterinary Medicine, Department of Animal Science and Biotechnology
Web: http://www.azabu-u.ac.jp/index-e.html (English)
Web: http://www.azabu-u.ac.jp/ (Japanese)
1-17-71 Fuchinobe, Sagamihara, Kanagawa 229-8501, Japan
Phone: +81-42-754-7111
Fax: +81-42-754-7661
Email: www-box@azabu-u.ac.jp

Chiba University
Graduate School of Pharmaceutical Sciences and Faculty of Pharmaceutical Sciences, Toxicology and Environmental Health
Web: http://www.p.chiba-u.ac.jp/e-index.html (English)
Web: http://www.chiba-u.ac.jp/e/index.html (English)
Web: http://www.p.chiba-u.ac.jp/ (Japanese)

Nishi-Chiba Campus
1-33 Yayoi-cho, Inage-ku, Chiba-shi, Chiba 263-8522, Japan
Phone: +81-43-251-1111
Fax: +81-43-290-2041
Email: www.admin@p.chiba-u.ac.jp

Fujita Health University
Web: http://www.fujita-hu.ac.jp/english/ (English)
Web: http://www.fujita-hu.ac.jp/ (Japanese)
1-98 Dengakugakubo, Kutsukake-cho, Toyoake, Aichi 470-1192, Japan
Phone: +81-562-93-2000

Fukuoka University
School of Medicine, Pharmaceutical Sciences
Web: http://www.fukuoka-u.ac.jp/english/indexe.htm (English)
Web: http://www.fukuoka-u.ac.jp/ (Japanese)
8-19-1 Nanakuma, Jonan-ku, Fukuoka 814-0180, Japan
Phone: +81-92-871-6631
Email: fupr@adm.fukuoka-u.ac.jp

Gifu University
School of Medicine
Web: http://www.gifu-u.ac.jp/english/index.shtml (English)
Web: http://www.gifu-u.ac.jp/ (Japanese)
1-1 Yanagido, Gifu-shi, Gifu 501-1194, Japan
Phone: +81-58-230-6000
Email: igakubu@gifu-u.ac.jp

Gunma University
Graduate School of Medicine, Faculty of Medicine
Web: http://www.med.gunma-u.ac.jp/index-en.shtml (English)
Web: http://www.med.gunma-u.ac.jp/index.shtml (Japanese)
3-39-22 Showa-machi, Maebashi-shi, Gunma 371-8511, Japan
Phone: +81-27-220-7111

Health Sciences University of Hokkaido
Faculty of Pharmaceutical Sciences, Graduate School of Pharmaceutical Sciences
Web: http://www.hoku-iryo-u.ac.jp/eng/ (English)
Web: http://www.hoku-iryo-u.ac.jp/ (Japanese)
1757 Kanazawa, Tobetsu-cho, Ishikari-gun, Hokkaido 061-0293, Japan
Phone: +81-133-23-1211
Fax: +81-133-23-1669
Email: nice@hoku-iryo-u.ac.jp

Hiroshima University
Faculty of Medicine, Faculty of Pharmacy, Faculty of Density
Web: http://www.hiroshima-u.ac.jp/index.html (English)
Web: http://www.hiroshima-u.ac.jp/index-j.html (Japanese)
1-2-3 Kasumi, Minami-ku, Hiroshima-shi, Hiroshima 734-8551, Japan
Phone: +81-82-257-5555
Email: www-admin@hiroshima-u.ac.jp

Hokkaido University
Graduate School of Veterinary Medicine
Web: http://www.hokudai.ac.jp/veteri/index.html (English & Japanese)

Laboratory of Toxicology
Web: http://www.hokudai.ac.jp/veteri/organization/env/toxicol/home-e.html (English)
Web: http://www.hokudai.ac.jp/veteri/organization/env/toxicol/Toxicology.htm (Japanese)
Kita 18, Nishi 9, Kita-ku, Sapporo 060-0818, Japan
Phone: +81-11-716-2111
Fax: +81-11-706-5190
Email: vsop@vetmed.hokudai.ac.jp

Hokuriku University
Faculty of Pharmaceutical Sciences
Web: http://www.hokuriku-u.ac.jp/english/index.html (English)
Web: http://www.hokuriku-u.ac.jp/ (Japanese)
1-1 Taiyogaoka, Kanazawa 920-1180, Japan

Phone: +81-76-229-1161
Fax: +81-76-229-1393

Hoshi University
Faculty of Pharmaceutical Sciences
Web: http://www.hoshi.ac.jp/english/ (English)
Web: http://www.hoshi.ac.jp/home/index.html (Japanese)
2-4-41 Ebara, Shinagawa-ku, Tokyo 142-8501, Japan
Phone: +81-3-5498-5821
Fax: +81-3-3787-0036
Email: www@hoshi.ac.jp

Iwate University
Faculty of Agriculture and Graduate School of Agriculture
Web: http://news7a1.atm.iwate-u.ac.jp/index-e.html (English)
Web: http://news7a1.atm.iwate-u.ac.jp/ (Japanese)
3-18-8 Ueda, Morioka, Iwate 020-8550, Japan
Phone: +81-19-621-6103
Fax: +81-19-621-6107

Juntendo University
School of Medicine
Web: http://www.juntendo.ac.jp/english/index.html (English)
Web: http://www.juntendo.ac.jp/med/index.html (Japanese)

Head office
2-1-1 Hongo, Bunkyo-ku, Tokyo 113-8421, Japan
Phone: +81-3-3813-3111
Fax: +81-3-3814-9100

Kanazawa University
Faculty of Medicine, Faculty of Pharmaceutical Sciences
Web: http://www.kanazawa-u.ac.jp/e/ (English)
Web: http://www.kanazawa-u.ac.jp/j/index.html (Japanese)
Kakuma-machi, Kanazawa, Ishikawa, 920-1192 Japan
Phone: +81-76-264-5111
Fax: +81-76-234-4010
Email: now@kanazawa-u.ac.jp

Keio University
Web: http://www.keio.ac.jp/index-en.html (English)
Web: http://www.keio.ac.jp/index-jp.html (Japanese)

School of Medicine:
Web: http://www.med.keio.ac.jp/ (Japanese only)

Mita Campus
2-15-45 Mita, Minato-ku, Tokyo 108-8345, Japan
Phone: +81-3-3453-4511
Email: www@info.keio.ac.jp

Kinki University
School of Medicine, School of Pharmaceutical Sciences
Web: http://ccpc01.cc.kindai.ac.jp/english/index.htm (English)
Web: http://www.kindai.ac.jp/ (Japanese)
3-4-1 Kowakae, Higashi-Osaka-shi, Osaka 577-8502, Japan
Phone: +81-6-6721-2332
Email: koho@msa.kindai.ac.jp

Kitasato University
Web: http://www.kitasato-u.ac.jp/index_e.html (English, under construction)
Web: http://www.kitasato-u.ac.jp/ (Japanese)

School of Pharmaceutical Sciences
Web: http://www.pharm.kitasato-u.ac.jp/index-e.html (English)
Web: http://www.pharm.kitasato-u.ac.jp/ (Japanese)
5-9-1 Shirogane, Minato-ku, Tokyo 108-8641, Japan
Phone: +81-3-5791-6197
Email: honbu@kitasato-u.ac.jp; webmaster@pharm.kitasato-u.ac.jp

Kobe Gakuin University
Faculty of Pharmaceutical Sciences
Web: http://www.kobegakuin.ac.jp/english/index.htmlhttp://www.kobegakuin.ac.jp/english/gakubu/pharmaceutical.html (English)
Web: http://www.kobegakuin.ac.jp/http://www.kobegakuin.ac.jp/pharmaceutical/index.html (Japanese)
518 Arise, Ikawadani-cho, Nishi-ku, Kobe 651-2180, Japan
Phone: +81-78-974-1551
Fax: +81-78-974-5689
Email: iwmaster@j.kobegakuin.ac.jp

Kumamoto University
School of Medicine, School of Pharmacy
Web: http://www.kumamoto-u.ac.jp/univ-e.html (English)
Web: http://www.kumamoto-u.ac.jp/ (Japanese)
2-39-1 Kurokami, Kumamoto 860-8555, Japan
Phone: +81-96-344-2111
Email: message@jimu.kumamoto-u.ac.jp

Kyorin University
School of Medicine
Web: http://www.kyorin-u.ac.jp/English/ (English)
Web: http://www.kyorin-u.ac.jp/ (Japanese)
6-20-2 Shinkawa, Mitaka-shi, Tokyo 181-8611, Japan
Phone: +81-422-47-5511
Email: koho@kyorin-u.ac.jp

Kyoto University
Graduate School of Medicine and Faculty of Medicine, Graduate School of Pharmaceutical Sciences
Web: http://www.kyoto-u.ac.jp/index-e.html http://www.kyoto-u.ac.jp/index-e.html (English)
Web: http://www.med.kyoto-u.ac.jp/E/ (English)
Web: http://www.pharm.kyoto-u.ac.jp/eng/index.html (English)
Web: http://www.kyoto-u.ac.jp/top.htm (Japanese)
Web: http://www.med.kyoto-u.ac.jp/J/index.html (Japanese)
Web: http://www.pharm.kyoto-u.ac.jp/index.html (Japanese)
Yoshida-Honmachi, Sakyo-ku, Kyoto 606-8501, Japan
Phone: +81-75-753-7531

Kyushu University
Faculty of Medicine, Faculty of Pharmaceutical Sciences
Web: http://www.kyushu-u.ac.jp/english/index.php (English)
Web: http://www.kyushu-u.ac.jp/top.php (Japanese)

Hakozaki Campus 1
6-10-1 Hakozaki, Higashi-ku, Fukuoka 812-8581, Japan
Phone: +81-92-642-2111
Fax: +81-92-642-2113

Meijo University
Web: http://www.meijo-u.ac.jp/english/index.html (English)
Web: http://www.meijo-u.ac.jp/index1.html (Japanese)

Faculty of Pharmacy:
Web: http://www-yaku.meijo-u.ac.jp/ (Japanese only)
1-501 Shiogamaguchi, Tempaku-ku, Nagoya 468-8502, Japan
Phone: +81-52-832-1151
Fax:+81-52-832-2317
Email: kouhou@ccmails.meijo-u.ac.jp

Nagasaki University
Web: http://www.nagasaki-u.ac.jp/index_en.html (English)
Web: http://www.nagasaki-u.ac.jp/ (Japanese)

School of Pharmaceutical Sciences:
Web: http://www.ph.nagasaki-u.ac.jp/indexe.html (English)
Web: http://www.ph.nagasaki-u.ac.jp/indexj.html (Japanese)

Bunkyo Campus
1-14 Bunkyo-machi, Nagasaki-shi, Nagasaki 852-8521, Japan
Phone: +81-95-819-2043
Fax: +81-95-819-2040
Email: www_admin@ml.nagasaki-u.ac.jp

Nagoya City University
Graduate School of Pharmaceutical Sciences/ Faculty of Pharmaceutical Sciences, Medical School/ Graduate School of Medical sciences
Web: http://www.nagoya-cu.ac.jp/english/index.html (English)
Web: http://www.nagoya-cu.ac.jp/ (Japanese)

Laboratory of Molecular Toxicology:
Web: http://www.med.nagoya-cu.ac.jp/moltox.dir/ (Japanese only)

Kawasumi Campus
1 Kawasumi, Mizuho-machi, Mizuho-ku, Nagoya-shi, Nogoya 467-8601, Japan
Phone: +81-52-853-8005
Fax: +81-52-841-6201
Email: www-admin@cc.nagoya-cu.ac.jp

Nagoya University
Web: http://www.nagoya-u.ac.jp/en/ (English)
Web: http://www.nagoya-u.ac.jp/ (Japanese)
Faculty of Medicine, Graduate School of Bioagricultural Sciences and School of Agricultural Sciences
Web: http://www.med.nagoya-u.ac.jp/html/En/index.htm (English)
Web: http://www.med.nagoya-u.ac.jp/ (Japanese)
Web: http://www.agr.nagoya-u.ac.jp/index-e.html (English)
Web: http://www.agr.nagoya-u.ac.jp/index-j.html (Japanese)
Furo-machi, Chidane-ku, Nagoya-shi, Nagoya 464-8601, Japan
Phone: +81-52-789-5111
Phone: +81-52-789-2044
Fax: +81-52-789-2045
Email: intl@post.jimu.nagoya-u.ac.jp

Nihon University
Faculty of Pharmaceutical Sciences
Web: http://www.nihon-u.ac.jp/english/purpose.html (English)
Web: http://www.nihon-u.ac.jp/ (Japanese)
4-8-24 Kudan-minami, Chiyoda-ku, Tokyo 102-8275, Japan
Phone: +81-3-5275-8110
Email: www-adm@nihon-u.ac.jp

Niigata University of Pharmacy and Applied Life Sciences
Web: http://www.niigatayakudai.jp/ (Japanese only)
265-1 Higashi-jima, Niigata-shi, Niigata 956-8603, Japan
Phone: +81-250-25-5000
Fax: +81-250-25-5021
Email: hainoe@niigata-pharm.ac.jp

Nippon Veterinary and Life Science University
Department of Veterinary
Web: http://www.nvlu.ac.jp/e/index.html (English)
Web: http://www.nvlu.ac.jp/ (Japanese)
1-7-1 Kyonan-cho, Musashino-shi, Tokyo 180-8602, Japan
Phone: +81-422-31-4151
Email: shomu@nvlu.ac.jp

Osaka City University
Medical School
Web: http://www.osaka-cu.ac.jp/index-e.html (English)
Web: http://www.osaka-cu.ac.jp/ (Japanese)

Sugimoto Campus
3-3-138 Sugimoto, Sumiyoshi-ku, Osaka-shi, Osaka 558-8585, Japan
Phone: +81-6-6605-2011

Osaka Prefecture University
School of Life and Environmental Sciences
Web: http://www.osakafu-u.ac.jp/english/index.html (English)
Web: http://www.osakafu-u.ac.jp/index_fla.html (Japanese)
1-1 Gakuen-cho, Naka-ku, Sakai, Osaka 599-8531, Japan
Phone: +81-72-252-1161

Osaka University
Faculty of Medicine, Faculty of Dentistry, School of Pharmaceutical Sciences
Web: http://www.osaka-u.ac.jp/eng/index.html (English)
Web: http://www.osaka-u.ac.jp/ (Japanese)

Department of Toxicology, Graduate School of Pharmaceutical Sciences:
Web: http://www.phs.osaka-u.ac.jp/homepage/b009/bunya2.html (Japanese only)

Suita Campus 1-1
Yamadagaoka, Suita-shi, Osaka 565-0871, Japan
Academic Affairs
Phone: +81-6-6879-7037
Fax: +81-6-6879-7106
Email: kokusai@hpc.cmc.osaka-u.ac.jp

Showa University
School of Medicine, School of Pharmaceutical Sciences
Web: http://www.showa-u.ac.jp/english/ (English)
Web: http://www.showa-u.ac.jp/ (Japanese)
Laboratory of Poisoning, Faculty of Pharmaceutical Sciences
Web: http://www10.showa-u.ac.jp/~toxicol/ (Japanese only)
1-5-8 Hatanodai, Shinagawa-ku, Tokyo 142-8555, Japan
Phone: +81-3-3784-8059

Sinshu University
School of Medicine
Web: http://www.shinshu-u.ac.jp/english/index.html (English)
Web: http://www.shinshu-u.ac.jp/ (Japanese)
3-1-1 Asahi, Matsumoto-shi, Nagano 390-8621, Japan
Phone: +81-263-37-3056
Fax: +81-263-36-6769
Email: shinhp@jm.shinshu-u.ac.jp

Teikyo University
Faculty of Medicine, Faculty of Pharmaceutical Sciences
Web: http://www.teikyo-u.ac.jp/en/ (English)
Web: http://www.teikyo-u.ac.jp/ (Japanese)

Laboratory of Toxicology:
Web: http://www.pharm.teikyo-u.ac.jp/lab/dokusei/index_e.html (English)
Web: http://www.pharm.teikyo-u.ac.jp/lab/dokusei/index.html (Japanese)

2-11-1 Kaga, Itabashi-ku, Tokyo 173-8605, Japan
Phone: +81-3-3964-1211

The Toho University
Faculty of Pharmaceutical Sciences
Web: http://www.toho-u.ac.jp/english/index.html (English)
Web: http://www.toho-u.ac.jp/ (Japanese)
5-21-16 Ohmorinishi, Ohta-ku, Tokyo 143-8540, Japan
Phone: +81-3-3762-4151

The University of Tokushima
Faculty of Medicine, Faculty of Pharmaceutical Sciences
Web: http://www.tokushima-u.ac.jp/English/englishtop.html (English)
Web: http://www.tokushima-u.ac.jp/ (Japanese)
2-24 Niikura-maci, Tokushima-shi, Tokushima 770-8501, Japan
Phone: +81-88-656-7021
Fax: +81-88-656-7012
Email: hibunsyok@jim.tokushima-u.ac.jp

The University of Tokyo
Faculty of Pharmaceutical Sciences, School of Medicine, Faculty of Agriculture
Web: http://www.u-tokyo.ac.jp/index_e.html (English)
Web: http://www.u-tokyo.ac.jp/index_j.html (Japanese)
General Affairs Dept, Public Relations Div.
Phone: +81-3-3811-3393

Tohoku Pharmaceutical University
Web: http://www.tohoku-pharm.ac.jp/index2.html (Japanese only)

4-4-1 Komatsujima, Aoba-ku, Sendai-shi, Miyagi 981-8558, Japan
Phone: +81-22-234-4181
Fax: +81-22-275-2013
Email: webmaster@tohoku-pharm.ac.jp

Tohoku University
Faculty of Pharmaceutical Sciences, School of Medicine, Faculty of Agriculture
Web: http://www.tohoku.ac.jp/english/index.html (English)
Web: http://www.tohoku.ac.jp/japanese/ (Japanese)

Graduate School/Faculty of Pharmaceutical Sciences
Web: http://www.pharm.tohoku.ac.jp/index-e.html (English)
Web: http://www.pharm.tohoku.ac.jp/index.html (Japanese)
6-3 Aoba, Aramaki, Aoba-ku, Sendai-shi 980-8578

Amamiya Campus
Tsutsumidori-Amamiyamachi, Aoba-ku, Sendai 981-8555, Japan
Phone: +81-22-717-8603
Aobayama Campus
Aoba, Aramaki, Aoba-ku, Sendai 980-8578, Japan
Phone: +81-22-717-7800

Tokyo Medical and Dental University
Faculty of Dentistry
Web: http://www.tmd.ac.jp/TMDU-e/ (English)
Web: http://www.tmd.ac.jp/ (Japanese)
1-5-45 Yushima, Bunkyo-ku, Tokyo 113-8510, Japan
Phone: +81-3-3813-6111
Email: kouhou.adm@tmd.ac.jp

Tokyo University of Agriculture and Technology
Faculty of Agriculture
Web: http://www.tuat.ac.jp/english/index.html (English)
Web: http://www.tuat.ac.jp/ (Japanese)
3-8-1 Harumi-cho, Fuchu-shi, Tokyo 183-8538, Japan
Phone: +81-42-364-3311

Tokyo University of Pharmacy and Life Sciences
School of Pharmacy, School of Life Science
Web: http://www.toyaku.ac.jp/campus/index_E.html (English)
Web: http://www.toyaku.ac.jp/ (Japanese)
1432-1 Horinouchi, Hachioji-shi, Tokyo 192-0392, Japan
Phone: +81-42-676-5111
Fax: +81-42-676-8800
Email: syomu@toyaku.ac.jp

Tokyo University of Science
Faculty of Pharmaceutical Sciences
Web: http://www.sut.ac.jp/en/ (English)
Web: http://www.sut.ac.jp/ (Japanese)
1–3 Kagurazaka, Shinjyuku-ku, Tokyo 162-8601, Japan
Academic Affairs Division International Exchange
Phone: +81-3-5228-8726
Email: intlexchg@admin.tus.ac.jp

Toyama Medical and Pharmaceutical University
Faculty of Pharmaceutical Sciences
Web: http://www.toyama-mpu.ac.jp/en/index.html (English)
Web: http://www.toyama-mpu.ac.jp/jp/index.html (Japanese)

Department of Toxicology
Web: http://www.toyama-mpu.ac.jp/ph/cliche2/top-j.html (Japanese only)
2630 Sugitani, Toyama 930-0194, Japan
Phone: +81-76-434-2281

University of Occupational and Environmental Health
School of Medicine, School of Health Sciences
Web: http://www.uoeh-u.ac.jp/index_e.html (English)
Web: http://www.uoeh-u.ac.jp/index.html (Japanese)
1-1 Iseigaoka, Yahata-nishi-ku, Kitakyushu, Fukuoka 807-8555, Japan
Phone: +81-93-603-1611

University of Shizuoka
School of Pharmaceutical Sciences, School of Food & Nutritional Sciences
Web: http://www.u-shizuoka-ken.ac.jp/~kijo4/english-annai-page-03/newpage2.htm (English)
Web: http://www.u-shizuoka-ken.ac.jp/ (Japanese)
52-1 Yata, Suruga-ku, Shizuoka-shi, Shizuoka 422-8526, Japan
Phone: +81-54-264-5102
Fax: +81-54-264-5099
Email: center@u-shizuoka-ken.ac.jp

University of the Ryukyu
Faculty of Medicine
Web: http://www.u-ryukyu.ac.jp/en/index.html (English)
Web: http://www.u-ryukyu.ac.jp/ (Japanese)
1 Senbaru, Nishihara, Okinawa 903-0213, Japan
Phone: +81-98-895-8012
Email: sosoumu@to.jim.u-ryukyu.ac.jp

Wakayama Medical University
School of Medicine
Web: http://www.wakayama-med.ac.jp/english/english/index.html (English)
Web: http://www.wakayama-med.ac.jp/ (Japanese)
811-1 Kimiidera, Wakayama-shi, Wakayama 641-8509, Japan

Phone: +81-73-447-2300
Email: www-admin@wakayama-med.ac.jp

Yokohama City University
School of Medicine
Web: http://www.yokohama-cu.ac.jp/index-e.html (English)
Web: http://www.yokohama-cu.ac.jp/ (Japanese)
22-2 Seto, Kanazawa-ku, Yokohama-shi, Kanagawa 236-0027, Japan
Phone: +81-45-787-2311

Yokohama National University
Web: http://www.ynu.ac.jp/index_en.html (English)
Web: http://www.ynu.ac.jp/index_top.html (Japanese)

Faculty of Engineering
Web: http:// //www.bsk.ynu.ac.jp/~envlab/ (Japanese only)
79-1 Tokiwadai, Hodogaya-ku, Yokohama 240-8501, Japan
Phone: +81-45-339-3036
Fax: 81-45-339-3039
Email: international@nuc.ynu.ac.jp

Professional Societies and their Official Journals

Japanese Society for Clinical Toxicology
Web: http://web.jiho.co.jp/toxicol/index.html (Japanese only)

Journal: The Japanese Journal of Toxicology (Japanese)
Web: http://www.jiho.co.jp/mag/tyudoku/back-number.html (Japanese Title only)
Jijo-nai, Hitotsubashi Buildg. 5F, 2-6-3 Hitotsubashi, Chiyoda-ku, Tokyo 101-0003, Japan
Phone: +81-3-3265-7660 (Jiho Co. Ltd., http://www.jiho.co.jp/mag/tyudoku)
Fax: +81-3-3265-0146
E-mail: Jpn.Toxicol@jiho.co.jp

Japanese Society of Alternatives to Animal Experiments
Web: http://wwwsoc.nii.ac.jp/jsaae/index-e.html (English)
Web: http://wwwsoc.nii.ac.jp/jsaae/ (Japanese)

Journal: Alternatives to Animal Testing and Experimentation (AATEX, English)
Asai Building No.501, 7-2-4, Hongo, Bunkyo-Ku, Tokyo 113-0033, Japan
Phone: +81-3-3811-3666
Fax: +81-3-3811-0676
Email: gakkai@g-jimukyoku.jp

Japanese Society of Food Chemistry
Web: http://www.jpsfc.com/index.htm (Japanese only)

Journal: Japanese Journal of Food Chemistry
Web: http://www.ffcr.or.jp/zaidan/Ronbun.nsf/E_index?openview (English Abstract)
Web: http://www.jpsfc.com/kaisi-jsfc/index.htm (Japanese)

Office of the Japanese Society of Food Chemistry
School of Pharmaceutical Sciences
Mukogawa Women's University
11-68 Kyubantyou, Koshien, Nishinomiya-shi, Hyogo 663-8179, Japan
Fax: +81-798-41-7525
Email: jsfc@minos.ocn.ne.jp

Japan Society for Biosciences, Biotechnology, and Agrochemistry
Web: http://www.jsbba.or.jp/e/index_e.html (English)
Web: http://www.jsbba.or.jp/(Japanese)

Journal: Bioscience, Biotechnology, and Biochemistry (English)
Web: http://www.jstage.jst.go.jp/browse/bbb (English site)
Web: http://www.jstage.jst.go.jp/browse/bbb/-char/ja (Japanese site)

Gakkai Center Building 2-4-16 Yayoi, Bunkyo-ku, Tokyo 113-0032, Japan
Phone: +81-3-3811-8789
Fax: +81-3-3815-1920
Email: jimudaihyo@jsbba.or.jp

Japan Society for Occupational Health
Web: http://www.sanei.or.jp/ (Japanese only)

Journal: Journal of Occupational Health
Web: http://joh.med.uoeh-u.ac.jp/e/index.html (English)
Koei Building, 1-29-8 Shinjuku, Shinjuku-ku, Tokyo 160-0022, Japan
Phone: +81-3-356-1536
Fax: +81-3-5362-3746

The Japanese Environmental Mutagen Society
Web: http://www.j-ems.org/en1/home.html (English)
Web: http://www.j-ems.org/index.html (Japanese)
Journal: Genes and Environment (English)
Web: http://www.j-ems.org/journal/index-e.html (English)
Web: http://www.jstage.jst.go.jp/browse/jemsge (English, direct link to J-STAGE)
Web: http://www.jstage.jst.go.jp/browse/jemsge/-char/ja (Japanese)

Oral Health Association of Japan
Komagome TS Building, 1-43-9 Komagome, Toshima-ku, Tokyo 170-0003, Japan
Phone: +81-3-3947-8891
Fax: +81-3-3947-8341
Email: gakkai1@kokuhoken.or.jp

The Japanese Society for Hygiene
Web: http://www.nacos.com/jsh/main/ (Japanese only)

Journal: Environmental Health and Preventive Medicine (English)
Web: http://www.jstage.jst.go.jp/browse/ehpm/-char/en (English)
Web: http://www.jstage.jst.go.jp/browse/ehpm/-char/ja/ (Japanese)
Osaka University
2-2 Yamadaoka, Suita-shi, Osaka 565-0871, Japan
Phone: +81-6-6879-3922
Fax: +81-6-6879-3928
Email: eisei@envi.med.osaka-u.ac.jp

The Japanese Society for the Study of Xenobiotics
Web: http://www.jssx.org/eg/index-eg.html (English)
Web: http://www.jssx.org/ (Japanese)

Journal: Drug Metabolism and Pharmacokinetics (English)
Web: http://www.jstage.jst.go.jp/browse/dmpk/20/6/_contents (English)
International Medical Information Center Shinanomachi Rengakan, 35 Shinano-machi, Shinjyuku-ku, Tokyo 160-0016, Japan
Phone: +81-3-5361-7075
Fax: +81-3-5361-7091
Email: secretariat@jssx.org

The Japanese Society of Toxicology
Web: http://www.jsot.gr.jp/english/index.html (English)
Web: http://www.jsot.gr.jp/ (Japanese)

Journal: The Journal of Toxicological Sciences (English)
Web: http://www.jtoxsci.org/index.html (English)

International Medical Center,
Shinanomachi Rengakan, 35 Shinano-machi Shinjuku-ku, Tokyo, 160-0016 Japan
Phone: +81-3-5361-7075
Fax: +81-3-5361-7091
Email: jst@imic.or.jp

The Japan Pharmacological Society
Web: http://plaza.umin.ac.jp/JPS1927/english/index.html (English)
Web: http://plaza.umin.ac.jp/JPS1927/ (Japanese)

Journals:
Folia Pharmacologica Japonica (Japanese)
Web: http://plaza.umin.ac.jp/JPS1927/fpj_e/index.html (English site)
Web: http://plaza.umin.ac.jp/JPS1927/fpj/index.html (Japanese site)

Journal of Pharmacological Sciences (formerly the Japanese Journal of Pharmacology)
Web: http://plaza.umin.ac.jp/JPS1927/jps/index.html (English)
Gakkai Center Bld., 4-16, Yayoi 2-chome, Bunkyo-ku, Tokyo 113-0032, Japan
Phone: +81-3-3814-4828
Fax: +81-3-3814-4809
Email: pharmacology@hi-ho.ne.jp OR society@pharmacol.or.jp

The Japan Radiation Research Society
Web: http://wwwsoc.nii.ac.jp/jrr/index-e.html (English)
Web: http://wwwsoc.nii.ac.jp/jrr/index-j.html (Japanese)

Journal: Journal of Radiation Research (English)
Web: http://www.jstage.jst.go.jp/browse/jrr (English)
52-1 Sakurai, Sakurai-shi, Nara 633-0091, Japan
Phone: +81-744-43-2927
Fax: +81-744-43-2927
Email: jrr@wwwsoc.nii.ac.jp

The Pharmaceutical Society of Japan
Web: http://www.pharm.or.jp/index_e.html (English)
Web: http://www.pharm.or.jp/ (Japanese)
Journals:
Biological & Pharmaceutical Bulletin (English)
Web: http://bpb.pharm.or.jp/ (English)

Journal of Health Science (English)
Web: http://jhs.pharm.or.jp/home.htm (English)
Yakugaku Zasshi (Journal of the Pharmaceutical Society of Japan, English & Japanese)
Web: http://yakushi.pharm.or.jp/ (English & Japanese)
2-12-15 Shibuy, Shibuya-ku, Tokyo 150-0002, Japan
Fax: +81-3-3498-1835
Email: doi@pharm.or.jp

The Society for Risk Analysis: Japan-Section
Web: http://dss.sys.eng.shizuoka.ac.jp/srajapan/english/index.html (English)
Web: http://dss.sys.eng.shizuoka.ac.jp/srajapan/ (Japanese)

Journal: News Letter (Japanese)
Web: http://dss.sys.eng.shizuoka.ac.jp/srajapan/news/newsletter.html (Japanese only)

The Society for Risk Analysis Japan-Section Secretariat
c/o Prof. Shoji TSUCHIDA
Faculty of Sociology, Kansai University
3-3-35 Yamatecho, Suita, Osaka 564-8680, Japan
Phone: +81-6-6368-1121
Fax: +81-6-6368-0735
Email: srajapan@soc.kansai-u.ac.jp

Poison Control Centers

Japan Poison Information Center (JPIC)
Web: http://www.j-poison-ic.or.jp/homepage-e.nsf (English)
Web: http://www.j-poison-ic.or.jp/homepage.nsf (Japanese)

The current activities of the Japan Poison Information Center (JPIC) are (1) Information Service (Limited to acute toxic exposure; Emergency telephone services and Exclusive lines for supporting members), (2) Information Collection and Preparation, (3) Use of computers in JPIC (Poison information database and Records of all inquiries), (4) Educational Activities (Post-graduate education for pharmacists and Education for other emergency service personnel).

A Poison Information Database for the general public is also provided on household goods and natural toxins in Japanese only.
c/o Tsukuba Medical Center
1-3-1 Amakubo, Tsukuba-shi, Ibaraki 305-0005, Japan
Phone: +81-298-56-3566
Fax: +81-298-56-3533
Email: head-jpic@j-poison-ic.or.jp

Legislation

Agricultural Chemicals Regulation Law
Web: http://www.maff.go.jp/nouyaku/ (Japanese only)

Law Concerning the Evaluation of Chemical Substances and Regulation of Their Manufacture, etc.
Web: http://www.safe.nite.go.jp/kasin.html (Japanese only)

Law for the Control of Household Products containing Harmful Substances
Web: http://www.nihs.go.jp/law/katei/ekatei.html (English)
Web: http://www.nihs.go.jp/law/katei/katei.html (Japanese)

Poisonous and Deleterious Substances Control Law
Web: http://www.nihs.go.jp/law/dokugeki/edokugeki.html (English)
Web: http://www.nihs.go.jp/law/dokugeki/dokugeki.html (Japanese)

Pollutant Release and Transfer Register (PRTR)
Web: http://www.prtr.nite.go.jp/index-e.html (English)
Web: http://www.prtr.nite.go.jp/ (Japanese)

Miscellaneous Resources

Kanagawa Environmental Research Center
Web: http://www.k-erc.pref.kanagawa.jp/en_hp/en_index/en_index.htm (English)
Web: http://www.k-erc.pref.kanagawa.jp/contents.htm (Japanese)
1-3-39 Shinomiya, Hiratsuka-shi, Kanagawa 254-0014, Japan
Phone: +81-463-24-3311
Fax: +81-463-24-3300
Email: k-center@k-erc.pref.kanagawa.jp

Japan Science and Technology Information Aggregator, Electronic (J-STAGE)
Web: http://www.jstage.jst.go.jp/browse/ (English)
Web: http://www.jstage.jst.go.jp/browse/_journallist (English)
Web: http://www.jstage.jst.go.jp/browse/-char/ja (Japanese)

In order to maintain and develop Japan's science and technology research at an international level, it is important to disseminate outstanding research and development results to the world instantaneously. To that end, it is important to digitize bulletins of academic societies and research papers that currently appear on paper and to disseminate them on the Internet.

Japan Science and Technology Information Agency
Web: http://www.jst.go.jp/EN/location/index.html (English)
Web: http://www.jst.go.jp/ (Japanese)
Headquarters
Kawaguchi Center Building
4-1-8 Honcho, Kawaguchi-shi, Saitama 332-0012, Japan
Phone: +81-48-226-5601
Fax: +81-48-226-5651
Email: contact@jstage.jst.go.jp

National Institute of Informatics (NII)
Web: http://www.nii.ac.jp/index.shtml.en (English)
Web: http://www.nii.ac.jp/ (Japanese)

As Japan's only general academic research institution seeking to create future value in the new discipline of informatics, the National Institute of Informatics (NII)

seeks to advance integrated research and development activities in information-related fields, including networking, software, and content.

Academic Society HomeVillage:
Web: http://wwwsoc.nii.ac.jp/index-e.html (English)
Web: http://wwwsoc.nii.ac.jp/ (Japanese)

Academic Society HomeVillage is a service to provide homepage data area for Japanese academic societies.
2-1-2 Hitotsubashi, Chiyoda-ku, Tokyo 101-8430, Japan
Contact Section: International Planning Section (International Affairs Division)
Fax: +81-3-4212-2180
Email: int-op@nii.ac.jp

Tokyo Metropolitan Institute of Public Health
Web: http://www.tokyo-eiken.go.jp/index.html (English)
Web: http://www.tokyo-eiken.go.jp/ (Japanese)
3-24-1 Hyakuninn-cho, Shinjyulu-ku, Tokyo 169-0073, Japan
Phone: +81-3-3363-3231
Fax: +81-3-3368-4060
Email: www@tokyo-eiken.go.jp

International MEDLARS Center

Japan Science and Technology Agency (JST)
Web: http://www.jst.go.jp/EN/ (English)
Web: http://www.jst.go.jp/ (Japanese)

Japan Science and Technology Agency (JST) aims to establish Japan as a nation built on the creativity of science and technology, as a core organization for implementing Japan's science and technology policy in line with the objectives of the Science and Technology Basic Plan.

Science Portal:
Web: http://scienceportal.jp/portal/ (Japanese only)

Headquarters
Kawaguchi Center Building
4-1-8 Honcho, Kawaguchi-shi, Saitama 332-0012, Japan
Phone: +81-48-226-5601
Fax: +81-48-226-5651

IFCS National Focal Point

Director of Office of Chemical Safety
Pharmaceutical and Food Safety Bureau, Ministry of Health, Labour and Welfare (MHLW)
Central Government Bldg. No. 5, 1-2-2 Kasumigaseki, Chiyoda-ku, Tokyo 100-8916, Japan
Phone: +81-3-3595-2298
Fax: +81-3-3593-8913

CHAPTER

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Malaysia

SALMAAN H. INAYAT-HUSSAIN, JAMALUDIN ABU BAKAR, EFFENDI IBRAHIM, MAZLIN MOKHTAR, AND MICHELLE ALIA NUNIS

INTRODUCTION

Malaysia's industries in the areas of medical devices, pharmaceuticals, herbal medicine, nutraceuticals, and cosmeceuticals are rapidly growing. Therefore, there is an increasing urgency for the toxicological safety assessment of these products. Some regulations are already in place in the country and certain regulations concerning toxicity testing are currently being discussed for mandatory adoption by the industries. As an example, in Malaysia the standard that has been accepted by the Industry Standard Committee on Medical Devices (ISC-R) was *MS ISO 10993-3:2005, Biological evaluation of medical devices – Part 3: Tests for genotoxicity, carcinogenicity and reproductive toxicity*. Other parts of the ISO 10993-3 biological evaluation of medical devices are currently being discussed for adoption to meet the goals of the Malaysia Medical Devices Act 2007.

The herbal industry is an important sector in the country where products developed include cosmetics, health foods and herbal pharmaceuticals. Universities and research institutions have been performing various types of toxicity testing and currently a committee at the Institute for Medical Research of the Ministry of Health is co-ordinating a global information hub on integrated medicine. In this committee, issues including the regulation of safety of herbal products are being discussed.

The release of hazardous waste into the environment has posed risks to the environment and to human health worldwide. Previous studies have indicated that waste water genotoxicity has significant effects to human health and therefore genotoxicity testing on waste water for safe human reuse is crucial. Recently, New Work Item Proposal DIN 38415 – Part 3 and ISO13829:2000 – Water quality – Determination of the genotoxicity of water and waste water using the *umu* test has been proposed to the standards committee for discussion and possible adoption in Malaysia.

Establishment of the National Institute of Occupational Safety and Health (NIOSH) has led to a better workplace and reduction in accidents relating to chemicals. Other governmental agencies including the Ministry of Health, Ministry of Natural Resources and Environment and Ministry of Science, Technology and Innovation are working together to ensure that Malaysia's toxicology advancements are progressing well. Human capital development is also an important issue and many universities in the country are now introducing toxicology subjects at both undergraduate and postgraduate levels.

RESOURCES

Books

Environmental Health Focus (2003)

A joint publication of the Environmental Health Research Centre, Institute for Medical Research, Malaysia and supported by Centre of Environmental Health Development, WHO Collaborating Centre for Environmental Health, University of Western Sydney, Australia

ISSN: 1675-3941
All editorial communications to:
Chief Editor at EHRC
Environmental Health Focus

Institute for Medical Research
Jalan Pahang
50588 Kuala Lumpur
Malaysia
Phone: (603)-2698-6033
Fax (603)-2693-8306
Email: lokman@imr.gov.my

Mohd SI (2006)
Environmental Law in Malaysia
ISBN: 9679427757

This book provides basic guidelines to the current legal mechanisms in Malaysia. Chapters overview the legal aspects of pollution as they relate to the atmosphere, inland water, coastal waters, land, flora and fauna, litigation, international factors and international cooperation, and NGOs.

Vincent JR, Mohamed Ali R (2005)
Managing Natural Wealth: Environment and Development in Malaysia
ISBN: 9812302379

With access to unpublished data and key decision makers, the authors of this book analyze major environmental policy issues in Malaysia during the 1970s and 1980s, a period which saw profound socioeconomic change, the emergence of serious problems with pollution as well as rapid depletion of natural resources. This volume is an update to the book, *Environment and Development in a Resource-Rich Economy: Malaysia under the New Economic Policy*, which was published in 1997. This update includes a review of key developments since the 1990s.

Journals

Journal of Occupational Safety & Health

The OSH journal features articles, papers and reports of local experiences and research in OSH in Malaysia and the region.

Further information can be obtained from:
The Secretariat
Journal of Occupational Safety and Health
NIOSH, Lot 1, Jalan 15/1
Section 15, 43650 Bandar Baru Bangi
Selangor, Malaysia
Fax: 603-89265900

Malaysian Applied Biology (1977–)

Malaysian Applied Biology publishes scientific articles on original research in all fields of biology and applied biology or in any related scientific field provided it has not been considered for publication in other journals. Acceptance for publication is based on contribution to scientific knowledge, originality of data, ideas or interpretations and on their conciseness, scientific accuracy and clarity, as judged by two referees appointed by the Editorial Board.

Manuscripts should be submitted in triplicate to:
Prof Zubaid Akbar
Editor, Malaysian Applied Biology
c/o School of Environment & Natural Resource Sciences
Faculty of Science and Technology
Universiti Kebangsaan Malaysia
43600 UKM, Bangi, Selangor D.E.
Malaysia
Phone/Fax: 03-89213827
Email: zubaid@ukm.my

Malaysian Journal of Medical Sciences
ISSN: 1394-195X

Malaysian Journal of Medical Sciences is the official journal of the School of Medical Sciences, Universiti Sains Malaysia. This journal publishes review articles, original articles and reports.

Sample copy can be obtained from: http://www.medic.usm.my/publication/mjms/.
All correspondence pertaining to articles and related matters should be addressed to:
The Editor
Malaysian Journal of Medical Sciences
School of Medical Sciences
Universiti Sains Malaysia
16150 Kubang Kerian
Kelantan
Phone: 609-7651700/7651711 ext: 4000/4007/4023
Fax: 609-7656532
Email: mjms@kb.usm.my/maljms@yahoo.co.uk

Malaysian Journal of Pathology (1978–)
ISSN: 0126-8635

Malaysian Journal of Pathology is the official journal of the Malaysian Society of Pathologists. The journal is published semi annually.

The Business Manager
The Malaysian Journal of Pathology
Department of Pathology
Faculty of Medicine
University of Malaya
50603 Kuala Lumpur, Malaysia
Web: http://www.geocities.com/cpathamm/

Medical Journal of Malaysia (1979–)
ISSN: 0300-5283

The *Medical Journal of Malaysia* invites articles of interest from various areas of medicine in the form of original papers, research notes, communications, and correspondence. This journal also allows brief abstracts, of not more than 50 words, of original papers published elsewhere, concerning medicine in Malaysia.

All correspondence pertaining to articles and related matters should be addressed to:
Hon Editor
Medical Journal of Malaysia
Malaysian Medical Association
4th Floor, MMA House
124 Jalan Pahang
53000 Kuala Lumpur
Web: http://www.mma.org.my/mjm/mmj.htm

Sains Malaysiana (1972–)
ISSN 0126-6039

A journal on mathematics, earth science, physical sciences and biology. The journal is issued semi-annually primarily as a channel for publication of research reports of the academics of the university. Articles are published in both Malay and English.

All correspondence pertaining to articles and related matters should be addressed to:
Editor-in-Chief
Sains Malaysiana
Fakulti of Science and Technology
Universiti Kebangsaan Malaysia
43600 UKM Bangi
Selangor D.E., Malaysia
Phone: 603-89215555

Technical Reports and Other Documents

Round table dialogue No. 12: Malaysian network for integrated management of chemicals and hazardous substances for environment and development (MYNICHE) (2005)
Mazlin Bin Mokhtar, Ahmad Fariz Mohamed, Nurul Wah (Eds.)
ISBN: 983-9444-64-6

Environmental Impact Assessment (EIA)
The EIA provides guidelines for:
Coastal Resort Development Projects
Petrochemical Industries
Industrial Estate Development
Groundwater and/or Surface Water Supply Projects
Thermal Power Generation and/or Transmission Projects
Drainage and/or Irrigation Projects
Fishing Harbours and/or Land Based Aquaculture Projects
Dam and/or Reservoir Projects
Mines and Quarries
Development of Resort and Hotel Facilities In Hill Stations
Development of Tourist and Recreational Facilities In National Parks
Development of Tourist and Recreational Facilities On Islands in Marine Parks
Industrial Projects
Municipal Solid Waste and Sewage Treatment and Disposal Projects
Toxic and Hazardous Waste Treatment and Disposal Projects
Management and Disposal of Waste In DownStream Petroleum Industries
Management and Disposal of Waste In UpStream Petroleum Industries
Siting and Zoning
Coastal and Land Reclamation
Forestry
Petroleum Industries

All the assessment is conducted by Department of Environment (DOE), Ministry of Natural Resources and Environment of Malaysia

Web: http://www.doe.gov.my
In Malaysia, EIA is required under section 34A, Environmental Quality Act, 1974.

Water Quality Report
Malaysia's water quality is controlled by the Department of Environment, Ministry of Natural Resources and Environment of Malaysia.
Web: http://www.doe.gov.my

It consists of three parts of monitoring programmes which are Marine Monitoring, Ground Water Monitoring and Surface Water Monitoring.

To date, a total of 927 manual stations are located within 120 river basins throughout Malaysia.

Air Quality Report

The Department of Environment (DOE) has formulated a set of air quality guidelines in 1989, termed Recommended Malaysian Air Quality Guidelines (RMG) for air pollutants, defining the concentration limits of selected air pollutants which might adversely affect the health and welfare of the general public. In 1993, the DOE developed its own air quality index system known as Malaysian Air Quality Index (MAQI). DOE revised the MAQI system by adapting

the Air Pollutant Index (API) which closely follows the Pollutants Standard Index (PSI) system of the United States

Web: http://www.doe.gov.my

The pollutants included in Malaysia's API are ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2) and suspended particulate matter less than 10 microns in size (PM_{10}).

Malaysian Standards

1. MS ISO 15225:2005, Nomenclature – Specification for a nomenclature system for medical devices for the purpose of regulatory data exchange
2. MS ISO 10993-1:2005, Biological evaluation of medical devices – Part 1: Evaluation and testing
3. MS ISO 10993-3:2005, Biological evaluation of medical devices – Part 3: Tests for genotoxicity, carcinogenicity and reproductive toxicity
4. MS ISO 10993-13:2005, Biological evaluation of medical devices – Part 13: Identification and quantification of degradation products from polymeric medical devices
5. MS ISO 10993-14:2005, Biological evaluation of medical devices – Part 14: Identification and quantification of degradation products from ceramics
6. MS ISO 10993-15:2005, Biological evaluation of medical devices – Part 15: Identification and quantification of degradation of products from metals and alloys
7. MS ISO 10993-16:2005, Biological evaluation of medical devices – Part 16: Toxicokinetic study design for degradation products and leachables
8. MS ISO 10993-17:2005, Biological evaluation of medical devices – Part 17: Establishment of allowable limits for leachable substances

Organizations (Government)

Atomic Energy Licensing Board
Web: http://www.aelb.gov.my

This agency acts as an enforcement body to implement the Atomic Energy Licensing Act (Act 304).

Address: Atomic Energy Licensing Board
Ministry of Science, Technology and Innovation
Batu 24, Jalan Dengkil
43800 Dengkil
Selangor, Malaysia
Phone: +603-8926-7699
Fax: +603-8922-3685
Email: kp@aelb.gov.my

Environmental Institute of Malaysia
Web: www.doe.gov.my

This institute was established under the Department of Environment to enhance manpower development programs and to raise public awareness on the importance of environmental conservation.

Address: Department of Environment
Ministry of Natural Resources and Environment
Level 1–4, Podium 2 & 3
Lot 4G3, Precint 4
Federal Government Administrative Centre
62574 Putrajaya, Malaysia
Phone: +603-8871-2000/8871-2200
Fax: +603-03-8889-1973/75

Forest Research Institute of Malaysia
Web: http://www.frim.gov.my

This is a statutory body governed under Ministry of Natural Resources and Environment which is involved in research and development and testing services for the forestry and forest products industry.

Address: Forest Research Institute Malaysia (FRIM)
52109 Kepong, Selangor
Malaysia
Phone: +603-6279-7000
Fax: +603-6273-1314
Email: webgroup@frim.gov.my

Malaysian Institute for Nuclear Technology Research
Web: www.mint.gov.my

This institute is involved in the research and development related to nuclear technology.

Address: Malaysian Institute for Nuclear Technology Research (MINT)
Bangi 43000 Kajang
Selangor, Malaysia
Phone: +603-8925-0510
Fax: +603-8925-8262
Email: CorporateComm@mint.gov.my

Melaka Institute of Biotechnology
Web: www.mib.gov.my

This is a state government institute involved in toxicity testing including mutagenicity and cytotoxicity.

Address: Melaka Biotechnology Corporation
Lot 7, MITC City
75450 Ayer Keroh
Melaka, Malaysia
Phone: +606-231-3622
Fax: +606-231-3276
Email: info@mib.gov.my

Ministry of Agriculture and Agro-based Industries
Web: http://agrolink.moa.my/moa/

The regulation of agrochemicals such as pesticides is controlled by this ministry.

Address: Ministry of Agriculture & Agro-Based Industry
Wisma Tani, Jalan Sultan Salahuddin
50624 Kuala Lumpur, Malaysia
Phone: +603-2617-5000
Fax: +603-2691-3758
Email: admin@moa.my

Ministry of Domestic Trade & Consumer Affairs
Web: http://www.kpdnhep.gov.my

This ministry looks into the protection of consumers and safety for the petroleum, petrochemical and gas industries.

Address: Ministry of Domestic Trade & Consumer Affairs
Lot 2G3, Presint 2
Pusat Pentadbiran Kerajaan Persekutuan
62623 Putrajaya, Malaysia
Phone: +603-8882-5500
Fax: +603-8882-5762

Ministry of Health Malaysia
Web: www.moh.gov.my

The Ministry of Health Malaysia and its institutes/centers include Institute for Medical Research, Institute of Public Health, National Public Health Laboratory, National Pharmaceutical Control Bureau and Environmental Health Research Centre.

Address: Ministry of Health, Malaysia
Blok E1, E6, E7 & E10, Kompleks E,
Pusat Pentadbiran Kerajaan Persekutuan
62590, Putrajaya, Malaysia
Phone: +603-8883-3888
Email: webmaster_portal@cube.moh.gov.my

Ministry of Human Resources
Web: www.mohr.gov.my

This ministry oversees the Department of Occupational Safety and Health (DOSH). DOSH is a government agency responsible for the administration and enforcement of legislations related to occupational safety and health for Malaysia.

Address: Ministry of Human Resources
Aras 6-9, Blok D3, Kompleks D
Pusat Pentadbiran Kerajaan Persekutuan
62530, Putrajaya, Malaysia
Phone: +603-8886-5000
Fax: +603-8889-2381
Email: ksm1@mohr.gov.my

Ministry of Natural Resources and Environment
Web: www.nre.gov.my

The Department of Environment (www.doe.gov.my) is under this ministry. The DOE has a division on hazardous/toxic substances and implements the Environmental Quality Act 1974 and its associated rules and regulations which include toxic substances.

Address: Ministry of Natural Resources and Environment
Aras 14, No.25, Persiaran Perdana
Wisma Sumber Asli, Presint 4
62574 Putrajaya, Malaysia
Phone: +603-8886-1111
Fax: +603-8889-2672
Email: webmaster@nre.gov.my

Ministry of Science, Technology and Innovation
Web: www.mosti.gov.my
Address: Ministry of Science, Technology and Innovation,
Aras 1-7, Blok C5, Pusat Pentadbiran Kerajaan Persekutuan,
62662 Putrajaya, Wilayah Persekutuan, Malaysia
Phone: +603-8885-8000
Fax: +603-8888-6070
Email: webmaster@mosti.gov.my

The Department of Chemistry (www.kimia.gov.my) is under the purview of this ministry and is a national organization of ten laboratories which provides comprehensive, modern, high-quality and cost-effective scientific services (analytical, investigatory, and consultancy).

These services are critical in supporting the implementation of 49 Acts/Regulations and various programmes by government agencies in:

Combating crime and maintaining public security and order
Protecting environmental quality
Maintaining food and water safety (Public Health)
Tariff classification for customs duties
Consumer protection
Evaluation of supplies for government contracts
Laboratory accreditation
Administration of Justice
Forensic (Toxicology, Narcotic, Serology, Criminalistic and Document Examination)
Environmental Health (Food, Water and the Environment)

National Hydraulic Research Institute of Malaysia
Web: www.nahrim.gov.my

This institute is involved in research and consultancy in aspects of water hydraulics and water environment. This institute also offers services based on advanced technologies within the fields of ecology and environmental chemistry.

Address: National Hydraulic Research Institute of Malaysia (NAHRIM)
Ministry of Natural Resources and Environment
Lot 5377, Jalan Putra Permai
43300 Seri Kembangan
Selangor, Malaysia
Phone: +603-8948-3033
Fax: +603-8948-3044
Email: iphk@nahrim.gov.my

Standards and Industrial Research Institute, Malaysia
Web: www.sirim.my

This institute has an environmental and bioprocess technology center.

Address: SIRIM Berhad Customer Service Centre
No. 1, Persiaran Dato' Menteri
Seksyen 2, Peti Surat 7035
40911 Shah Alam
Selangor, Malaysia
Phone: +603-5544-6693/6692/6631
Fax: +603-5544-6694
Email: web@sirim.my

Organizations (Non-Government)

Alam Sekitar Malaysia Sdn. Bhd.
Web: http://www.enviromalaysia.com.my/index.asp

Alam Sekitar Malaysia Sdn. Bhd. (ASMA) has been at the forefront of environmental monitoring since 1995 when it was awarded a concession by the government of Malaysia to set up a systematic and comprehensive monitoring network for air quality and water quality for the nation and to establish the National Environmental Data Centre.

Address: Alam Sekitar Malaysia Sdn. Bhd.
Bukit Jelutong Business & Technology Centre
40150 Shah Alam
Selangor, Malaysia
Phone: +603-7845-4566
Fax: +603-7845-3566
Email: asma@enviromalaysia.com.my

Centre for Environment, Technology and Development, Malaysia
Web: www.cetdem.org.my

Founded in 1985, CETDEM is an independent, non-profit, training, research, consultancy, referral, and development organization. It is committed to improving environmental quality through the appropriate use of technology and sustainable development.

Address: CETDEM
P.O. Box 382
17, Jalan SS2/53
46740 Petaling Jaya
Selangor, Malaysia
Phone: +603-7875-7767
Fax: +603-7875-4039
Email: proj@cetdem.org.my

Confederation of Scientific and Technological Associations in Malaysia (COSTAM)
Web: www.costam.org.my

COSTAM organizes a number of activities within the interests of the national science and technology communities of Malaysia including the UNESCO-COSTAM Society of Free Radical Research Workshop every 3 years.

Address: COSTAM Secretariat
Damansara Intan, C-3A-10 (4th Floor), Block C, (Lift No: 5)
No.1, Jalan SS 20/27
47400, Petaling Jaya
Selangor, Malaysia
Phone: +603-7118-2062
Fax: +603-7118-2063
Email: secretariat@costam.org.my

Consumer's Association Penang
Web: http://www.jeef.or.jp/EAST_ASIA/malaysia/CAP.htm or www.consumer.com.my

This association is actively involved in education and solving issues on toxic chemicals and environmental health.

Address: Consumer's Association of Penang
228, Jalan Macalister
10400 Pulau Pinang
Malaysia
Phone: +604-2293511
Fax: +604-2298106
Email: meenaco@pd.jaring.my

Environmental Management & Research Association of Malaysia
Web: http://www.ensearch.org/

ENSEARCH is a non-profit association of organizations, professionals, students, and people with interest in learning and promoting effective ways to manage the impacts of human activities on the environment.

Address: ENSEARCH
No. 30-3, Jalan PJU 5/16
Dataran Sunway, Kota Damansara
47810 Petaling Jaya

Selangor, Malaysia
Phone: +603-6156-9807/8
Fax: +603-6156-9803
Email: admin@ensearch.org

Malaysian Biotechnology Corporation
Web: www.biotechcorp.com.my

This agency under the purview of Ministry of Science, Technology and Innovation, is wholly owned by the Ministry of Finance Incorporated. The objective of this establishment amongst others is to identify value propositions in both R&D and commerce and support these ventures via financial assistance and developmental services.

Address: Malaysian Biotechnology Corporation Sdn. Bhd. (691431-D)
Corporate Office
Level 23, Menara Naluri
161 Jalan Ampang
50450 Kuala Lumpur
Malaysia
Phone: +603-2116-5588
Fax: +603-2116-5411
Email: info@biotechcorp.com.my

Malaysian Environmental NGOs
Web: www.mengo.org

A federation of 18 different NGOs concerning the environment. A grouping of Malaysian Environmental NGOs (MENGO) was formed under the DANIDA-supported program for environmental assistance to Malaysia. DANIDA is the Danish International Development Assistance. The objective of the program is to contribute to the strengthening of the MENGOs and facilitate their impact on the decision making at all levels in the Malaysian society. One of the main strategic aims of the program is to support and facilitate a more effective interaction between MENGO and the Government of Malaysia on environmental policies.

Address: MENGO Support Unit
c/o ENSEARCH
No 30-1 Jalan PJU 5/16
Dataran Sunway, Kota Damansara
47810 Petaling Jaya
Selangor, Malaysia
Phone: +603-6157-5708
Fax: +603-6157-6707
Email: mengo@tm.net.my

National Institute of Occupational Safety and Health
Web: www.niosh.com.my
Address: National Institute of Occupational Safety and Health (NIOSH)
Lot 1, Jalan 15/1, Section 15
43650, Bandar Baru Bangi
Selangor, Malaysia
Phone: +603-8769-2100
Fax: +603-8926-2900
Email: admin@niosh.com.my

Universities

Universiti Kebangsaan Malaysia
Web: www.ukm.my

Environmental Health Program, Faculty of Allied Health Sciences
Web: http://www.fskb.ukm.my/
Phone: +603-92897607
Fax: +603-26938717
Email: dkfskb@medic.ukm.my

Department of Pharmacy, Faculty of Allied Health Sciences
Web: http://www.fskb.ukm.my/
Phone: +603-40405331
Email: ibj@fskb.ukm.my

Department of Pharmacology, Faculty of Medicine
Web: www.medic.ukm.my
Phone: +603-40405281
Fax: +603-26938205
Email: badrulh@mail.hukm.ukm.my

Toxicology and Biocompatibility Laboratory, Faculty of Allied Health
Sciences and Faculty of Science and Technology
Phone : +603-92897819
Email : salmaan@medic.ukm.my

Institute for Environment and Development (LESTARI)
Web: http://www.lestari.ukm.my
Address: Institute for Environment and Development (LESTARI)
Universiti Kebangsaan Malaysia,
43600 Bangi,
Selangor, Malaysia
Phone: +603-89214149
Fax: +603-89255104
Email: lestari@pkrisc.cc.ukm.my

Universiti Malaya
Web: www.um.edu.my

Department of Pharmacology, Faculty of Medicine
Web: http://www.um.edu.my/um_life/academics/faculties/fac_of_medicine.php
Address: Dean
Faculty of Medicine
University of Malaya
50603 Kuala Lumpur
Malaysia

Phone: +603-7949-4422
Fax: +603-7949-4422
Email: ummc@ummc.edu.my

Institute of Biological Sciences
Web: http://www.um.edu.my/um_life/academics/faculties/fac_of_science.php?intPrefLangID=1&
Address: Faculty of Science
University of Malaya
50603 Kuala Lumpur
Malaysia
Phone: +603-7967-4277/4379/4223
Fax: +603-7967-4376/603-7956

Universiti Sains Malaysia
Web: www.usm.my

Forensic Science Program, School of Health Sciences
Web: http://www.ppsk.usm.my/
Address: School of Health Sciences
Universiti Sains Malaysia, Kampus Kesihatan
16150 Kubang Kerian
Kelantan, Malaysia
Phone : +609-766-3807/3583
Fax: +609-764-7884
Email: hadzri@kb.usm.my

Department of Pharmacology, School of Medical Sciences
Web: http://www.medic.usm.my/
Address: School of Medical Sciences
Universiti Sains Malaysia, Kampus Kesihatan,
16150 Kubang Kerian
Kelantan, Malaysia
Phone: +609-766-3000
Fax: +609-765-3370
Email: msuhaimi@kb.usm.my

National Poison Center
Web: www.prn.usm.my
Address: National Poison Centre
Universiti Sains Malaysia
11800 Penang, Malaysia
Phone: +604-657-0099
Fax: + 604-656-8417
Email: prnnet@prn.usm.my

School of Pharmaceutical Sciences
Web: http://www.pha.usm.my/pharmacy/school_of_pharmaceutical_science1.htm
Address: School of Pharmaceutical Sciences
Minden
11800 Penang, Malaysia
Phone: +604-653-3888; ext. 2229, 2211, 2212
Fax: +604-657-0017
Email: abas@usm.my

Universiti Putra Malaysia
Web: www.upm.edu.my

Environmental and Occupational Health Program, Faculty of Medicine and Health Sciences
Web: http://www.medic.upm.edu.my/

Department of Biomedical Sciences, Faculty of Medicine and Health Sciences
Web: http://www.medic.upm.edu.my/
Address: Faculty of Medicine and Health Sciences
Universiti Putra Malaysia
43400 Serdang
Selangor, Malaysia
Phone: +603-8947-2574
Fax: +603-8947-2585

Faculty of Veterinary Sciences
Web: http://www.vet.upm.edu.my/
Address: Faculty of Veterinary Medicine
Universiti Putra Malaysia
43400 UPM Serdang
Selangor, Malaysia
Phone:+603-8943-5387
Fax:+603-8948-6317
Email: webmaster@vet.upm.edu.my

Universiti Malaysia Sarawak
Web: www.unimas.my

Faculty of Medicine and Health Sciences
Web: http://www.fmhs.unimas.my/

Universiti Malaysia Sabah
Web: www.ums.edu.my

Faculty of Medicine
Web: http://www.ums.edu.my/appl/index.php?mod=Publication&action=introaccess&sek=spu&lang=_en
Address: Universiti Malaysia Sarawak
Jalan Datuk Mohd Musa
94300 Kota Samarahan
Sarawak, Malaysia
Phone: +60-82-581-000
Fax: +60-82-581-185
Email: webmaster@unimas.my

Universiti Teknologi Malaysia
Web: www.utm.my
Faculty of Chemical and Natural Resources Engineering
Web: http://web.utm.my/fkkksa/
Address: Faculty of Chemical & Natural Resources Engineering
Universiti Teknologi Malaysia
81310 UTM Skudai,
Johor, Malaysia

Phone: +607-553-5500
Fax: +607-558-1463

Institute of Environmental & Water Resource Management
Web: http://web.utm.my/ipasa/
Address: Director
Institute of Environmental & Water Resource Management
Universiti Teknologi Malaysia
81310 UTM Skudai
Johor, Malaysia
Phone: +607-553-1578/1508
Fax: +607-558-1575

Universiti Teknologi MARA
Web: www.uitm.edu.my

Faculty of Medicine
Web: http://www.medic.uitm.edu.my/
Address: Faculty of Medicine
University Technology MARA
40450 Shah Alam
Selangor, Malaysia
Phone: +603-5544-2833/2836
Fax: +603-5544-2831

Faculty of Pharmacy
Web: http://www.pharmacy.uitm.edu.my/
Address: Faculty of Pharmacy
Universiti Teknologi MARA
40450 Shah Alam
Selangor, Malaysia
Phone: +603-5544-2727
Fax: +603-5544-2725

Universiti Malaysia Terengganu
Web: http://www.umt.edu.my/

Department of Biological Science, Faculty of Science and Technology
Web: http://www.umt.edu.my/department_of_biology_science.php
Address: Department of Biology (Science)
Faculty of Science and Technology
University Malaysia Terengganu (UMT)
21030 Kuala Terengganu
Terengganu, Malaysia
Phone: +609-668-3111/3211/3226
Fax: +609-668-3217
Email: jasbio@umt.edu.my

International Islamic University of Malaysia
Web: www.iiu.edu.my
Kulliyah of Science
Web: http://www.iiu.edu.my/academic/ksc.shtml
Address: Dean
Kulliyyah of Science
International Islamic University Malaysia
P.O. Box 10
50728 Kuala Lumpur, Malaysia
Phone: +603-6196-5441
Fax: +603-6196-4899

Kulliyah of Medicine
Web: http://www.iiumedic.edu.my
Address: Dean
Kulliyyah of Medicine
International Islamic University Malaysia
P.O Box 141
25710 Kuantan
Pahang Darul Makmur, Malaysia
Phone: +609-571-6400
Fax: +609-571-6770
Email: medean@iiu.edu.my

Kulliyah of Pharmacy
Web: http://www.iiu.edu.my/academic/kpharmacy.shtml
Address: Dean
Kulliyyah of Pharmacy
International Islamic University Malaysia
P.O Box 141
25200 Kuantan
Pahang, Malaysia
Phone: +609-571-6400
Fax: +609-573-5431

Monash University Malaysia
Web: www.monash.edu.my

School of Art and Sciences
Web: http://www.artsci.monash.edu.my/
Address: School of Art and Sciences
2, Jalan Universiti, Bandar Sunway
46150 Petaling Jaya
Selangor, Malaysia
Phone: +603-5636-0600
Fax: +603-5635-8640
Email: study@monash.edu

Professional Societies

Malaysian Association of Environmental Health
Phone: +603-2282-1333
Fax: +603-2282-3114

Malaysian Institute of Chemistry
Web: http://www.ikm.org.my/
Phone: +603-7728-3272
Fax: +603-7728-9909
Email: ikmmy@pc.jaring.my or ikmmy@tm.net.my

Malaysian Society of Applied Biology
Web: http://pkukmweb.ukm.my/~msab/
Phone: +603-8921-3815
Fax: +603-8925-2698
Email: nazlina@pkrisc.cc.ukm.my

Malaysian Society of Biochemistry and Molecular Biology (MSBMB)
Web: http://genome.ukm.my/msbmb/
Phone: +603-8921-3862/8926-7446
Fax: +603-8925-2698

Malaysian Society for Occupational Safety and Health (MSOSH)
Phone: +603-7956-1763
Fax: +603-7955-7195
Email: msosh@po.jaring.my

Malaysian Society of Pharmacology and Physiology
Web: http://www.geocities.com/HotSprings/Spa/7550/

Malaysia Pharmaceutical Society
Web: http://www.mps.org.my/
Phone: +603-7729-1409
Fax: +603-7726-3749
Email: mspharm@po.jaring.my

Society for Occupational and Environmental Medicine – Malaysian Medical Association
Web: http://www.mma.org.my/soem/
Phone: +603-4041-3740/ + 603-4041-1375

Poison Control Center

National Poison Center, Penang
Web: www.prn.usm.my
Contact details:
National Poison Centre, Universiti Sains Malaysia, 11800 Penang, Malaysia
Phone: 04-6570099
Fax: 04-6568417
Email: prnnet@prn.usm.my

Legislation

Legislations of Malaysia which are related directly or indirectly to toxicology and toxicity:

By Laws of Uniformed Buildings 1984
Web: http://www.nre.gov.my/English_Version/pemuliharaan_pengurusan_alamsekitar/akta.htm

Civil Aviation Act 1969
Web: http://www.nre.gov.my/English_Version/pemuliharaan_pengurusan_alamsekitar/akta.htm

Consumers Protection Act 1999
Web: www.kpdnhep.gov.my/pub/kpdn/

Control of Drugs and Cosmetics Regulations 1984
Web: www.pharmacy.gov.my/html/legislations

Customs Act 1967
Web: www.customs.gov.my

Environmental Quality Act 1974
Web: http://www.nre.gov.my/English_Version/pemuliharaan_pengurusan_alamsekitar/akta.htm

Food Act 1983
Web: www1.moh.gov.my/fsq/warta

Occupational Safety and Health Act 1994
Pesticides Act 1974
Web: http://www.nre.gov.my/English_Version/pemuliharaan_pengurusan_alamsekitar/akta.htm

Petroleum (Safety Measure) Act 1994
Web: http://www.nre.gov.my/English_Version/pemuliharaan_pengurusan_alamsekitar/akta.htm

Poisons List Order 1983
Web: www.pharmacy.gov.my/html/legislations

Poisons Ordinance 1952
Web: www.pharmacy.gov.my/html/legislations

Road Transport Act 1987
Web: http://www.nre.gov.my/English_Version/pemuliharaan_pengurusan_alamsekitar/akta.htm

Sale of Drugs Act 1952
Web: www.pharmacy.gov.my/html/legislations

Street, Drainage and Building Act 1974
Web: http://www.nre.gov.my/English_Version/pemuliharaan_pengurusan_alamsekitar/akta.htm

The Chemist Act 1975
Web: www.ikm.org.my/about_ikm.htm

The Poisons (Sodium Arsenite) 1949
Web: www.pharmacy.gov.my/html/legislations

Miscellaneous Resources

The Japan Society for the Promotion of Science – Malaysian Universities Vice Chancellors' Council on Environmental Toxicity Evaluation and Risk Management
Web: http://www.ippp.um.edu.my/index.php?pg=linkages&sc=0

CHAPTER

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Mexico

MARIA E. GONSEBATT

INTRODUCTION

The history of toxicology in Mexico should include, at the outset, reference to the indigenous cultures which had acquired an intimate knowledge of the medicinal properties of the land's flora. These early civilizations even cultivated botanical gardens of medicinal plants. The use of medicinal plants by the Aztecs was described by Sahagun in his *General history of the things of the New Spain* and in 1552, the *Libellus de Medicinalibus Indorum Herbis,* containing a description of medicinal plants and their uses, was published.

Modern toxicology began to take root in Mexico in the early 1970s in several laboratories at different institutes and universities, such as the Instituto Politécnico Nacional and the Universidad Nacional Autónoma de México. Today, research in toxicology, genotoxicology, environmental toxicology, and food toxicology is performed mostly in public universities in Mexico City such as those mentioned above but also in various state universities such as the Universidad Autónoma de Aguascalientes, Universidad de Durango, Universidad Autónoma de Nuevo León, Universidad de San Luis Potosí, Universidad Autónoma de Querétaro and Instituto Tecnológico de Sonora. Toxicology is taught in an assortment of Mexican university faculties, such as chemistry, medicine, veterinary science, and sometimes biology, as a part of the academic curricula. Food toxicology is currently taught within several university departments within the new Food Science and Technology degree programs. There are postgraduate programs in toxicology, environmental toxicology, and environmental management in public and private superior education institutions. The CONACYT or Consejo Nacional de Ciencia y Tecnología (National Science and Technology Council) funds most of the research and the postgraduate programs. The Secretary of Environmental Resources (SEMARNAT) also funds research in specific areas. The Sociedad Mexicana de Toxicología, SOMTOX (Mexican Society of Toxicology) was founded in 1994 by members of the Mexican chapter of the Latin American Society of Toxicology (ALATOX). SOMTOX holds biennial meetings. Dr. Lilia Albert Palacios was its first president. Genetic toxicologists participate in academic societies such as the Sociedad Mexicana de Genética (Mexican Society of Genetics) and the Sociedad Mexicana de Genética Humana (Mexican Society of Human Genetics). The publication of books in the area has been sponsored mostly by the Pan American Health Organization (PAHO) and by government agencies such as the Instituto de Ecología (Ecology Institute) and the Secretary of Environmental Resources (SEMARNAT), and universities. There are no specialized toxicology journals in Mexico, although chemistry, biology, ecology and clinical sciences journals publish toxicological research findings. The journal *Revista de Contaminación Ambiental,* edited by several universities, specializes in environmental pollution research.

RESOURCES

Books

Adame Romero A (1993)
Contaminación Ambiental (Environmental Pollution)
Trilla: México

A text describing environmental aspects of pollution and toxicology.

Albert LA (1988)
Curso básico de toxicologia ambiental (Basic course on environmental toxicology)
Limusa: Noriega, México

An introduction to environmental toxicology, a basic course.

Albert LA, Saldívar Osorio L (Eds.) (1996)
La Toxicologia en Mexico: estado actual y perspectivas (Toxicology in Mexico: actual state and perspectivas)
Sociedad Mexicana de Toxicología: México

Meeting proceedings.

Alvarez Moya C (2000)
Genetica, ambiente y salud (Genetic, Environment and Health)
Universidad de Guadalajara: México

A text on human genetics, genetics toxicolgy, carcinogenesis, environmetal pollution.

Asociación Mexicana de Pediatría (2004)
Intoxicaciones (Intoxications)
McGraw-Hill Interamericana: México

Aspects of pediatric toxicology.

Botello AV, et al (Eds.) (1996, 2005)
Golfo de México, contaminación e impacto ambiental: diagnóstico y tendencias (Gulf of Mexico, pollution and environmental impact: diagnosis and tendencies)
Universidad Autonoma de Campeche and UNAM: México

Analyzes the impact of marine pollution by pesticidas, etc. in the Gulf of Mexico.

Calixto Flores R, et al. (2003)
Ecologia y Medio Ambiente (Ecology and Environment)
Thomson Learning Ibero: México

Describes ecology as a science, the dynamic of ecosystems, ecodevelopment and health with emphasis in pollution, erosion and restoration.

Cervantes C, Moreno-Sanchez R (1999)
Contaminacion ambiental por metales pesados: impacto en los seres vivos (Heavy Metals Environmental Pollution: impact in living organisms)
A. G. T: México

Describes the pollution due to heavy metals and its effects in plants.

Curso Toxicologia Ambiental, Economica y Forense (1986)
Memorias del curso toxicologia ambiental, economica y forense (Proceedings of the Environmental, economic and forensic toxicology Course)
UNAM, Facultad de Medicina Veterinaria y Zootecnia, Division de Estudios de Posgrado, Coordinacion de cursos de actualizacion: México

Veterinary toxicology texts.

Félix-Burgos G, Romero Sevilla L (1998)
Ecología y Salud (Ecology and Health)
McGraw-Hill Interamericana: México

A basic course to learn about environmental health.

Gordillo Hernández D (1995)
Ecologia y contaminacion ambiental (Ecology and environmental pollution)
Interamericana: McGraw-Hill: México

A basic text describing those aspects of environmental pollution that affect ecology. Environmental protection.

Jaramillo F, et al (2006)
Toxicología básica (Basic Toxicology)
Universidad Autónoma de Aguascalientes, Universidad de Guadalajara, UJED: México

Basic toxicology describing the principles of toxicokinetics and toxicodynamics, and analyzing the effects and mechanisms of toxic xenobiotics in organs and systems. The book presents up-to-date information, and examples with tables and figures. In the appendix the problem of the half life and toxicity of pharmaceutical drugs is analyzed.

Perez Lucio C (coordinator) (1999)
Toxicologia laboral (Occupational Toxicology)
Conferencia Interamericana de Seguridad Social: México

Proceedings of the Interamerican Conference on Social Security.

Perez Zapata A, De Leon Rodríguez I (1993)
La contaminacion por plomo en Coatzacoalcos: un ejemplo de deterioro ambiental (Lead pollution in Coatzacoalcos: an example of environmental deterioration)
IPN: México

A text describing lead pollution in a specific oil area in Mexico.

Posadas del Río FA, et al (2006)
Biotransformation of Xenobiotics
Universidad Autónoma de Aguascalientes: México

Analyzes the biotransformation, metabolism or detoxification of xenobiotics as part of the interaction of xenobiotics with living organisms. Chemical changes and biological effects. The book was printed in English

Rodríguez-Arnaiz R (2003)
Las toxinas ambientales y sus efectos genéticos, 4a ed (Environmental toxics and its genetics effects, 4th Ed.)
Fondo de Cultura Economica: México

An introduction on topics of genetic damage by environmental mutagens.

Rosiles Martinez R, Ocampo Cambero L (coordinadores) (1978)
Memorias del primer curso de actualizacion en toxicologia veterinaria (Memoirs of the first course of actualization in toxicology)
UNAM. Facultad de Medicina Veterinaria y Zootecnia. Division de Estudios Superiores: México

A veterinary toxicology course.

Sánchez Gómez J (2003)
Manejo de residuos industriales (Industrial waste management)
Universidad Autónoma de Aguascalientes: México

Keywords: hazardous waste, pollution, natural resources, sites, permeability, different types of geology, dumping sites.

Sumano López H, Lizarraga Madrigal I (2001)
Farmacología y toxicología aplicada en equinos (Equine applied pharmacology and toxicology)
UNAM, Facultad de Medicina Veterinaria y Zootecnia, Departamento de Medicina y Zootecnia para Equinos: México

Descriptions of horse diseases and treatments, pharmacological and toxicological information for veterinary students.

Publications sponsored by the Panamerican Center of Human Ecology and Health (Centro Panamericano de Ecología Humana y Salud) PAHO, WHO, México

Albert LA (1997)
Ejercicios complementarios [para el] curso basico de toxicologia ambiental (Complementary exercises for the basic course on Environmental Toxicology)
Centro Panamericano de Ecologia Humana y Salud-WHO: México

Exercises for students of basic toxicology courses. Publication sponsored by PAHO.

Aitio A, et al (1986)
Control de calidad en laboratorios de toxicologia ocupacional (Quality control in occupational toxicology laboratories)
Centro panamericano de ecologia humana y salud: México

Spanish translation of the book: Euro-WHO Quality control in the occupational toxicology laboratory European cooperation on environmental health aspects of the control of chemicals-interim document 4. Copenhagen Euro-WHO.

Carreón Valencia T (1995)
Manual de procedimiento en la toma de muestras biológicas y ambientales para determinar niveles de contaminantes (Procedure manual for biological and environmental sampling to determine levels of pollutants)
Centro Panamericano de Ecología Humana y Salud División de Salud y Ambiente: México

A description of the requirements to perform and to obtain biological and environmental simples to determine levels of pollutants.

Centro Panamericano de Ecología Humana (1986)
Toxicología Alimentaria (Food Toxicology)

Food poisoning.

de Fernicola NGG (1985)
Cursos de toxicologia a nivel de grado y de posgrado en america latina (Pregraduate and Postgraduate Toxicology Courses in Latin America. A compilation)
Centro Panamericano de Ecologia Humana y Salud: México

A description of the toxicology courses, graduate and postgraduate studies in Latin America. A publication sponsored by PAHO.

Listado de Plaguicidas Restringidos y Prohibidos en Paises de la Region de Las Americas (1989) (List of restricted and prohibited plaguicides in the Americas region)

Centro de Ecologia Humano, Centro Panamericano de Ecología Humana y Salud Programa de Salud Ambiental, Organización Panamericana de la Salud: México

Secretaría de Salubridad y Asistencia (1973)
Apuntes sobre intoxicaciones (Notes on intoxications)

Consejo nacional de prevencion de accidents: México

Valle Vega P (1986, 1991)
Toxicología de alimentos (Food Toxicology)
Centro Panamericano de Ecología Humana y Salud, Programa de Salud Ambiental
Coedición con: Organización Panamericana de la Salud y la Organización Mundial de la Salud: México

Vega GS (1985)
Aspectos específicos de la toxicología de algunos contaminantes (Specific aspects of some pollutants toxicology)

Centro Panamericano de Ecología Humana y Salud, PAHO, WHO: México

A publication sponsored by the Pan American Health Organization on the epidemiologic evaluation of the risks by environmental chemical agents.

Vega GS (1985)
Toxicología (Toxicology)

A basic toxicology text describing the toxicology of pollutants, genotoxicity, carcinogenesis.

Publications sponsored by PUMA (University Program of the Environment at the Universidad Nacional Autónoma de México) www.puma.unam.mx/publica.htm (Programa universitario del Medio Ambiente (PUMA)

Cortinas de Nava C, Mosler García C (2002)
Gestión de resíduos peligros (Hazardous waste management)

Contains information for researchers and other professionals interested in learning about the management of hazardous waste, their disposal, toxic evaluation, recycling, etc.

Mendieta JG (1997)
Medio Ambiente en México Parte I: Autores y Artículos (The Environment in Mexico, Part I: Authors and Publications)

An analytic presentation of the main publications on the environment in Mexico.

Mosler García C, Rodríguez Hernández MC, Garfias y Ayala FC (1999)
Compendio de Información Ambiental 1998 (Compendium of Environmental Information 1998)

Information on environmental pollution, quality of fuels, impact on the environment, toxic and hazardous waste, effects of toxic substances, etc.

Rivero Serrano O, Garfias Vázquez M, González Martínez S (1996)
Residuos Peligrosos (Hazardous waste)

National and foreign experts analyze the generation, management, transport and final disposal of hazardous waste in Mexico and in other countries

Rivero Serrano O, Ponciano Rodríguez G (1996)
Riesgos ambientales para la salud en la Ciudad de México (Environmental Health Risk in Mexico City)

Analysis by national and foreign experts of the factors involved in the health risk for the inhabitants of Mexico City and Valley.

Riveros H, Cabrera E (1999)
Emisiones vehiculares (Vehicular emissions)

Describes the emissions of hydrocarbons and carbon monoxide of the different motor vehicles used in Mexico City.

Manuals

Lazaro-Chavez Mancilla E (1985)
Sustancias desinfectantes y drogas de utilidad en las piscifactorias: Manual de usos (Disinfectant substances and useful drugs in fisheries)

Secretaría del Trabajo y Previsión Social (1990)
Instructivo relativo a las condiciones de seguridad e higiene para el almacenamiento, transporte y manejo de sustancias corrosivas, irritantes y toxicas en los centros de trabajo (Instructions for the security and hygienic conditions for the storage, transport and handling of hazardous substances)
Secretaría del Trabajo y Previsión Social: México

Secretaria de Salud Direccion General de Salud Ambiental (1993)
Manual de Toxicología (Toxicology Manual)
Secretaria de Salud, Direccion General de Salud Ambiental: Secretaria de Salud, Dirección de Control de Riesgos Ambientales: México

A manual describing emergencies, poisonings, and treatments.

Publications of the National Ecology Institute, México

Botello AV, et al (2006)
Golfo de México. Contaminación e impacto ambiental. Diagnóstico y tendencias (Gulf of Mexico. Environmental pollution and impact. Diagnosis and tendencies)
Several editorials.

Cárdenas B, et al (2003)
Tratamiento biológico de compuestos orgánicos volátiles de fuentes fijas (Biological treatment of volatile organic compounds from fixed sources)

General description of air pollution in Mexico and of the Mexican legislation. Describes the general methods for the treatment of the air polluted with VOC. Biofiltration as a methodology for the effective reduction of VOC emission.

Fernandez A, et al (2004)
Sustancias tóxicas persistentes (Persistent toxic substances)
INE, Semarnat: IMP

A detailed analysis of organic persistent compounds. This text represents the first intent to communicate the

problem of OPC to the different groups of interest. Although there is not an objective evaluation of the risk due to organic persistent compounds, the text presents a useful analysis for the discussion of a national diagnosis on these compounds.

Fernández L, et al. (2006)
Manual de técnicas de análisis de suelos contaminados (Technical manual for the analysis of polluted soils)

Compilation of the methodologies for the analysis soils for the follow up of remediation and characterization of polluted soils.

Gutiérrez Avedoy V (coordinator) (2006)
Diagnóstico basico para la gestión integral de residuos (Basic diagnostic for an integral waste management)

Important information for the necessary policy and instrument design in the search of adequate solutions for integral waste management.

Instituto Nacional de Ecología (2004)
Introducción al análisis de riesgos ambientales (Introduction to environmetal risk analysis)
A manual providing basic concepts and tools for the analysis and decision making.

Instituto Nacional de Ecología (2006)
Inventario nacional de emisiones de gases efecto invernadero (Nacional inventory of greenhouse gases emisión)
Statistic complement to Mexico's third communication to UN on climate change.

Rosas I, et al. (2003)
Microbiología ambiental (Environmental Microbiology)

Description of the bacterial and other unicellular microorganisms present in the environment.

Toledo A (2003)
Agua, hombre y paisaje (Water, man and landscape)

The challenge to understand and analyze the landscape we inhabit and to think about our reality using a new science that understand the creativity of the natural systems and of human imagination.

Bases para una política nacional de residuos peligrosos (2001) (Bases for a national policy for hazardous waste)

Updated information for the discusión of the country's problem on hazardous waste disposal policy.

Velasco E, Bernabé M (2004)
Emisiones biogénicas (Biogenic Emissions)

A revision on the basic concepts and relevant aspects of these subjects. A material for beginners as well as for those already familiarized with biogenic emissions.

Volke Sepúlveda T, Velasco Trejo JA (2003)
Tecnologías de remediación para suelos contaminados (Remediation Technologies for Soil Pollution)

A revision of the main technologies for soil remediation.

Volke Sepúlveda T, et al (2005)
Suelos contaminados por metales y metaloides: muestreo y alternativas para su remediación (Metal and metalloid contaminated soils: methods and bioremediation alternatives)

A general information of inorganic pollutants more frequently found in the contaminated sites in Mexico. The human activities that lead to these contaminations. Sampling methodologies to characterize the sites and technical information to plan, develop, and select bioremediation strategies.

Zuk MM, et al (2006)
Introducción a la evaluación de los impactos de las termoeléctricas de México (Introduction to the impact evaluation of thermoelectrics in México)

Careful description of the relationship between the generation of electricity, pollution emission and their impact on air quality and population health.

Legislation on Natural Protected Areas (National Ecology Institute, México)

Áreas naturales protegidas de México con decretos estatales (2003) (Mexico's natural protected areas with state decrees)
Volúmenes 1 y 2

Compilation of 173 decrees, agreements, and declarations of the protected areas in 22 states.

Áreas naturales protegidas de México con decretos federales (2003) (Mexico's natural protected areas with federal legislation)
Primera reimpresión

Compilation of the 218 secretarial decrees and agreements.

Journals

Toxicology and Environmental Pollution

Revista internacional de contaminación ambiental (International Journal of Environmental Pollution)

Edited by the Universidad Nacional Autónoma de México, Autónoma de Tlaxcala y Veracruzana publishes original peer-review genetic toxicology, environmental pollution and toxicological research and reviews.

Speciality Journals: Health and Medical Sciences

Archives of Medical Research

Edited by Elsevier Science, publishes original peer-reviewed medical research grouped in three main categories: biomedical, clinical, and epidemiological.

Archivos de Cardiología de Mexico (Archives of Cardiology of Mexico)

Edited by the Nacional Institute of Cardiology. Publishes clinical and experimental cardiovascular research.

Gaceta Médica de México (Medical Gazette of Mexico)

Official organ of the National Academy of Medicine. Publishes, clinical, epidemiological, historical, and review articles.

Revista Ciencia (Science Journal)

Edited by the Mexican National Academy of Science. Publish members works with general scientific and humanistic interest.

Revista de Investigación Clínica (Journal of Clinical Research)

Edited by the National Institute of Medical Sciences and Nutrition and publishes clinical, biomedical and epidemiological research.

Revista del Instituto Nacional de Cancerología (Journal of the Nacional Institute of Cancer)

Edited by the Nacional Institute of Cancer and publishes clinical, epidemiological, and basic research on cancer.

Revista de la Facultad de Salud Pública y Nutrición (Journal ofthe Faculty of Public Health and Nutrition)

Edited by the Universidad Autonoma de Nuevo León, publishes epidemiological, clinical, and nutricional research.

Salud Mental (Mental Health)

Edited by the National Institute of Psychiatry, publishes clinical, basic, and epidemiological research related with the neuropsychiatric area.

Biological and Chemical Sciences

Acta botánica mexicana
Edited by the Instituto de Ecología

The objective of this journal is to disseminate the results of research carried out in different disciplines of botany, with an emphasis on the plants of Mexico.

Acta zoológica mexicana (nueva serie)
Edited by the Instituto de Ecología

Publishes original scientific research about terrestrial fauna in the fields of Behavior, Ecology, Physiology, Genetics, Morphology, Systematics and Zoogeography.

Bioquimia
Edited by the Mexican Association of Clinial Biochemistry

Publish original clinical laboratory research.

Ciencias marinas
Edited by the Instituto de Ciencias del Mar, UNAM

Publishes original research on all the areas of Marine Sciences.

Ciencia y Tecnología Alimentaria
Edited by the Mexican Society of Nutrition and Food technology

Publishes original research on subjects related with the food science and technology.

Hidrobiológica
Edited by the Universidad Autonoma Metropolitana

Publishes original research on hydrobiology, biology, and ecology of aquatic systems.

Journal of the Mexican Chemical Society
Edited by the Mexican Chemical Society

Publishes original contributions of research in all areas of the theory and practice of chemistry in its broadest context, as well as critical reviews.

Laborat Acta
Edited by Laborat Acta

Publishes experimental data and laboratory methodologies.

Revista mexicana de ciencias farmacéuticas
Edited by the Asociación Farmacéutica Mexicana (AFMAC)

Publishes scientific research, original technical information, and bibliographic research with interest for the pharmaceutical community.

Revista mexicana de biodiversidad
Edited by the Instituto de Biología, Universidad Nacional Autónoma de México

Publishes original work on systematics, biogeography, ecology, and evolution of American taxons.

General

Science and Development Magazine (Revista Ciencia y Desarrollo)

Edited by CONACYT mainly intended for science and technology communication.

Gaceta Ecológica (Ecological Gazette)

Edited by the National Ecology Institute with analysis of environmental subjects and environmental legislation.

Organizations (Non-Governmental)

Center for Judicial and Environmental Studies (Centro de Estudios Jurídicos y Ambientales)

Promotes the study, development, and application of the environmental legislation.
Av. Universidad 700-401
Colonia del Valle
México, D. F. 03650
Web: http://www.ceja.org.mx

Ecological Culture (Cultura Ecológica A.C.)

Develops toxicological and environmental legislation databases (local and national).
Magdalena 22-404
Colonia Del Valle
México D.F. 03100

Measoamerican Network of Biotic Resources (Red Mesoamericana de Recursos Bióticos)

International network of universities from Central-South México, Guatemala, Belice, Nicaragua, Honduras, El Salvador, Costa Rica y Panamá for teaching and research on regional biotic resources.
Web: http://www.redmeso.net

Mexican Association of Occupational Hygiene (Asociación Mexicana de Higiene Industrial)

Non-profit organization that trains and certifies industries. Holds annual meetings and paticipates in international events
Aquiles Elorduy No. 271
Col. Electricistas
México, D.F., C.P. 02060
Web: http://www.amhi.org.mx

Nacional Federation of Occupational Health (Federación Nacional de Salud en el Trabajo (FeNasTAC)

Non-profit organization that promotes research and training on Occupational Health. Organizes annual meetings to communicate and update information on Occupational Health.
Aquiles Elorduy 271
Col. Electricistas, CP 02060
México D.F., México
Web: http://www.fenastac.org

National Association of the Chemical Industry (Asociación Nacional de la Industria Química)

An association that represents 90% of the private production of chemicals. Has different committees: Environmental, Emergency System in the Transport for the Chemical Industry and Security and Hygiene.
Angel Urraza 505
Colonia del Valle
Mexico, D.F. 03650
Web: http://www.aniq.org.mx

Regional Laboratories of the Mesoamerican Network of Biotic Resources, Toxicology and Pollution (Red Mesoamericana de Recursos Bióticos, Toxicología y Contaminación)

To provide solutions for the toxicological and pollution problems of Mesoamérica region,
Jose Fernando Mendez Sanchez (Coordinator)
Email: fms@uaemex.mx
Web: http://www.redmeso.net/RMjun02/lab_reg/toxicologia.htm

Mexican Health Foundation (Fundación Mexicana para la salud)

Its mission is to contribute towards scientific and technological knowledge and to the study of health policies by promoting research, the development of highly qualified human resources and technological development.
Periférico Sur No. 4809
Col. El Arenal Tepepan, Deleg. Tlalpan
C.P. 14610, México, D. F.
Web: http://www.funsalud.org.mx

Pan American Health Organization (PAHO) in Mexico (Organización Panamericana para la Salud en México)

Blvd. Manuel Ávila Camacho 191, Piso 3, Of. 305
Col. Los Morales Polanco, CP 11510 México DF
Web: http://www.mex.ops-oms.org

Poison Control Centers

Red Nacional de Toxicologia (RETOMEX)
Nacional Toxicology Network

Participant Centers and Institutions in the different States:

Campeche State

Toxicological Center at "Dr. Manuel Campos" Hospital (Centro Toxicológico del Hospital "Dr. Manuel Campos")
Av. Boulevard s/n, Colonia Centro, Campeche, Campeche
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Fax: 55761-2594
Email: pgutierrezo@starmedia.com
Responsable: Dr. Porfirio Gutierrez Orozco

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(Hospital General de Torreón Coahuila de la S.S.A)
Departamento de Toxicología
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Fax: (52-871) 18-7606
Email: drtorres@avantel.net
Responsable: Dr. Adriana Torres Vega

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Email: rnunezd@uach.mx
Responsible (Responsible): Dr. René Nuñez Bautista

Autonomous University of Ciudad Juarez
(Universidad Autónoma de Ciudad Juárez)
Dirección General de Investigación y Post-grado
Departamento de Toxicología
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Phone: (52-656) 11-3655 al 59 ext. 36
Fax: (52-656) 11-2914
Email: erico@uacj.mx
Director (Directora): Dra. Edna M. Rico Escobar

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(Centro de Información Toxicológica Cruz Verde de Guadalajara)
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Fax: (52-3) 669-1325
Email: criatguadalajara@usa.net
Responsible (Responsable): Dra. Verónica Alejandra Guevara González

Mexico City
Pediatric Hospital at the "XXI Century Medical Nacional Center"
(Hospital de Pediatría "Centro Médico Nacional Siglo XXI- IMSS")
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Fax: 55761-2594
Email: ciatimss@yahoo.com.mx
Director (Directora): Dra. Patricia Escalante Galindo

"La Raza" Medical Center
(Centro Médico "La Raza")
Planta Baja Hospital General "Gaudencio González Garza"
Urgencias
Jacarandas esq. Vallejo s/n, Col. La Raza, Del. Atzcapozalco, CP. 02990, México, D.F
Phone: (52-55) 5724-5900 ext. 2042/2043
Responsible (Responsable): Dr. Miguel Andrade Padilla

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(Servicio de Información Toxicológica SINTOX)
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Fax: (52-55)-5-598-6666
Email: gdiaz@amifac.org.mx
Coordinator (Coordinador): Dr. Gabriel Díaz Izeta

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(Hospital Infantil de México "Federico Gómez")
Depto. de Toxicología adscrito a Urgencias
Dr. Márquez No. 162, Colonia Doctores, Del. Cuauhtémoc, CP 06720, México, D.F
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Fax: (52-55) 5761-8974
Email: olga_tox@yahoo.com
Responsible: (Responsable) Dra. Olga Balbina Martínez Pantaleón
Center for Toxicological Aid
(Centro de Atención Toxicológica "Venustiano Carranza")
Prolongación Río Churubusco esq. Ernesto P. Uruchurto, Col. Adolfo López Mateos, Del. Venustiano Carranza, CP. 15970, México, D.F

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Phone: (52-55)-5659-6548
Fax: (52-55)-5659-1355
Email: wilfredoq@prodigy.net.mx
Responsible: (Responsable) Dr. Wilfredo Quiñones Leyva

Pharmacosurveillance system for pharmacological intoxication
(Sistema de Farmacovigilancia sobre intoxicaciones por medicamentos (GLAXO-WELCO))
Calzada México-Xochimilco No. 4900, San Lorenzo Huipilco, CP. 14370, México, D.F
Phone: (52-55)-5676-2885
Fax: (52-55)-5676-2885
Responsible: (Responsable) Dr. Víctor Reyes Maldonado

Xochimilco Center for Toxicological Aid (only for drug or alcohol abuse)
(Centro de Atención Toxicológica "Xochimilco")
(Unicamente intoxicados por drogas y alcohólicos)
Prolongación División del Norte y Av. México, Colonia San Marcos, Huichapan, Xochimilco, CP. 16030, México, D.F.
Phone: (52-55)-5728-5281/01-800-705-8000
Responsible: (Responsable) Dr. José Antonio Galindo López

Michoacán State
Toxicological Center of Michoacan State
(Centro Toxicológico en el Estado de Michoacán)
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Email: toximich@hotmail.com
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Nayarit Health Services
(Servicios de Salud de Nayarit)
Centro Regional de Toxicología de Nayarit
Dr. Gustavo Baz # 33, CP. 06300, Tepic, Nayarit
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Fax: (52-32)-13-1180
Responsible: (Responsable) Dra. Bertha Elizabeth Lara García

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Departamento de Urgencia
Carret. México-Laredo esq. Ángel Oliva, Fraccionamiento Oxitipa, CP 79060, Cd. Valles, San Luis Potosí
Phone: (52-138)-1-3210–12
Fax: 52-55761-2594
Email: metellez61@hotmail.com
Responsible (Responsable): Dr. Mario Enrique Téllez Ramos

Sinaloa State
Cualiacan "Bernardo J Gastelum" General Hospital
(Hospital General de Culiacán "Bernardo J. Gastelum" S.S.A.)
Unidad de Atención Médica Toxicológica
Aldama y Nayarit s/n, Colonia Rosales, Culiacán, Sinaloa
Phone: (52-67)-16-8560/16-8565
Fax: (01-67)-16-9851
Email: dauttleyvajg@hotmail.com
Responsible (Responsable): Dr. José Guadalupe Dautt Leyva

Sonora State
Sonora General Hospital
(Hospital General de Sonora)
Centro Toxicológico
Blvd Luis Encinos s/n, Colonia Centro, CP. 83000, Hermosillo, Sonora
Phone: (01-62)-13-2556
Responsible (Responsable): Dr. Manuel de Jesús Tellechea Rascón

Tabasco State
"Dr. Gustavo Rovirosa Pérez" Hospital
(Hospital "Dr. Gustavo Rovirosa Pérez")
Coordinación Urgencias
Departamento de Toxicología
Calle Tres s/n, Colonia el Recreo, Villahermosa, Tabasco

Phone: (01-93)-57-1111/57-0780/57-0872/(01-93)-57-0879 ext. 22
Fax: (01-93)-57-0780/57-0781
Responsible (Responsable): Dr. Manuel Antonio Peña Vidal

Tamaulipas State
"Mano con Mano" Reynosa General Hospital
(Hospital General de Reynosa "Mano con Mano")
Centro Toxicológico
Alvaro Obregón s/n, Colonia La Presa, Reynosa, Tamaulipas
Phone: (01-89)-26-3104
Fax: (01-89)-26-3004 ext. 241
Email: familia_balboa@hotmail.com
Responsible (Responsable): Dr. Alfredo Balboa Bustamante

Veracruz State
Veracruz Health Service
Servicios de Salud de Veracruz
Hospital General de Veracruz
Centro de Información Toxicológica de Veracruz
20 de Noviembre No. 1074, Colonia Centro, CP. 91700, Veracruz, Veracruz
Phone: (01-229)-932-9753/(01-229)-931-7848
Fax: (01-299)-932-2705
Email: citver@terra.com.mx
Responsible (Responsable): Dr. Manuel Salazar Ortega

Yucatán State
Yucatán Autonomous University
(Universidad Autónoma de Yucatán)
Facultad de Medicina
Av. Itzaes No. 498, Colonia Centro, CP 97000, Mérida, Yucatán
Phone: (01-99)-28-5985
Fax: (01-99)-23-3297
Email: gnavar@tunku.uady.mx
Responsible (Responsable):Dra. Rosa Leticia González Navarrete

Redtox.org
Centers of Information for the Control and Treatments of Intoxications with Animal Poisons (Centros de Información para el Control y Tratamiento de intoxicaciones con animals ponzoñosos)
Center Leon, Guanajuato (Centro León, Guanajuato)
Responsible: Alfredo Luis Chavez Haro
Phone: 52-477-670-2185

Center Campeche (Centro Campeche)
Hospital General de Campeche "Dr. Álvaro Vidal Vera", Circuito Baluartes x av central s/n, Col. Centro, Campeche
Phone: 52-981-816-4233

Center Durango (Centro Durango)
Cuahutemoc No. 225 Norte Zona Centro CP. 34000, Durango, Durango
Phone: 52-618-8-18-24-80

Center Tampico, Tamaulipas (Centro Tampico, Tamaulipas)
Hospital General Carlos Canseco, SSA. Av. Ejército Mexicano No. 1403, Col. Allende C.P. 89130, Tampico, Tamaulipas
Phone: 52-833-2181-330

Sistema de Emergencias en Transporte para la Industria Química. SETIQ (Emegency System in the Transport for the Chemical Industry)
Angel Urraza 505, Colonia del Valle, México, 03100, D.F.
Contacto Institucional (Contact)
Ing. Miguel Benedetto
Director General de la
Asociación Nacional de la Industria Química Ing. Ulises López
Gerente del SETIQ
Phone: +52-(55)-5575-0838
Fax: +52-(55)-5575-0842
Email:ulopez@aniq.org.mx Web: http://www.aniq.org.mx/setiq/index.asp

Scientific Societies

Sociedad Mexicana de Bioquímica (Mexican Society of Biochemistry)
Instituto de Fisiología Celular, UNAM
Apartado Postal 70-600
04510 Mexico D.F.
Email: infosmb@ifc.unam.mx

Sociedad Mexicana de Toxicologia, A.C (Mexican Society of Toxicology)
Contact:
Dr. Jorge Alberto Alvarado Mejía, President
Facultad de Medicina, Universidad Autónoma de Yucatán
Av. Itzaes No. 498 × 59-A
97000 Mérida, Yucatán, México
Email: amejia@tunku.uady.mx
Web: http://www.somtox.unam.mx/somtox

Capitulo México de Society for Environmental Toxicology and Chemistry (SETAC) (Mexican Chapter for the SETAC)
División de CBS
Universidad Autónoma Metropolitana-Unidad Iztapalapa
AP. Postal 55-535, 09740 México, D.F.

Contact:
Dr. Patricia Ramírez Romero
Presidenta
Phone: (55)-58-04-64-93
Email: patt@xanum.uam.mx

Toxicology Laboratories

Laboratorio de Toxicología del Centro de Investigación Biomédica del Oriente
Calle 19 Sur No. 4717
C. P. 72340 Puebla
México
Contacto Institucional
Dr. Juan Manuel Gallardo Montoya
Director
Phone: (22)-439410/(22)-400959
Email: labtox@yahoo.com
Web: http://labtox.blogspot.com

Laboratorio de Toxicología Clínica y Ambiental
Departamento de Farmacología y Toxicología
Facultad de Medicina, Universidad Autónoma de Nuevo León
Ave. Gonzalitos 235 Norte, Primer Piso
Col. Mitras Centro. Monterrey N.L.
C. P. 64460
Contacto Institucional
Dr. med. Oscar Torres Alanís
Phone: (+52-81)-8348-5147/8348-6883/8348-6936
Fax: (+52-81)-8348-7763
Email: otorres@ccr.dsi.uanl.mx

Laboratorio de Toxicología
Centro Regional de Información y Atención Toxicológica CRIAT – Ayuntamiento de Guadalajara
Cruz Verde de Guadalajara
Av. Los Angeles esq. Analco
Unidad Administrativa Reforma, Col. Las Conchas
C. P. 44460, Guadalajara, Jal.
México
Contacto Institucional
Dr. Gildardo David Flores Robles
Coordinador
Directo: (333)-6691338
Conmutador: (333)-6691320–25 Ext. 1338
Email: criatguadalajara@usa.net; sangildardo@yahoo.com.mx

Sección Externa de Toxicología – Centro de Investigación y de Estudios Avanzados del IPN (CINVESTAV-IPN)
Av. IPN 2508 esq. Ticomán, Colonia Zacatenco,
México D.F., C.P.07360
Contacto Institucional
Dr. Arnulfo Albores
Jefe de la Sección
Dr. Guillermo Elizondo Azuela
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Phone: +52-55-5061-3307 (Jefatura), +52-55-5061-3800 Ext. 5421.
Fax: desde México: 01-55-5061-3395, desde otros países +52-55-5061-3395
Email: aalbores@cinvestav.mx; gazuela@cinvestav.mx
Web: http://www.cinvestav.mx/toxicologia/

Servicio Médico Forense
Niños Héroes No. 102
Colonia Doctores, CP 06720
México D.F.
Contacto Institucional
Dr. Felipe Takajashi Medina
Director de SEMEFO
Quim. Adrián Waldo Capetillo
Responsable del laboratorio:
Phone: 51-34-13-60 (dirección); 51-34-13-95 (laboratorio)
Email: adrianwaldo@hotmail.com

Departamento de Toxicología Ambiental
Avenida Venustiano Carranza No. 2405
Codigo Postal 78210, San Luis Potosí
México
Contacto institucional
Dr. Fernando Díaz Barriga
Director
Phone: 52-444-8262354
Fax: 52-444-8262354
Email: fdia@uaslp.mx

Laboratorio de Toxicología Pre-clínica
Escuela Nacional de Ciencias Biológicas
Instituto Politécnico Nacional
Prolongación Carpio y Plan de Ayala S/N
Colonia Casco de Santo Tomás
México DF. CP 11340
Contacto institucional:
Dr. Germán Chamorro Cevallos
Responsible:
Phone: 53-968929 (directo)/57-296300 ext. 62345
Fax: 53-968929
Email: gchamcev@yahoo.com.mx
Web: http://www.ipn.mx

Laboratorio de Patología Clínica S.A. de C.V.
Zaragoza No. 213
Centro, Oaxaca
Oaxaca, México
Contacto institucional
Dr. Eduardo Pérez Ortega
Responsible
Phone: 01-951-5161140
Fax: 01-951-5161140

Email: Eduardo@laboratorio.com.mx
Web: http://www.laboratorio.com.mx

Laboratorio Galindo S.C.
Avenida Juarez 501-A, Esq. Constitución,
Centro, Oaxaca
Oaxaca, México
Contacto institucional
Phone: 01-951-5161303/01-951-5010788
Web: http://www.labgalindo.com.mx

Procuraduría General de la Justicia San Antonio de la Cal, Oaxaca
Oaxaca
México
Contacto institucional
Quim. Genaro Torres Santos
Responsible
Phone: 01-951-5115770

Legislation and Regulations

These General Laws are effective after their publication at the *Diario Oficial* where people can have access to the texts. That is why the date of publication is given. They can also be accessed at: www.cem.itesm.mx/derecho/nlegislacion/federal/index.html/.

General Law of Health (Ley General de Salud), Diario Oficial de la Federación 7 de febrero de 1984).

General law for the ecologic equilibrium and environmental protection (Ley general para el equilibrio ecológico y la protección ambiental), Diario Oficial de la Federación 28 de enero de 1988)

Law of national waters (Ley de aguas nacionales), Diario Oficial de la Federación 1 de Diciembre de 1992).

The below regulations as well as many others can be consulted at: www.semarnat.gob.mx/leyesynormas/pages/inicio.aspx.

General law for the prevention and integral management of waste (Ley General para la prevención y gestion integral de residuos, Diario Oficial de la Federación 8 de octubre de 2003)

NOM-001-Semarnat-1996 Establece los límites máximos permisibles de contaminantes en las descargas de aguas residuales en aguas y bienes nacionales (Regulation for the concentration limits of pollutants in residual waters discharges)

Education/Schools

In various Mexican university faculties, such as chemistry, medicine, and veterinary colleges, and some biology, the discipline of toxicology is studied within the normal curriculum and also as monographic courses. Lately several private and public institutions offer college degrees in Environmental Sciences such as the Centro de Investigación en Ecosistemas at the Universicad Nacional Autónoma de México (www.oikos.unam.mx/licenciatura/index.html), the Technological Institute of Sonora which offers a degree in Environmental Engineering (www.itson.mx/OfertaAcademica/ica.html), the University of Mexico State offers a college degree in Environmental Sciences at the Faculty of Urban and Regional Planning (www.uaemex.mx/pestud/licenciaturas/CAmbientales.html). Food toxicology is currently taught at several university departments within the new Food Science and Technology degree programs. Different university faculties and professional societies provide monographic courses and specialization programs for postgraduates. Some specific postgraduate programs are:

Postgraduate program on Toxicology at the Toxicology Section, CINVESTAV (www.cinvestav.mx/toxicologia)
Postgraduate program in Biomedical Sciences (www.pdcb.unam.mx/index.php), Biological, Chemical and Biochemical Sciences at the Universidad Nacional Autónoma de Mexico, UNAM (www.posgrado.unam.mx/programas/alfabetico.html)
Multidisciplinary Program of Postgraduate Program in Environmental Sciences at the Autonomous University of San Luis Potosí. (www.uaslp.mx)

Postgraduate studies in Environmental Sciences:
Universidad Autonoma del Estado de México (www.uaemex.mx/pestud/mae_doc/ciencias%20ambientales/index.html)´
Benemérita Universidad Autonoma de Puebla (www.csambientales.buap.mx/posgrados/index.html

Environmental toxicology and restoration is an area of interest in several postgraduate programs in science and engineering. The Universidad Nacional Autónoma de México has an Environmental Program called PUMA (www.puma.unam.mx) that promotes research, education, and publications in hazardous waste management, air, and soil pollution, etc.
Most of the programs in toxicology, environmental sciences and related areas offered by the different

educational institutions can be accessed at: http://agenda.universia.net.mx/

ACKNOWLEDGMENTS

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References

de la Cruz, M (1964) Libellus de Medicinalibus Indo-rum Herbis. ManuscritoAzteca de 1552, según traducción latina de Juan Badiano. Versión Española con estudios y comentarios por diversos autores (encabezados por Efren C. del Pozo). Instituto Mexicano del Seguro Social, México.

del Pozo, EC (1948) Aztec Pharmacology. Ann. Rev. Pharmacol. 94.

CHAPTER

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The Netherlands

YURI BRUINEN DE BRUIN AND JACQUELINE VAN ENGELEN

SHORT HISTORY OF TOXICOLOGY IN THE NETHERLANDS

The First Developments (1800–1950)

Before World War II, toxicological research in The Netherlands was dispersed over several institutions. The first lecturer in toxicology was the physician A.W.M. van Hasselt (1814–1902), who taught toxicology at the State Military Training Hospital. In 1848 he published a book entitled *De noodzakelijkheid van algemeen toezigt op het gebruik van vergiften* (The Need to Regulate the Use of Venoms). Although Van Hasselt contributed significantly to the training and practical skills of physicians, he did not succeed in establishing continuity in the practice of toxicology.

The first professor of toxicology at Leiden University was the pharmacist E.A. van der Burg, who was appointed in 1877. His major accomplishment was the application of the emerging discipline of analytical chemistry in the confirmation of criminal poisoning. He established his name in the famous mass murder case of Goeie Mie ('good Mary') of Leiden in 1881–82. She poisoned at least 100 people, 27 of whom died, with the arsenic compound orpiment. This was confirmed by Van der Burg's analysis in exhumed bodies by means of the arsenic mirror method developed by Marsh some years before. Van der Burg and his successors continued to play a central role in forensic toxicology until the 1950 when the Central Laboratory of Forensic Sciences, now the Netherlands Forensic Institute, was founded.

Post 1950

Toxicology as a biomedical discipline emerged in The Netherlands after World War II. This process was invigorated on the one hand by the need to develop antidotes against chemical warfare agents, and on the other by the emergence of the chemical industry in The Netherlands and the need to protect the workforce and general population. The result was a prosperous growth of all aspects of toxicology in the Dutch universities, and industrial and governmental institutions. Among others, four people can be identified who have been instrumental in this development: Ernst M. Cohen (biological toxicology, TNO and Leiden University), Herman van Genderen (biological toxicology, RIVM and University of Utrecht), Ad N.P. van Heijst (clinical toxicology, RIVM and Utrecht University Hospital) and Reinier L. Zielhuis (occupational and environmental toxicology, University of Amsterdam) were pioneers each in his own field. The result was a flourishing toxicology community in The Netherlands, in which all aspects of the discipline were covered, ranging from molecular to public health aspects.

1979: Establishment of the Foundation of the Netherlands Society of Toxicology, Training and Accreditation

Toxicologists soon outnumbered the other professions in the Netherlands Society of Physiology and Pharmacology, necessitating the foundation of the Netherlands Society of Toxicology (NVT: *Nederlandse Vereniging voor Toxicologie)* in 1979. Within 10 years, the NVT, with a membership of 750, became the 4th largest toxicology society in the world, after the United States, Japanese, and British. In the 1980s, the NVT was the first European society to develop a system of postdoctoral training and accreditation, which

formed the model for the European registration as Eurotox Registered Toxicologist.

2007: Current Situation of Toxicology in the Netherlands

At present, toxicology is practiced in a broad sense with the aim to protect man and its environment. Major subfields of toxicology consist of Nutrition Toxicology, Medicinal Toxicology, Occupational Toxicology, Genetic Toxicology, Environmental Toxicology, Teratology and Reproductive Toxicology, Toxicological Pathology, Toxicology and Risk Assessment and In-Vitro Toxicology.

The education and registration of toxicologists remain an important area of the Netherlands Society of Toxicology, which actively encourages the education in toxicology at all universities. After completion of education there are two ways to register as a toxicologist in the Netherlands. The first route – primarily the route followed by PhD – students with additional training with post-doctoral education in toxicology proceeds via the Dutch 'Association for Education to Biomedical Scientific Research' (Dutch abbreviation: SMBWO) and leads to registration as Medical Biological Researcher-Toxicologist. The second route to registration as a toxicologist is operated by the Society itself. A detailed 'Concilicum Toxicologicum (CT)' specifies all requirements to qualify for registration. Every 5 years the registration has to be renewed. A registration committee and an independent committee of appeal have been established.

Recently, a number of toxicology departments at several universities and university medical centres had to stop their activities. This development conflicts with the current increasing (international) need for well-trained toxicologists working for the Dutch Universities and research and policy support and implementation institutions like the RIVM, TNO, Notox and other private and governmental organizations. The Netherlands Society of Toxicology is undertaking major efforts to fulfill these needs and to return toxicology to the flourishing position it held in previous years.

RESOURCES

Books

Chemiekaarten, gegevens over veilig werken met chemicaliën (Datasystem Concerning Chemicals and Safe Working Conditions), 11th Ed.
(1995) Samson HD Tjeenk Willink, Alphen a/d Rijn
ISBN: 90-6092-804-0

Chemische feitelijkheden – actuele chemische encyclopedie – (single papers) Chemical Facts – Updated Chemical Encyclopedia)
(1996) KNCV, Den Haag

Henderson PTh, Borm PJA, Kant IJ (1995)
Basisboek Arbeidstoxicologie: isico-inventarisatie en-evaluatie (Textbook on Occupational Toxicology: Risk Assessment and Evaluation)
Kerkebosch bv: Zeist
ISBN 90-6720-156-1

Henderson PTh, Van Bladeren PJ, Vermeulen NPE (1992)
Biotransformatie en toxicokinetiek (Biotransformation and Toxicokinetics)
Pudoc: Wageningen
ISBN 90-220-1036-8

Koeman JH (1991)
Algemene inleiding in de toxicologie (General Introduction to Toxicology), 2nd Edn.
Pudoc: Wageningen
ISBN 90-220-0968-8

Nationaal Millieubeleidsplan – Kiezen of Verliezen (National Environmental Policy – Choose or Lose) (1990)
SDU: Den Haag
ISSN 0921-7371

Nationale MAC lijst (National TLV – values)
(1999)
Ministerie Sociale Zaken en Werkgelegenheid SDU: Den Haag
ISBN 90-12-08678-7

Copius Peereboom JW (Ed.) (1994)
Basisboek Milieu en Gezondheid (Textbook on Environment and Health)
Boom: Amsterdam
ISBN 90-53-52-048-1

van Leeuwen CJ, Hermens JLM (1995)
Risk Assessment of Chemicals: An Introduction
Kluwer Academic Publishers: Dordrecht/Boston/London
ISBN 0-7923-3740-9 (update in preparation)

Van Loveren H, Vos JG (1991)
Toxicologie van het immuunsysteem (Toxicology of the Immune System)
Pudoc: Wageningen
ISBN 90-220-1035-X

Verberk MM, Zielhuis RL (1990)
Voedsel in Beweging (Food on the Move)
Van Dokkum: Wen Van der Heij, DG
ISBN 90-220-1034-1

Journals

Although no journals concentrate exclusively on toxicology, relevant articles may be found in the following:

Chemie magazine
Magazine on topics related to chemistry.
Web: http://www.vnci.nl/actueel/chemiemagazine/default.asp (Dutch only)

Chemisch2Weekblad
Magazine for professionals in chemistry, life sciences, laboratory, and process technology.
Web: http://www.c2w.nl/Default.lynkx?id=5 (Dutch only)

Natuur, wetenschap & techniek
Magazine about nature sciences and technology.
Web: http://www.natutech.nl/ (Dutch only)

Nederlands tijdschrift voor geneeskunde (Netherlands Journal of Medicine)
Web: http://www.ntvg.nl/ (Dutch only)

Pharmaceutische weekblad
Weekly magazine for pharmacists.
Web: http://www.pw.nl/ (Dutch only)

Tijdschrift Kanker
Journal about cancer research and therapy.
KBU Uitgevers B.V.: Oisterwijk

Tijdschrift voor Bedrijfs – en verzekeringsgeneeskunde
Magazine to promote the science of professional insurance medicine covering scientific and monitoring research
Bohn, Stafleu & Van Loghum: Houten
ISSN 0929-600X

Tijdschrift voor diergeneeskunde
Veterinary journal
Web: http://www.knmvd.nl/tvd (Dutch only)

Tijdschrift voor sociale gezondheidszorg
Bi-weekly journal of social health care
Web: http://www.onderzoek.hva.nl/artefact-1018.892.html (Dutch only)

Technical Reports and Other Documents

Chemical maps
Safety information on chemical substances.
Web: http://chemiekaarten.sdu.nl/do/home (Dutch only)

Health Council
Reports related to issues relating to public health
Web: http://www.gr.nl/adviezen.php (English and Dutch)

Databases

National Database of Dangerous substances used in Healthcare
Web: https://www.databankzorg.nl/action/home;jsessionid=5C6D41919D08A3199A159194DE81C796) (Dutch only)

Organizations (Government)

Biosafety Clearing-House
Information exchange mechanism on Biosafety.
Web: http://www.vrom.nl/ggo-vergunningverlening/ (English and Dutch)
Postal address: P.O. Box 1, 3720 BA Bilthoven, The Netherlands
Phone: +31-(0)30-2742793
Fax: +31-(0)30-2744401
Email: bggo@rivm.nl

Chemical Substances Bureau
Performs national legal tasks with respect to New and Existing Chemicals.
Web: http://www.rivm.nl/bms/english/ (English)
Web: http://www.rivm.nl/bms/over_bms/ (Dutch)
Postal address: P.O. Box 1, 3720 BA Bilthoven, The Netherlands
Phone: +31-(0)30-2744077
Fax: +31-(0)30-2744401
Email: bms.ns@rivm.nl (new substances), bms.bs@rivm.nl (existing substances)

Food and Consumer Product Safety Authority
Monitors food and consumer products to safeguard public health and animal health and welfare.
Web: http://www2.vwa.nl/portal/page?_pageid=35,1554211&_dad=portal&_schema=PORTAL (English)
Web: http://www2.vwa.nl/portal/page?_pageid=35,1554060&_dad=portal&_schema=PORTAL (Dutch)
Postal address: P.O. Box 19506, 2500 CM Den Haag, The Netherlands
Phone: +31-(0)70-4484848
Fax: +31-(0)70-4484747
Email: info@vwa.nl.

InfoMil
Information centre for the environment to intermediate between authorities and target groups.
Web: http://www.infomil.nl/aspx/get.aspx?xdl=/views/infomil/xdl/page&ItmIdt=28225&SitIdt=111&VarIdt=46 (English)
Web: http://www.infomil.nl/aspx/get.aspx?xdl=/views/infomil/xdl/page&ItmIdt=28063&SitIdt=111&VarIdt=46 (Dutch)

Postal address: P.O. Box 93144, 2509 AC Den Haag, The Netherlands
Phone: +31-(0)70-3735575
Fax: +31-(0)70-3735600

Ministry of Agriculture
Nature and food quality policy making on food production.
Web: http://www9.minlnv.nl/servlet/page?_pageid=163&_dad=portal30&_schema=PORTAL30 (English)
Web: http://www9.minlnv.nl/servlet/page?_pageid=78&_dad=portal30&_schema=PORTAL30 (Dutch)
Postal address: PO Box 20401, 2500 EK Den Haag, The Netherlands
Phone: +31 (0)70 3786868

Ministry of Health, Welfare and Sport (VWS)
Promotion of health, social infrastructure and sport.
Web: http://www.minvws.nl/en/ (English)
Web: http://www.minvws.nl/ (Dutch)
Postal address: P.O. Box 20350, 2500 EJ Den Haag, The Netherlands
Phone: +31-(0)70-3407911
Fax: +31-(0)70-3407834

Ministry of Housing, Spatial Planning and the Environment (VROM)
Policy making on Housing, Spatial Planning and the Environment.
Web: http://international.vrom.nl/pagina.html?id=7318 (English)
Web: http://www.vrom.nl/pagina.html?id=1 (Dutch)
Postal address: P.O. Box 20951, 2500 EZ Den Haag, The Netherlands
Phone: +31-(0)70-3395050 (Monday to Friday 9.00–21.00 h)

Ministry of Social Affairs and Employment
Encouragement of employment, modern industrial relations and social security.
Web: http://www.employment.gov.nl/ (English)
Web: http://home.szw.nl/index/dsp_index.cfm (Dutch)
Postal address: P.O. Box 90801, 2509 LV Den Haag, The Netherlands
Phone: +31-(0)70-3334444
Fax: +31-(0)70-3334033

Ministry of Transport, Public Works and Water Management
Responsible for mobility policy in the Netherlands and for protection against floods or falling water tables.
Web: http://www.verkeerenwaterstaat.nl/?lc=uk (English)
Web: http://www.verkeerenwaterstaat.nl/?lc=nl (Dutch)
Postal address: P.O. Box 20901, 2500 EX Den Haag, The Netherlands
Phone: +31-(0)88-4890000 (Monday–Friday 09.00–17.00 h)
Email: venwinfo@PO Box51.nl

RIZA, Institute for Inland Water Management and Waste Water Treatment
Research advisory body for inland water and international integrated water management.
Web: http://www.rijkswaterstaat.nl/rws/riza/home/english/index.html (English)
Web: http://www.rijkswaterstaat.nl/rws/riza/home/home.html (Dutch)
Postal address: P.O. Box 17, 8200 AA Lelystad, The Netherlands
Phone: +31-(0)320-298411
Fax: +31-(0)320-249218
Email: rizarws@riza.rws.minvenw.nl

Municipality Healthservice
Promotion of public health care.
Web: http://www.ggd.nl/kennisnet/statpagina/show_pagina.asp?dmod=statpagina&paginanr=101&style=1&headerparam=1017 (Dutch only)
Postal address: P.O. Box 85300, 3508 AH Utrecht, The Netherlands
Phone: +31-(0)30-2523004
Fax: +31-(0)30-2511869
Email: helpdesk@ggdkennisnet.nl

National Institute for Public Health and the Environment
Research to public and environmental health via a 'centre for infectious diseases', and divisions on 'public health', 'nutrition, medicines, and consumer safety', and 'environmental safety'.
Web: http://www.rivm.nl/en/ (English)
Web: http://www.rivm.nl/ (Dutch)
Postal address: P.O. Box 1, 3720 BA Bilthoven, The Netherlands
Phone: +31-(0)30-2749111
Fax: +31-(0)30-2742971
Email: info@rivm.nl

Netherlands Environmental Assessment Agency
Advises the Dutch government on a wide variety of environmental issues from a scientific base built on knowledge and expertise.
Web: http://www.mnp.nl/en/index.html (English)
Web: http://www.mnp.nl/nl/index.html (Dutch)
Postal address: Antonie van Leeuwenhoeklaan 9, 3721 MA Bilthoven, The Netherlands
Phone: +31-(0)30-2742745
Fax: +31-(0)30-2744479
Email: info@mnp.nl.

Netherlands Forensic Institute
Technical and scientific research for the purpose of crime solving.
Web: http://www.forensischinstituut.nl/NFI/en (English)
Web: http://www.forensischinstituut.nl/NFI/nl (Dutch)
Postal address: P.O. Box 24044, 2490 AA Den Haag, The Netherlands
Phone: +31-(0)70-8886666
Fax: +31-(0)70-8886555
Email: info@nfi.minjus.nl

Royal Netherlands Institute for Sea Research (NIOZ)
Promotion of multidisciplinary marine research in coastal and shelf seas as well as in the open ocean covering biology, toxicology, biochemistry.
Web: http://www.nioz.nl/nioz_nl/fe091c5f4f44361f88aa41f8a230a729.php (English)
Web: http://www.nioz.nl/ (Dutch)
Phone: +31-(0)222-369300

The Health Council of the Netherlands
Advisory body for Ministers and Parliament in the field of public health.
Web: http://www.gr.nl/index.php?phpLang=en (English)
Web: http://www.gr.nl/missie.php?phpLang=nl (Dutch)
Postal address: P.O. Box 16052, 2500 BB Den Haag, The Netherlands
Phone: +31-(0)70-3407520
Fax: +31-(0)70-3407523
Email: info@gr.nl

The State Inspectorate of Health
Protects and promotes health and healthcare.
Web: http://www.igz.nl/uk/ (English)
Web: http://www.igz.nl/ (Dutch)
Postal address: P.O. Box 2680, 3500 GR Utrecht, The Netherlands
Phone: +31-(0)88-1205000 (Monday–Friday 9:00–17:00 h)
Fax: +31-(0)88-1205001
Email: loket@igz.nl

VROM Inspection
Inspection of construction and demolition, waste treatment and dangerous substances
Web: http://www.vrom.nl/pagina.html?id=16535 (Dutch only)
Postal address: P.O. Box 20951, 2500 EZ Den Haag, The Netherlands
Phone: +31-(0)70-3395050 (Monday–Friday 9.00–21.00 h)

Organizations (Non-Government)

IVAM
Research agency in chemical risks, sustainable building, energy, chain management, quality of living and cleaner production.
Web: http://www.ivam.uva.nl/uk/index.htm (English)
Web: http://www.ivam.uva.nl/nl/index.htm (Dutch)
Postal address: P.O. Box 18180, 1001 ZB Amsterdam, The Netherlands
Phone: +31-(0)20-5255080
Fax: +31-(0)20-5255850
Email: office@ivam.uva.nl

KNAW, Royal Netherlands Academy of Arts and Sciences
Advising the government on research related to research quality assurance and promotion.
Web: http://www.knaw.nl/organisation/organisation.html (English)
Web: http://www.knaw.nl/index.html (Dutch)
Postal address: P.O. Box 19121, 1000 GC Amsterdam, The Netherlands
Phone: +31-(0)20-5510700
Fax: +31-(0)20-6204941
Email: knaw@bureau.knaw.nl

KNAW – Fungal Biodiversity Centre
Development of taxonomy and evolution of fungi and functional aspects of fungal biology and ecology applying molecular and genomics approaches.
Web: http://www.cbs.knaw.nl/index.htm (English)
Web: http://www.cbs.nl/nl-NL/default.htm (Dutch)
Postal address: P.O. Box 85167, 3508 AD Utrecht, The Netherlands
Phone: +31-(0)30-2122600
Fax: +31-(0)30-2512097
Email: info@cbs.knaw.nl.

KNAW – Hubrecht Laboratory
Research into developmental biology, strategic biomedical and genomics.
Web: http://www.niob.knaw.nl/ (English)
Web: http://www.niob.knaw.nl/index_nl.html (Dutch)
Postal address: Uppsalalaan 8, 3584 CT Utrecht, The Netherlands
Phone: +31-(0)30-2121800
Fax: +31-(0)30-2516464

Netherlands Genomics Initiative
Excellence research performed at 11 genomics centers on human and environmental health.
Web: http://www.genomics.nl/ (English only)
Postal address: P.O. Box 93035, 2509 AA Den Haag, The Netherlands
Phone: +31-(0)70-3440672/3440640
Fax: +31-(0)70-3440632
Email: info@genomics.nl

NIZO Food Research B.V.
Research into flavor, texture, health, food safety, and processing.
Web: http://www.nizo.nl/ (English only)
Postal address: P.O. Box 20, 6710 BA Ede, The Netherlands
Phone: +31-(0)318-659511
Fax: +31-(0)318-650400
Email: info@nizo.nl

NOW, Netherlands Organization for Scientific Research
National research council for the development of science, technology and culture in the Netherlands.
Web: http://www.nwo.nl/nwohome.nsf/pages/NWOP_5SME25_Eng (English)
Web: http://www.nwo.nl/nwohome.nsf/pages/NWOP_5SME25 (Dutch)
Postal address: P.O. Box 93138, 2509 AC Den Haag, The Netherlands
Phone: +31-(0)70-3440640
Fax: +31-(0)70-3850971
Email: nwo@nwo.nl

Sanquin Blood Supply Foundation
Supplies blood products, promotes transfusion medicine, and carries out research and training in immunology, immunohematology, and infectious diseases.
Web: http://www.sanquin.nl/sanquin-eng/sqn_home_eng.nsf/ (English)
Web: http://www.sanquin.nl/sanquin-nl/sqn_home_nl.nsf (Dutch)
Postal address: P.O. Box 9892, 1006 AN Amsterdam, The Netherlands
Phone: +31-(0)20-5123000
Fax: +31-(0)20-5123303
Email: website@sanquin.nl

TNO
Application of science to strengthen businesses and the government.
Web: http://www.tno.nl/tno/index.xml (English)
Web: http://www.tno.nl/tno/index.xml (Dutch)
Phone: +31-(0)15-2696900
Fax: +31-(0)15-2612403
Email: wegwijzer@tno.nl

TNO Built Environment and Geosciences
Spatial organization in the Netherlands including use of subsurface, mobility, the infrastructure, renewable energy, and intercity networks.
Web: http://www.tno.nl/bouw_en_ondergrond/index.xml (English and Dutch)

TNO Defence, Security and Safety
Building up the defense knowledge-base, such as military operations, military equipment, command and control and operational decision making, threat and protection, instruction and training and crime, calamity and terrorism combat.
Web: http://www.tno.nl/defensie_en_veiligheid/index.xml (English and Dutch)

TNO Quality of Life
Research into work and employment, chemistry, innovation, prevention and healthcare, pharma and food and nutrition.
Web: http://www.tno.nl/kwaliteit_van_leven/index.xml (English and Dutch)

TNO Science and Industry
Designing, engineering, planning, processing techniques and the management of the manufacturing process.
Web: http://www.tno.nl/industrie_en_techniek/index.xml (English and Dutch)

ZonMw
The Netherlands organization for health research and healthcare innovation.
Web: http://www.zonmw.nl/en/home.html (English)
Web: http://www.zonmw.nl/nl.html (Dutch)
Postal address: P.O. Box 93 245, 2509 AE Den Haag, The Netherlands
Phone: +31-(0)70-3495111
Fax: +31-(0)70-3495100
Email: info@zonmw.nl

Universities and Hospitals

Academic Medical Center (AMC)
Integrated academic hospital and medical center performing medical health research.
Web: http://www.amc.nl/index.cfm?sid=8 (English)
Web: http://www.amc.nl (Dutch)
Postal address: P.O. Box 22660, 1100 DD Amsterdam, The Netherlands
Phone: +31-(0)20-5669111

Amsterdam University
Research in areas among which are science and medicine.
Web: http://www.english.uva.nl/ (English)
Web: http://www.uva.nl/object.cfm (Dutch)
Postal address: P.O. Box 19268, 1000 GG Amsterdam, The Netherlands
Phone: +31-(0)20-5259111
Email: info@uva.nl

Delft University of Technology
Multidisciplinary research via research centers
Web: http://www.tudelft.nl/live/pagina.jsp?id=b226846d-f19f-4c34-97ed-165fecc5ad8f&lang=en (English)

Web: http://www.tudelft.nl/live/pagina.jsp?id=b226846d-f19f-4c34-97ed-165fecc5ad8f&lang=nl (Dutch)
Postal address: P.O. Box 5, 2600 AA Delft, The Netherlands
Phone: +31-(0)15-2785404
Fax: +31-(0)15-2781855
Email: voorlichting@tudelft.nl

Delft Centre for Life Science and Technology
Research into micro-organisms for food, medicines, and material production.
Web: http://www.tudelft.nl/live/pagina.jsp?id=8e492e6a-5d2b-4456-9647-fb21b7e088cf&lang=en (English only)
Postal address: Julianalaan 67, 2628 BC Delft, The Netherlands
Phone: +31-(0)15-2787156
Fax: +31-(0)15-2782355
Email: drclst@tudelft.nl

Safety Science Group
Development of tools to predict risk and risk perception
Web: http://www.tbm.tudelft.nl/live/pagina.jsp?id=6e6f2439-b657-4f31-a6dc-1787e92a86f6&lang=en (English)
Web: http://www.vk.tbm.tudelft.nl/live/pagina.jsp?id=6e6f2439-b657-4f31-a6dc-1787e92a86f6&lang=nl) (Dutch)
Postal address: P.O. Box 5015, 2600 GA Delft, The Netherlands
Phone: +31-(0)15-2785143
Fax: +31-(0)15-2784811
Email: info@tbm.tudelft.nl

TNW Department of Biotechnology
Design of new organisms, novel proteins, biocatalysts and new products for application in health care, chemical manufacture and environmental protection.
Web: http://www.bt.tudelft.nl/live/pagina.jsp?id=e327376f-7742-4725-baa7-fd7f2fa47a3d&lang=en (English only)
Postal address: Julianalaan 67, 2628 BC Delft, The Netherlands
Phone: +31-(0)15-2782342
Fax: +31-(0)15-2782355
E-mail: bpt@tnw.tudelft.nl

Eindhoven University of Technology
Fundamental/strategic technological research in areas such as Biomedical Engineering and Polymer Sciences and Technology.
Web: http://w3.tue.nl/en/ (English)
Web: http://w3.tue.nl/nl/ (Dutch)
Postal address: P.O. Box 513, 5600 MB Eindhoven, The Netherlands
Phone: +31-(0)-40 2479111

Eramus MC
University medical center specialized in individual to community health(care).
Web: http://www.erasmusmc.nl/content/englishindex.htm (English)
Web: http://www.erasmusmc.nl (Dutch)
Postal address: P.O. Box 2040, 3000 CA Rotterdam, The Netherlands
Phone: +31-(0)10-4639222 (hospital)
Email: info@erasmusmc.nl

NIHES – The Netherlands Institute for Health Sciences
Research training in medicine and the health sciences.
Web: http://www.nihes.nl/site/index.php (English only)
Postal address: P.O. Box 2040, 3000 CA Rotterdam, The Netherlands
Phone: +31-(0)10-4638450
Fax: +31-(0)10-4638451
Email: info@nihes.nl

FUGON, The Netherlands Federation for Innovative Drug Research (FIGON)
Promoting innovative drug research in the Netherlands.
Web: http://www.figon.nl/english/index.html (English)
Web: http://www.figon.nl/index.html (Dutch)
Postal address: P.O. Box 93245, 2509 AE Den Haag, The Netherlands
Phone: +31-(0)70-3495170
Fax: +31-(0)70-3495387
Email: selhorst@zonmw.nl

Leiden/Amsterdam Center for Drug Research (LACDR)
Advanced innovative drug research.
Web: http://www.lacdr.nl/index.php3?c=44&m=&session=(English only)
Postal address: P.O. Box 9502, 2300 RA Leiden, The Netherlands
Phone: +31-(0)71-5274341
Email: m.ham@chem.leidenuniv.nl

Leiden University Medical Center
Healthcare-oriented research and education for the faculties of Medicine and Biomedical Sciences
Web: http://www.lumc.nl/english/start_english.html (English)
Web: http://www.lumc.nl/ (Dutch)
Postal address: 9600, 2300 RC Leiden, The Netherlands
Phone: +31-(0)71-5269111
Email: informatie@lumc.nl

Maastricht University
Multidisciplinary themes and focal points via independent research institutes and participation in research schools.
Web: http://www.unimaas.nl/default.asp?taal=en (English)
Web: http://www.unimaas.nl/default.asp?taal=nl (Dutch)
Postal address: P.O. Box 616, 6200 MD Maastricht, The Netherlands
Phone: +31-(0)43-3882222
Email: communicatie@bu.unimaas.nl

Health Risk Analysis and Toxicology
Studying endogenous and exogenous (chemical) factors in relation to human health in particular to genetic and genomic effects.
Web: http://www.grat.unimaas.nl/ (English only)
Postal address: P.O. Box 616, 6200 MD Maastricht, The Netherlands
Phone: +31-(0)43-3881097
Fax +31-(0)43-3884146
Email: mc.vandevoort@grat.unimaas.nl

NUTRIM Nutrition and Toxicology Research Institute Maastricht
Research in the fields of nutrition and toxicology.
Web: http://www.nutrim.unimaas.nl/uk/01.html (English)
Web: http://www.nutrim.unimaas.nl/nl/01.html (Dutch)
Postal address: P.O. Box 616, 6200 MD Maastricht, The Netherlands
Phone: +31-(0)43-3881476
Fax: +31-(0)43-3670286
Email: Mh.Grispen@nutrim.unimaas.nl

Radboud University Nijmegen
Innovative and fundamental multidisciplinary research via independent research institutes.
Web: http://www.ru.nl/english/ (English)
Web: http://www.ru.nl/ (Dutch)
Postal address: P.O. Box 9102, 6500 HC Nijmegen, The Netherlands
Phone: +31-(0)24-3616161
Fax: +31-(0)24-3564606

Centre for Molecular Life Sciences (NCMLS)
Research into molecular medicine and cell biology.
Web: http://www.ncmls.nl/ (English only)
Postal address: P.O. Box 9101, 6500 HB, Nijmegen, The Netherlands
Phone: +31-(0)24-3610707
Fax: +31-(0)24-3610909
Email: info@ncmls.ru.nl

SENSE Research School
Joint venture of eight Dutch Universities for social economic and natural sciences of the environment.
Web: http://www.sense.nl/index.php?module=ContentExpress&func=display&ceid=4&menuID=M100000000 (English only)
Postal address: De Boelelaan 1087, 1081 HV Amsterdam, The Netherlands
Phone: +31-(0)20-5989532
Fax: +31-(0)20-5989553
Email: avando@sense.nl

Utrecht University
Research via faculties and institutes, thematic research programs, national research schools and top technological institutes, companies.
Web: http://www.uu.nl/uupublish/homeuu/homeenglish/1757main.html (English)
Web: http://www.uu.nl/uupublish/homeuu/1main.html (Dutch)
Postal address: P.O. Box 80125, 3508 TC Utrecht, The Netherlands
Phone: +31 (0)30 2533550

Academic Biomedical Centre Utrecht
Biomedical research, education, facilities, and bio-business.
Web: http://www.abc.uu.nl (English only)
Postal address: P.O. Box 80163, 3508 TD Utrecht, The Netherlands
Phone:+31-(0)30-2535804/+ 31-(0)6-54782612
Email: info@abc.uu.nl

Department of Pharmaceutics
Research into the development and use of medicines
Web: http://www.pharm.uu.nl/ffwuk.htm?/english/ (English)
Web: http://www.pharm.uu.nl/ffwnl.htm?/pharmaceutics/ (Dutch)
Postal address: P.O. Box 80082, 3508 TB Utrecht, The Netherlands
Phone: +31-(0)30-2537306
Fax: +31-(0)30-2517839

Institute for Risk Assessment Sciences
Research into Environment and Occupational Health, Toxicology and Public Health and Food Safety.
Web: http://www.iras.uu.nl/ (English only)
Postal address: P.O. Box 80.176, 3508 TD Utrecht, The Netherlands
Phone: +31-(0)30-2535400
Fax: +31-(0)30-2535077

University of Groningen
Research into multidisciplinary areas via research schools and institutes.

Web: http://www.rug.nl/corporate/index?lang=en (English)
Web: http://www.rug.nl/corporate/index (Dutch)
Postal address: P.O. Box 72, 9700 AB Groningen, The Netherlands
Phone: +31-(0)50-3639111
Email: communicatie@rug.nl

Groningen Research Institute of Pharmacy
Linking medical sciences with chemistry, biology and physics.
Web: http://www.rug.nl/farmacie/onderzoek/organisatieeninbedding/index?lang=en (English)
Web: http://www.rug.nl/farmacie/onderzoek/organisatieeninbedding/index (Dutch)
Postal address: P.O. Box 72, 9700 AB Groningen, The Netherlands
Phone: +31-(0)50-3639111
Email: vpr@bureau.rug.nl

Life Sciences & Medical Sciences
Research into Neurosciences & Behavior, Genomics, Bioinformatics, Biomolecular Sciences, Biotechnology, Biomolecular Sciences and Biotechnology, Ecology and Evolution, Drug research, Pathophysiology of Disease, Biomedical engineering, Healthcare
Web: http://www.rug.nl/Corporate/onderzoek/overzichtLifeSciences?lang=en (English)
Web: http://www.rug.nl/Corporate/onderzoek/overzichtLifeSciences?lang=nl (Dutch)
Postal address: P.O. Box 72, 9700 AB Groningen, The Netherlands
Phone: +31-(0)50-3635480/+31-(0)6-51702959
Email: communicatie@rug.nl

Wageningen University and Research Centre
An internationally leading education and research organization.
Web: http://www.wur.nl/UK/ (English)
Web: http://www.wur.nl/NL/ (Dutch)
Postal address: P.O. Box 9101, 6700 HB Wageningen, The Netherlands
Phone: +31-(0)317-477477
Fax: +31-(0)317-484884
Email: info@w ur.nl

Department of Toxicology
Toxicology research into food products, genetic polymorphism and lifestyle, biomarkers and risk assessment.
Web: http://www.tox.wur.nl/UK/ (English)
Web: http://www.tox.wur.nl/NL/ (Dutch)

Product Design and Quality Management
Research into food-related areas.
Web: http://www.pdq.wur.nl/UK/ (English)
Web: http://www.pdq.wur.nl/NL/ (Dutch)

RIKILT, Institute of Food Safety
Research into food quality, health, and the safety of food and animal feed.
Web: http://www.rikilt.wur.nl/UK/ (English)
Web: http://www.rikilt.wur.nl/NL/ (Dutch)
Postal address: P.O. Box 230, 6700 AE Wageningen, The Netherlands
Phone: +31-(0)317-475422
Fax: +31-(0)317-417717
Email: info.rikilt@wur.nl

Van Hall Instituut
University for Agriculture, Food Technology, and Environmental and Animal Sciences.
Web: http://www.vhall.nl/International/English/General/Index_Introduc.htm (English)
Web: http://www.vhall.nl/Hoofd.htm (Dutch)
Postal address: P.O. Box 1528, 8901 BV Leeuwarden, The Netherlands
Phone: +31-(0)58-2846100
Fax: +31-(0)58-2846423

VLAG
Research into food technology, nutrition, and health.
Web: http://www.vlaggraduateschool.nl/about.htm (English only)
Postal address: P.O. Box 8129, 6700 EV Wageningen, The Netherlands
Phone: +31-(0)317-485108/485751
Fax: +31-(0)317-483342
Email: vlag@wur.nl

The Centre for Human NutriGenomics
Research into genomics, nutrition, and human health.
Web: http://www.nutrigenomics.nl (English only)
Email: ingeborg.vanleeuwen-bol@wur.nl

Vrije Universiteit van Amsterdam
Research into multidisciplinary areas via research schools and institutes.
Web: http://www.english.vu.nl/home/index.cfm (Research only)
Postal address: De Boelelaan 1105, 1081 HV Amsterdam, The Netherlands
Phone: +31-(0)20-5987777
Fax: +31-(0)20-5985611
Email: international@dienst.vu.nl

Faculty of Earth and Life Sciences
Research into Biology, Biomedical Sciences, Public Health, and the Environment.
Web: http://www.falw.vu.nl/english/index.cfm (English)
Web: http://www.falw.vu.nl (Dutch)

Postal address: De Boelelaan 1085, 1081 HV Amsterdam, The Netherlands
Phone: +31-(0)20-5987000
Fax: +31-(0)20-6462457
Email: falw@falw.vu.nl

Faculty of Sciences, Group of Chemistry and Pharmaceutical Sciences
Research into chemistry and pharmaceutical sciences.
Web: http://www.chem.vu.nl/en/index.php (English)
Web: http://www.chem.vu.nl (Dutch)
Postal address: De Boelelaan 1083, 1081 HV Amsterdam, The Netherlands

Enterprise/Industry

Akzo Nobel
Research, development and manufacture of pharmaceuticals, coatings, and chemical products.
Web: http://www2.akzonobel.nl/company/ (English)
Web: http://www2.akzonobel.nl/nl/home/ (Dutch)
Postal address: P.O. Box 9300, 6800 SB Arnhem, The Netherlands
Phone: +31-(0)26-3664433
Fax: +31-(0)26-3663250

Biomedical Research – Primate Centre
Vital research that contributes to the identification and development of new medicines.
Web: http://www.bprc.nl/BPRCE/L2/HomeUK.html (English)
Web: http://www.bprc.nl/BPRCNL/L2/HomeNL.html (Dutch)
Postal address: P.O. Box 3306, 2280 GH Rijswijk, The Netherlands
Phone:+31-(0)15-2842500
Fax:+31-(0)15-2842600
Email: website@bprc.nl

DSM Life Science Products
Performance materials, industrial chemicals, nutritional products.
Web: http://www.dsm.com/en_US/html/about/about_us_home.htm (English)
Web: http://www.dsm.com/nl_NL/html/about/about_us_home.htm (Dutch)
Postal address: P.O. Box 6500, 6401 JH Heerlen, The Netherlands
Phone: +31-(0)45-5788111
Fax: +31-(0)45-5719753

KIWA NV
Certification and research with strong emphasis on water and energy, construction and infrastructure, mobility, feed and food, safety, environmental care and personal care.
Web: http://www.kiwa.nl/index_en.html (English)
Web: http://www.kiwa.nl/index_nl.html (Dutch)
Postal address:
Kiwa Certificatie, P.O. Box 70, 2280 AB Rijswijk, The Netherlands
Phone: +31-(0)70-4144400
Fax: +31-(0)70-4144420
Email: certif@kiwa.nl

Kiwa Water Research, P.O. Box 1072, 3430 BB Nieuwegein, The Netherlands
Phone: +31-(0)30-6069511
Fax: +31-(0)30-6061165
Email: alg@kiwa.nl

NOTOX
New drug, substance, and plant protection and biocidal product development.
Web: http://www.notox.nl/index.html (English only)
Postal address: P.O. Box 3476, 5203 DL's, Hertogenbosch, The Netherlands
Phone: +31-(0)73-6406700
Fax: +31-(0)73-6406799
Email: notox@notox.nl

Philips
Research into electrical engineering, physics, chemistry, mathematics, mechanics, information technology, and software.
Web: http://www.research.philips.com/index.html (English)
Web: http://www.philips.nl/about/research/index.html (Dutch)
Postal address: Boschdijk 525, 5621 JG Eindhoven, The Netherlands
Phone: +31-(0)40-2793333

Proctor & Gamble
Research into consumer product and food chemical safety.
Web: http://pg.com/company/who_we_are/globalops.jhtmlhttp://www.nl.pg.com/cgi-bin/display.cgi?p=Home (English)
Web: http://www.nl.pg.com/cgi-bin/display.cgi?p=Home (Dutch)
Postal address: Watermanweg 100, 3067 GG Rotterdam, The Netherlands
Phone: +31-(0)10-2863100
Email: externalcomm.im@pg.com

Shell Petrol Company
Shell focuses on risk management associated with their operations and products to improve health, safety, security, and environment performance.
Web: http://www.shell.com/home/Framework?siteId=home (English)

Web: http://www.shell.com/home/Framework?siteId=nl-nl (Dutch)
Postal address: P.O. Box 444, 2501 CK Den Haag, The Netherlands
Phone: +31-(0)70-3779111/3778743
Fax: +31-(0)70-3778745

Solvay Pharmaceuticals
Development of pharmaceuticals.
Web: http://www.solvaypharmaceuticals.com/ (English)
Web: http://www.solvaypharmaceuticals.nl/ (Dutch)
Postal address:
P.O. Box 900, 1380 DA Weesp, The Netherlands
Phone: +31-(0)294-477000
Fax: +31-(0)294-413906
P.O. Box 1, 8120, AA Olst, The Netherlands
Phone: +31-(0)570-568211
Fax: +31-(0)570-562899
P.O. Box 70, 3900 AB Veenendaal, The Netherlands
Phone: +31-(0)318-545754
Fax: +31-(0)318-529374
P.O. Box 501, 1380 AM Weesp, The Netherlands
Phone: +31-(0)294-465909
Fax: +31-(0)294-432423

Unilever
Production of food and consumer products.
Web: http://www.unilever.com/ (English)
Web: http://www.unilever.nl/ (Dutch)
Postal address: P.O. Box 160, 3000 AD Rotterdam, The Netherlands
Phone: +31-(0)10-4394911
Fax: +31-(0)10-4394311
Email: info.nl@unilever.com

Professional Societies

Association of the Dutch Chemical Industry
Web: http://www.vnci.nl/ (Dutch only)
Postal address: P.O. Box 443, 2260 AK Leidschendam, The Netherlands
Phone: +31-(0)70-3378787
Fax: +31-(0)70-3203903
Email: info@vnci.nl

Dutch Cosmetics Association (NCV)
Association of manufacturers and importers of cosmetics, or products for personal care.
Web: http://www.ncv-cosmetica.nl/index_en.asp (English)
Web: http://www.ncv-cosmetica.nl/index.asp (Dutch)
Postal address: P.O. Box 914, 3700 AX Zeist, The Netherlands
Phone:+31-(0)30-6049480
Fax: +31-(0)30-6049999
Email: info@ncv-cosmetica.nl

Dutch Society of Soap and Detergent Producers
Association of manufacturers and importers of washing and detergent products.
Web: http://www.nvz.nl/internet/pages/index.php (Dutch only)
Postal address: P.O. Box 914, 3700 AX Zeist, The Netherlands
Phone: +31-(0)30-6921880
Fax: +31-(0)30-6919394
Email: nvz@nvz.nl

Dutch Society of Pathology
Organization for clinical, animal, and experimental pathology.
Web: http://www.pathology.nl (Dutch only)
Postal address: P.O. Box 9101, 6500 HB Nijmegen, The Netherlands
Phone: +31-(0)24-3614323
Fax: +31-(0)24-3668750
Email: info@pathology.nl

Royal Netherlands Chemical Society (KNCV)
Professional organization for chemists and chemical engineers in The Netherlands.
Web: http://www.kncv.nl/ (Dutch only)
Postal address: P.O. Box 249, 2260 AE Leidschendam, The Netherlands
Phone: +31-(0)70-3378790
Fax: +31-(0)70-3378799
Email: kncv@kncv.nl

The Netherlands Society of Toxicology (NVT)
Promotion of science and applications in the field of toxicology, such as occupational toxicology, genetics, environment, teratology and reproduction, pathology, and risk assessment.
Web: http://www.toxicologie.nl/uk/index1.html (English)
Web: http://www.toxicologie.nl/ (Dutch)
Postal address: P.O. Box 249, 2260 AE Leidschendam, The Netherlands
Phone: +31-(0)70-3378797
Fax: +31-(0)70-3378799

Poison Control Centers

National Poisons Information Centre (NVIC)
Rapid health risk assessments of exposure to xenobiotic compounds.
Web: http://www.rivm.nl/en/aboutrivm/organization/mev/vic/index.jsp (English)
Web: http://www.rivm.nl/vergiftigingeninformatie/ (Dutch)
Postal address: P.O. Box 1, 3720 BA Bilthoven, The Netherlands
Phone: +31-(0)30-2508561
Email: nvic@rivm.nl

Legislation

ARBO
Information on safety and health at work.
Web:http://www.arbo.nl/deskundigen_eng.stm (English)
Web: http://www.arbo.nl/ (Dutch)

Dutch legislation
Web: http://wetten.overheid.nl/ (Dutch only)

Dutch Ministry of Agriculture
Development of policy in the fields of agriculture, nature and food quality.
Web: http://www9.minlnv.nl/servlet/page?_pageid=163&_dad=portal30&_schema=PORTAL30 (English)
Web: http://www9.minlnv.nl/servlet/page?_pageid=78&_dad=portal30&_schema=PORTAL30 (Dutch)

Dutch Ministry of Education, Culture and Science
Development of policy on education, culture, and science.
Web: http://www.minocw.nl/english/index.html (English)
Web: http://www.minocw.nl/ (Dutch)

Dutch Ministry of Foreign Affairs
Coordination of the Dutch government's foreign policy.
Web: http://www.minbuza.nl/default.asp?CMS_ITEM=12E5DC3F5E024ADFB2AA6B315606A627×2×31365×4 (English)
Web: http://www.minbuza.nl/default.asp?CMS_ITEM=4C61BF16924C4D658AB165C98A7E41CBX1×46723×73 (Dutch)

Dutch Ministry of Health, Welfare and Sport
Development of policy in the fields of health care, social care, and sports.
Web: http://www.minvws.nl/en/ (English)
Web: http://www.minvws.nl/ (Dutch)

Dutch Ministry of Housing, Spatial Planning and the Environment (VROM)
Development of policy on housing, spatial planning, and the environment.
Web: http://international.vrom.nl/pagina.html?id=7318 (English)
Web: http://www.vrom.nl/pagina.html?id=1 (Dutch)

Dutch Ministry of Social Affairs and Employment
Development of policy on employment.
Web: http://www.employment.gov.nl/ (English)
Web: http://home.szw.nl/index/dsp_index.cfm (Dutch)

European Legislation
Web: http://europa.eu.int/eur-lex/lex/en/index.htm (English)
Web: http://europa.eu.int/eur-lex/lex/nl/index.htm (Dutch)

Food and Consumer Product Safety Authority
Monitors food and consumer products to safeguard public health and animal health and welfare.
Web: http://www2.vwa.nl/portal/page?_pageid=35,1554211&_dad=portal&_schema=PORTAL (English)
Web: http://www2.vwa.nl/portal/page?_pageid=35,1554060&_dad=portal&_schema=PORTAL (Dutch)

Miscellaneous Resources

National Initiatives

ConsExpo, Human Exposure to Consumer Products
Tool to mathematically predict human exposure to consumer products.
Web: http://www.rivm.nl/en/healthanddisease/productsafety/Main.jsp (English)
Web: http://www.rivm.nl/rvs/overig/risico/methoden/ConsExpo.jsp (Dutch)

Postgraduate Education in Toxicology
Co-operation program between six Dutch universities offering a yearly Postgraduate Education in Toxicology.
Web: http://www.toxcourses.nl/ (English only)

Risks of Substances
Information on chemicals and chemical groups, legislation, and substances from consumer products.
Web: http://www.rivm.nl/rvs/ (Dutch only)

Substance Manager
Risk management tool of chemicals for small and medium-sized enterprises
Web: http://www.stoffenmanager.nl/ (Dutch only)

Certifying and Advisory Boards

Committee for the Registration of Pesticides
P.O. Box 217, 6700 AE, Wageningen, The Netherlands

Dutch Expert Committee on Occupational Standards
P.O. Box 20350, 2500 EJ, Den Haag, The Netherlands

Food Allergy
P.O. Box 51, 2100 AB, Heemstede, The Netherlands

Health Council
P.O. Box 20350, 2500 EJ, Den Haag, The Netherlands

National Service for Occupational Health and Safety
P.O. Box 879, 2700 AW, Zoetermeer, The Netherlands

Office of Dangerous Environmental Substances, RIVM
P.O. Box 1, 3720 BA, Bilthoven, The Netherlands

Registration Committee for Human Drugs
P.O. Box 20350, 2500 EJ, Den Haag, The Netherlands

Registration Committee for Veterinary Drugs
P.O. Box 289, 6700 AG, Wageningen, The Netherlands

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CHAPTER

99

Norway

BIRGITTE LINDEMAN

INTRODUCTION

Norway is a Scandinavian country and has approximately 4.6 million inhabitants and an extensive coast line along the North Atlantic Ocean. Norway's outlying possessions are Svalbard and Jan Mayen in the Arctic Ocean and Bouvet and Peter I Islands in the South Atlantic. Norway also has claims in Antarctica. For geographic and historic reasons Norway gives high priority to the management of natural resources and the environment in the polar areas. Furthermore, due to a high dependence both on petroleum and gas production as well as fishing and aquaculture, extensive programs for environmental monitoring of pollution along the Norwegian coast and on the Norwegian continental shelf have been established.

The increasing awareness of environmental pollution issues during the last part of the 20th century led to the establishment of the Ministry of the Environment in 1972 and shortly thereafter of the Pollution Control Authority. The Ministry of the Environment is generally responsible for most aspects of environmental protection covering water, air, noise, and waste, as well as nature reserves. It is responsible also for the coordination of local planning under the Building and Planning Act of 1965. Planning is regarded as a local responsibility under this act, with guidance from the Ministry. Five subordinate institutions currently (2007) report to the Ministry of the Environment (Directorate for Cultural Heritage, Directorate for Nature Management, Norwegian Pollution Control Authority, Norwegian Mapping Authority, Norwegian Polar Institute).

The Norwegian Pollution Control Authority (SFT) is responsible for providing the relevant documentation for the Ministry of the Environment in connection with pollution issues. It also sets emission standards and controls industrial activities. Chemical safety is an important activity covered by SFT. Due to the EFTA/EU Agreement on the European Economic Area (EEA Agreement), Norway regulates the use of chemicals largely in the same way as the EU countries; decisions in the EU system are of direct relevance as to how Norway develops its legislation concerning chemicals.

Along with the increasing interest for toxicology in the 1970s, toxicology as a distinct field of science entered a period of expansion and consolidation. In response to the need for competence in toxicological sciences, the Norwegian Research Council initiated a 3-year research and educational program in toxicology in 1979, involving 18 students with backgrounds in medicine, dental medicine, veterinary medicine, biology, biochemistry, biophysics, and agricultural sciences. At the same time, there was a great increase in education and research activities at universities and at institutions working within environmental health and occupational health. Currently, teaching in toxicology at MSc level takes place at several universities and university colleges. The University in Oslo has recently established a lecture course in Regulatory Toxicology to meet the national need for toxicological risk assessment competence. As there are only a few pharmaceutical companies with research departments in Norway, most toxicological scientists are employed in research institutions and universities. The Norwegian Society of Pharmacology and Toxicology (NSFT) is the national professional society for both toxicologists as well as pharmacologists. By 2007 NSFT had approximately 300 members in the Section of Toxicology.

Presently (2007) there are approximately 60 Norwegian toxicologists registered in The European Register of Toxicologists.

RESOURCES

Books

Most of the toxicological textbooks used at Universities and University Colleges are not published in Norway.

Stenersen J (2002)
Gifter: virkninger og mekanismer: utvalgte emner fra toksikologien (Poisons – effects and mechanisms)
ISBN 82-584-0480-6

A basic textbook in Norwegian covering selected topic in toxicology and ecotoxicology.

Journals

In Norway there are no special journals in the field of toxicology. One of the reasons for not having journals in Norwegian is the fact that the Nordic (Scandinavian) countries co-operate in publishing journals together. For example, The Nordic Pharmacological Society, of which the Norwegian Society of Pharmacology and Toxicology is a member, publishes *Pharmacology and Toxicology*.

There are several special reports concerning different aspects of toxicology such as criteria documents regarding individual chemicals, classification, and labeling of chemical substances for toxic effects, biomarkers, etc.

Journal of the Norwegian Medical Association
Web: http://www.tidsskriftet.no (Norwegian only)

The journal publishes papers on toxicological issues written in Norwegian, but the journal's editorial policy is medical science in general. Scientific articles have summaries written in English.

Technical Reports and other Documents

Gold E (2006)
Gard handbook on protection of the marine environment
ISBN 82-90344-19-8

Småstuen Haug L, Becker G (2006)
Interlaboratory Comparison on Dioxins in Food 2006
Norwegian Institute of Public Health, Report 2006: 7
Web: www.fhi.no

Stoltenberg C, Dybing E (Eds.) (2006)
Kunnskapsoppsummering om barns helse og miljø
Norwegian Institute of Public Health, Report 2006: 3
Web: www.fhi.no

This report is a follow up of the Fourth Ministerial Conference on Environment and Health in 2004 in Budapest where the countries in the WHO European Region committed themselves to building a healthy future for their children by adopting the Children's Environment and Health Action Plan for Europe. The report describes children's health and environment in Norway.

Organizations (Government)

Links to all governmental ministries are found at http://government.no/.

The Ministry of Agriculture and Food
Address: P.O. Box 8007 Dep, N-0030, Oslo
Visiting address: Akersgt. 59 (R5)
Phone: (+47)-22-24-90-90
Email: postmottak@lmd.dep.no

Ministry of Fisheries and Coastal Affairs
Address: P.O. Box 8118 Dep, NO-0032, Oslo
Visiting address: Grubbegt. 1
Phone: (+47)-22-24-90-90
Email: postmottak@fkd.dep.no

Ministry of Foreign Affairs
Address: P.O. Box 8114 Dep, N-0032, Oslo
Visiting address: 7. juni-plassen/Victoria Terrasse
Phone: (+47)-22-24-90-90
Email: post@mfa.no

Norwegian Agency for Development Cooperation (Norad)
Web: http://www.norad.no (Norwegian; Click on 'English' to see English version)

The Norwegian Agency for Development Cooperation (Norad) is a directorate under the Norwegian Ministry of Foreign Affairs (MFA). Norad's most important task is to contribute in the international co-operation to fight poverty.
Address: P.O. Box 8034 Dep, NO-0030, Oslo
Visiting address: Ruseløkkveien 26
Phone: (+47)-22-24-20-30
Email: postmottak@norad.no

Ministry of the Environment
Address: P.O. Box 8013 Dep, NO-0030, Oslo
Visiting address: Myntgt. 2
Phone: (+47)-22-24-90-90
Email: postmottak@md.dep.no

Ministry of Health and Care Services
Address: P.O. Box 8011 Dep, NO-0030, Oslo

Visiting address: Einar Gerhardsens plass 3
Phone: (+47)-22-24-90-90
Email: postmottak@hod.dep.no

The Ministry of Government Administration and Reform
Address: P.O. Box 8004 Dep, NO-0030, Oslo
Visiting address: Akersgt. 59
Phone: (+47)-22-24-90-90
Email: postmottak@fad.dep.no

Ministry of Labour and Social Inclusion
Address: P.O. Box 8019 Dep, NO-0030, Oslo
Visiting address: Einar Gerhardsens plass 3
Phone: (+47)-22-24-90-90
Email: postmottak@aid.dep.no

Ministry of Transport and Communications
Address: P.O. Box 8010 Dep, NO-0030, Oslo
Visiting address: Akersgt. 59
Phone: (+47)-22-24-90-90
Email: postmottak@sd.dep.no

Directorate of Fisheries
Web: http://www.fiskeridir.no (Norwegian; Click on 'English' to see English version)

The Directorate of Fisheries serves as the Ministry of Fisheries and Coastal Affairs advisory and executive body in matters pertaining to fishing and the management of aquaculture.
Address: P.O. Box 2009, NO-5817, Bergen
Visiting address: Strandgt. 229
Phone: (+47)-55-23-80-00
Email: postmottak@fiskeridir.no

Directorate for Health and Social Affairs (SHdir)
Web: http://www.shdir.no (Norwegian; Click on 'English' to see English version)

The Directorate for Health and Social Affairs is an integral part of the central administration of health and social affairs in Norway, and is organized under the joint auspices of the Ministry of Health and Care Services and the Ministry of Labour and Social Affairs.
Address: P.O. Box 7000 St. Olavs plass, NO-0130, Oslo
Visiting address: Universitetsgata 2
Phone: (+47)-810-200-50
Email: postmottak@shdir.no

Directorate for Nature Management
Web: http://english.dirnat.no (English)
Web: http://www.naturforvaltning.no (Norwegian)

The Directorate for Nature Management is a national body that has the scientific responsibility for managing the Norwegian countryside. It is responsible to the Ministry of Environment.
Address: NO-7485, Trondheim
Visiting address: Tungasletta 2
Phone: (+47)-73-58-05-00
Email: postmottak@dirnat.no

Health, Environment, and Safety
Web: http://www.hmsetatene.no/english (English)
Web: http://www.hmsetatene.no (Norwegian)

This is the website of the four authorities who are responsible for the co-ordinated supervisory activities pursuant to regulations relating to Systematic Health, Environmental and Safety Activities (HES) in Enterprises. Directorate for Civil Protection and Emergency Planning[1], Norwegian Labour Inspection Authority[2], Norwegian Industrial Safety and Security Organisation[3], Norwegian Pollution Control Authority[4]
[1]Address: P.O. Box 2014, NO-3103 Tønsberg
Visiting address: Rambergveien 9
Phone: (+47)-33-41-25-00
Email: postmottak@dsb.no

[2]Address: Statens hus, NO-7013 Trondheim
Visiting address: Prinsens gate 1
Phone: (+47)-73-19-97-00
Email: direktoratet@atil.no

[3]Address: P.O. Box 5468 Majorstuen, NO-0305, Oslo
Visiting address: Essendropsgate 6
Phone: (+47)-23-08-85-30
Email: nso@nso.no

[4]Address: P.O. Box 8100 Dep
NO-0032, Oslo
Visiting address: Strømsveien 96
Phone: (+47)-22-57-34-00
Email: postmottak@sft.no

National Institute of Occupational Health
Web: http://www.stami.no/In_English (English)
Web: http://www.stami.no (Norwegian)

The National Institute of Occupational Health is a research institute contributing to the increased knowledge and practical applications of occupational health. The Institute is organized under the Ministry of Labour and Social Inclusion as an integrated part of the national system for protection of workers.

NOA (national surveillance system for work environment and occupational health)
Web: http://www.stami.no/NOA/In_English (English)
Web: http://www.stami.no/NOA (Norwegian)

NOA is the national surveillance system for work environment and occupational health in Norway, and is a department at the National Institute of Occupational

Health. NOA shall co-ordinate, systematize and disseminate information on the status and time trends in work-related hazards, exposure factors, and health outcomes.
Address: P.O. Box 8149 Dep, NO-0033, Oslo
Visiting address: Gydas vei 8
Phone: (+47)-23-19-51-00
Email: stami@stami.no

Norwegian Board of Health Supervision
Web: http://www.helsetilsynet.no (Norwegian; Click on 'In English' to see English version)

The Norwegian Board of Health Supervision is an independent supervision authority, with responsibility for general supervision of health and social services in the country.
Address: P.O.Box 8128 Dep, NO-0032, Oslo
Visiting address: Calmeyers gate 1
Phone: (+47)-21-52-99-00
Email: postmottak@helsetilsynet.no

Norwegian Defence Research Establishment (FFI)
Web: http://www.mil.no/felles/ffi/English (English)
Web: http://www.ffi.no (Norwegian)

The Norwegian Defence Research Establishment is responsible for defense-related research in Norway.
Address: P.O. Box 25, NO-2027, Kjeller
Visiting address: Instituttveien 20
Phone: (+47)-63-80-70-00
Email: ffi@ffi.no

Norwegian Food Safety Authority
Web: http://www.mattilsynet.no (Norwegian; Click on British flag to see English version)

The Norwegian Food Safety Authority is a governmental body with responsibility for food and drinking safety. The Norwegian Food Safety Authority also performs duties relating to cosmetics and medicines, and inspects animal health personnel.
Address: Felles postmottak, P.O.Box 383, NO-2381, Brumunddal
Visiting address: Ullevålsveien 76, Oslo
Phone: (+47)-23-21-68-00
Email: postmottak@mattilsynet.no

The Norwegian Scientific Committee for Food Safety (VKM)
Web: http://www.vkm.no (Norwegian; Click on 'English web' to see English version)

VKM is appointed by and financed by the Ministry of Health. VKM is an independent body that performs risk assessment for the Norwegian food safety authority.
Email: vkm@fhi.no

The Food Portal
Web: http://matportalen.no/Emner/english (English)
Web: http://matportalen.no (Norwegian)

The Food Portal is a consumer-oriented portal focusing on food safety. The information is usually published in Norwegian, but may occasionally publish articles in English.
Email: redaksjon@matportalen.no

Norwegian Industrial Safety and Security Organisation
Web: http://www.nso.no/index.htm (Norwegian; Click on British flag to see English version)

The main purpose of the Norwegian Industrial Safety and Security Organisation (NSO) is to organize and control own protection (emergency preparedness) in operations governed by the regulations relating to emergency preparedness requirements.
Address: P.O. Box 5468 Majorstuen, NO-0305, Oslo
Visiting address: Essendropsgate 6
Phone: (+47)-23-08-85-30
Email: nso@nso.no

Norwegian Institute for Agricultural and Environmental Research (Bioforsk)
Web: http://www.bioforsk.no (Norwegian; Click on 'English' to see English version)

Bioforsk is a national R&D institute under the Norwegian Ministry of Agriculture and Food. The main areas of competence are linked to food quality and safety, agriculture and rural development, environmental protection and natural resources management.
Address: Fr. A. Dahlsvei 20, NO-1432 ÅS
Visiting address: Fr. A. Dahlsvei 20
Phone: (+47)-64-94-70-00
Email: post@bioforsk.no

Norwegian Institute of Public Health
Web: http://www.fhi.no (Norwegian; Click on 'English' to see English version)

The Norwegian Institute of Public Health is a national center for expert knowledge of epidemiology, infectious disease control, environmental medicine, forensic toxicology, and research on drug abuse.
Address: P.O. Box 4404 Nydalen, NO-0403, Oslo
Visiting address: Geitmyrsveien 75
Phone: (+47)-22-04-22-00
Email: folkehelseinstituttet@fhi.no

Norwegian Labour Inspection Authority
Web: http://www.arbeidstilsynet.no (Norwegian; Click on 'In English' to see English version)

The Norwegian Labour Inspection Authority is a governmental agency under the Ministry of Labour and Social Inclusion, focused on occupational safety and health.
Address: Statens hus, NO-7013, Trondheim
Visiting address: Prinsens gate 1
Phone: (+47)-73-19-97-00
Email: direktoratet@atil.no

Norwegian Mapping Authority
Web: http://www.statkart.no/IPS (Norwegian only)

The Norwegian Mapping Authority is responsible for providing nationwide geographic information and services to private and public users. It also serves as the central government's professional body in the area of maps and geodata and handles the administrative tasks associated with this.
Address: NO-3507, Hønefoss
Visiting address: Kartverksveien 21
Phone: (+47)-32-11-81-00
Email: firmapost@statkart.no

Norwegian Maritime Directorate
Web: http://www.sjofartsdir.no/no (Norwegian only)
Address: P.O. Box 2222, NO-5509, Haugesund
Visiting address: Smedasundet 50A
Phone: (+47)-52-74-50-00
Email: postmottak@sjofartsdir.no

Norwegian Pollution Control Authority (SFT)
Web: http://www.sft.no (Norwegian; click 'Norwegian Pollution Control Authority' for English version)

The Norwegian Pollution Control Authority (SFT) is a directorate under the Ministry of the Environment. SFT's main fields of responsibility include marine and fresh water pollution, hazardous substances, regulation of onshore and offshore industry, waste management, noise, air pollution and climate change. SFT exercise regulatory authority under the Pollution Control Act, the Product Control Act and the Greenhouse Gas emission Trading Act.

State of the Environment Norway
Web: http://www.environment.no (English)
Web: http://www.miljostatus.no (Norwegian)

State of the Environment Norway aims to provide you with the latest information about the state and development of the environment. The Norwegian Pollution Control Authority has the overall editorial responsibility.
Address: P.O. Box 8100 Dep, NO-0032, Oslo
Visiting address: Strømsveien 96
Phone: (+47)-22-57-34-00
Email: postmottak@sft.no

Norwegian Radiation Protection Authority
Web: http://www.stralevernet.no (Norwegian; click English flag for English version)

The Norwegian Radiation Protection Authority is the competent national authority in the area of radiation protection and nuclear safety.
Address: P.O. Box 55, NO-1332, Østerås
Visiting address: Grini Næringspark 12
Phone: (+47)-67-16-25-00
Email: nrpa@nrpa.no

Norwegian Water Resources and Energy Directorate
Web: http://www.nve.no (Norwegian; Click on 'In English' to see English version)

The Norwegian Water Resources and Energy Directorate (NVE) is subordinated to the Ministry of Petroleum and Energy, and is responsible for the administration of Norway's water and energy resources.
Address: P.O. Box 5091 Majorstuen, NO-0301, Oslo
Visiting address: Middelthunsgate 29
Phone: (+47)-22-95-95-95
Email: nve@nve.no

Petroleum Safety Authority Norway (PSA)
Web: http://www.ptil.no/English (English)
Web: http://www.ptil.no (Norwegian)

The Petroleum Safety Authority Norway is an independent regulatory body under the Ministry of Labour and Government Administration. The PSA has the regulatory responsibility for safety, emergency preparedness, and the working environment in the petroleum activities.
Address: P.O. Box 599, NO-4003, Stavanger
Visiting address: Professor Olav Hanssens vei 10
Phone: (+47)-51-87-60-50
Email: postboks@ptil.no

Norwegian Polar Institute
Web: http://npiweb.npolar.no (English)
Web: http://npweb.npolar.no (Norwegian)

The Norwegian Polar Institute is Norway's central institution for research, environmental monitoring and mapping of the Polar Regions. The Institute's activities are concentrated on environmental management needs at both poles.
Address: Polar Environmental Centre, NO-9296, Tromsø
Visiting address: Hjalmar Johansens gate 14
Phone: (+47)-77-75-05-00
Email: postmottak@npolar.no

The Product Register
Click on 'Norwegian Pollution Control Authority' to see English version.
Web: http://www.SFT.no (Norwegian)

The Product Register is the Norwegian authorities' central register of substances and chemical products that are on the market in Norway. The information is used as a tool for preventing damage to health and the environment caused by chemicals. The Product Register (PR) was established in 1981 by the Norwegian parliament.
Address: P.O. Box 8180 Dep, NO-0034, Oslo
Visiting address: Schweigaards gate 34E
Phone: (+47)-22-05-48-80
Email: produktregisteret@produktregisteret.no

Institute of Marine Research
Web: http://www.imr.no/english (English)
Web: http://www.imr.no (Norwegian)

The Institute of Marine Research is a national consultative research institute which is owned by the Ministry of Fisheries and Coastal Affairs. The Institute performs research and provides advisory services in the fields of marine ecosystems and aquaculture.
Address: P.O. Box 1870 Nordnes, NO-5817, Bergen
Visiting address: Nordnesgt. 50
Phone: (+47)-55-23-85-00
Email: post@imr.no

Organizations (Non-government)

The Bellona Foundation
Web: http://www.bellona.org (English)
Web: http://www.bellona.no (Norwegian)

The Bellona Foundation is a multi-disciplinary international environmental NGO based in Oslo. Bellona works with questions related to the clean-up of the Cold War legacy in Russia, the safety of the oil and gas industry in Russia and Europe, and fighting global warming.
Address: P.O. Box 2141 Grünerløkka, NO-0505, Oslo
Visiting address: Nordregate 2
Phone: (+47)-23-23-46-00
Email: info@bellona.no

Greenliving
Web: http://www.gronnhverdag.no (Norwegian only)

Greenliving is the major green consumer's network in Norway.
Address: Grensen 9B, NO-0159, Oslo
Visiting address: Grensen 9B
Phone: (+47)-23-10-95-50
Email: post@gronnhverdag.no

The Standardization Organizations in Norway
Web: http://www.standard.no (Norwegian; Click on 'English' to see English version)

Standards Norway (SN), The Norwegian Electrotechnical Committee (NEK), and The Norwegian Post and Telecommunication Authority (PT) are the three standards writing bodies in Norway.

Universities

The Norwegian University of Life Sciences (UMB)
Web: http://www.umb.no/?avd=30 (English)
Web: http://www.umb.no (Norwegian)

The Norwegian University of Life Sciences (UMB) is focused on higher education and research within environmental and biosciences. UMB focuses specifically on biology, food, environment, land use, and natural resource management.
Address: P.O. Box 5003, NO-1432, ÅS
Visiting address: ÅS
Phone: (+47)-64-96-50-00
Email: postmottak@umb.no

National Veterinary Institute
Web: http://www.vetinst.no (Norwegian; Click on 'In English' to see English version)

The National Veterinary Institute is a national research institute in the fields of animal health, fish health, and food safety, whose primary function is supply of independent research-based advisory support to the governing authorities.
Address: P.O. Box 8156 Dep, NO-0033, Oslo
Visiting address: Ullevålsveien 68
Phone: (+47)-23-21-60-00
Email: adm@vetinst.no

Norwegian School of Veterinary Science
Web: http://www.veths.no/default.aspx?id=566 (English)
Web: http://www.veths.no (Norwegian)

The Norwegian School of Veterinary Science (NVH) is the sole institution educating veterinary surgeons and veterinary nurses in Norway. The school is also responsible for the major part of all veterinary research conducted in the country.
Address: P.O. Box 8146 Dep, NO-0033, Oslo
Visiting address: Ullevålsvn 72
Phone: (+47)-22-96-45-00
Email: post@veths.no

Foodsafety.no
Web: http://www.foodsafety.no (English)

This website is a joint venture between the Norwegian School of Veterinary Science and the National Veterinary Institute of Norway. Foodsafety aims to ensure that the

food we eat is safe and does not contain infective agents or contaminants that can make it injurious to our health. The website provides a presentation of the activity of the two major veterinary institutions in Norway dealing with food safety.

Norwegian University of Science and Technology
Web: http://www.ntnu.no/indexe.php (English)
Web: http://www.ntnu.no (Norwegian)

Address: NTNU, NO-7491, Trondheim
Visiting address: Gløshaugen/Dragvoll
Phone: (+47)-73-59-50-00
Email: postmottak@adm.ntnu.no

University of Bergen
Web: http://www.uib.no/info/english (English)
Web: http://www.uib.no (Norwegian)

Address: P.O. Box 7800, NO-5020, Bergen
Visiting address: Nygårdshøyden/ Haukeland
Phone: (+47)-55-58-00-00
Email: post@uib.no

University of Oslo
Web: http://www.uio.no/english (English)
Web: http://www.uio.no (Norwegian)

The University of Oslo is Norway's largest and oldest institution of higher education.
Address: P.O. Box 1072 Blindern, NO-0316, Oslo
Visiting address: Problemv. 7
Phone: (+47)-22-85-50-50
Email: informasjon@uio.no

Centre for Development and the Environment
Web: http://www.sum.uio.no (English)

The Centre for Development and the Environment (Senter for utvikling og miljø, SUM), is primarily a research institution. It was established by the University of Oslo in 1990 in response to the report of the Brundtland Commission: Our Common Future.
Address: P.O.Box 1116 Blindern, NO-0317, Oslo
Visiting address: Sognsveien 68
Phone: (+47)-22-85-89-00
Email: info@sum.uio.no

University of Tromsø
Web: http://uit.no/informasjon/english (English)
Web: http://uit.no (Norwegian)

Arctic research is one of the University's highest priorities. The Roald Amundsen Centre for Arctic Research is an umbrella organization for all those involved in Arctic research at the University, irrespective of faculty affiliation. The main objective of the Centre is to enhance Arctic research at the University of Tromsø.

Centre for Environment and Development Studies (SEMUT)

SEMUT shall contribute to strengthen research, education, and dissemination of research results with a focus on environment and development at the University of Tromsø and with research and development institutions in other parts of North Norway. The work of SEMUT is mainly directed towards developing countries.
Address: 9037 Tromsø
Visiting address: Breivika
Phone: (+47)-77-64-40-00
Email: postmottak@uit.no

Professional Societies

The Norwegian Medical Association (NMA)
Web: http://www.legeforeningen.no (Norwegian; Click on 'In English' to see English version)

Norwegian Association of Occupational Medicine (NAMF)
Web: http://www.legeforeningen.no/index.gan?id=8058 (Norwegian only)

Address: 1152 Sentrum, NO-0107, Oslo
Visiting address: Akersgt. 2
Phone: (+47)-23-10-90-00
Email: legeforeningen@legeforeningen.no

Norwegian Biochemical Society
Web: http://www.biokjemisk.com/index.php?section=63 (English)
Web: http://www.biokjemisk.com (Norwegian)

Within this society there are several special interest groups such as that for biochemical toxicology, including neurotoxicology, genetic toxicology, and the toxicology of solvents.
Address: Erik Boye, General Secretary, Institute for Cancer Research, Montebello, NO-0310 Oslo
Phone: (+47)-22-93-42-56
Email: erik.boye@rr-research.no

Norwegian Farmers' Association for Occupational Health and Safety
Web: http://www.lhms.no/default.asp (Norwegian; Click on 'English Summary' for information in English)

Address: P.O. Box 120, NO-3602, Kongsberg
Visiting address: Thornesvei 3A
Phone: (+47)-32-29-90-30
Email: hk@lhms.no

Norwegian Society of Pharmacology and Toxicology (NSFT)
Web: http://www.nsft.net (Norwegian; Click 'English' for English version)

The Norwegian Society of Pharmacology and Toxicology is the main organization for toxicology in Norway. It includes two specialty sections: one for Toxicology and one for Basic Pharmacology and Clinical Pharmacy.
Address: c/o Department of Biology, UiO, P.O. Box 1066 Blindern, NO-0316, Oslo
Email: NSFT@nsft.net

Norwegian Society for Pharmacoepidemiology (DURG Norway)
Web: http://www.farmakoterapi.uio.no/durg/indexEng.html (English)
Web: http://www.farmakoterapi.uio.no/durg (Norwegian)

Poison Control Centers

National Poisons Information Centre
Web: http://www.shdir.no/giftinfo (Norwegian only)

Address: P.O. Box 7000 St. Olavs plass, NO-0130, Oslo
Phone: (+47)-22-59-13-00
Email: postmottak.giftinfo@shdir.no

Legislation

Act relating to the Prevention of Fire, Explosion and Accidents involving Hazardous Substances and the Fire Services
Web: http://www.dsb.no/Article.asp?ArticleID=1473 (English)

The Directorate for Civil Protection and Emergency Planning (DSB)

Acts and regulations provided by the Ministry of the Environment
Web: http://www.regjeringen.no/en/dep/md/Documents-and-publications/Acts-and-regulations.html?id=271041 (English)
Regulations on Environmental Impact Assessment
Pollution Control Act
Environmental Information Act
Svalbard Environmental Protection Act
Product Control Act
Wildlife Act
Web: http://www.ub.uio.no/ujur/ulovdata/lov-19810529-038-eng.pdf

Environmental Treaties and Resource Indicators – Norway
Web: http://sedac.ciesin.columbia.edu/entri/countryProfile.jsp?ISO=NOR (English)
ENTRI is an online service for accessing multilateral environmental treaty data.

Acts and Regulations administered by the Labour Inspection Authority
Web: http://www.arbeidstilsynet.no/c26840/artikkel/vis.html?tid=29289#2 (English)

Working Environment Act (Arbeidsmiljøloven)
Regulations relating to systematic health, environmental and safety activities in enterprises

Miscellaneous Resources

Det Norske Veritas (DNV)
Web: http://www.dnv.com (English)
Web: http://www.dnv.no (Norwegian)

DNV is an independent foundation with the objective of safeguarding life, property, and the environment and is a provider of services for managing risk.
Address: P.O. Box Veritasveien 1, NO-1322, Høvik
Visiting address: Veritasveien 1
Phone: (+47)-67-57-99-00
Email: DNV.Corporate@dnv.com

Fridtjof Nansen Institute
Web: http://www.fni.no (English only)

The Fridtjof Nansen Institute (FNI) is an independent foundation engaged in research on international environmental, energy, and resource management politics.
Address: P.O. Box 326, NO-1326, Lysaker
Visiting address: Fridtjof Nansens vei 17
Phone: (+47)-671119-00
Email: post@fni.no

Nordic Institute of Dental Materials
Web: http://www.niom.no (English)

The Nordic Institute of Dental Materials (NIOM) is under the auspices of the Nordic Council of Ministers. The institute's main goal is to ensure that dental biomaterials used in the Nordic countries are safe to use and that they last as long as possible.
Address: P.O. Box 70, NO-1305, Haslum
Visiting address: Kirkeveien 71B
Phone: (+47)-67-51-22-00
Email: niom@niom.no

Norwegian Environmental Education Network
Web: http://sustain.no (English)
Web: http://miljolare.no (Norwegian)

The network has been established in order to facilitate co-operation between schools, environmental authorities, research institutions, and NGOs. Sustain.no is a resource for promoting training in sustainable development at all levels.

Norwegian Foundation for Sustainable Consumption and Production (GRIP)
Web: http://www.grip.no/Felles/english.htm (English)
Web: http://www.grip.no (Norwegian)

GRIP was established by the Norwegian Ministry of the Environment and promotes and supports sustainable production and consumption patterns.
Address: P.O. Box 8900 Youngstorget, NO-0028, Oslo
Visiting address: Storgata 23C (Operapassasjen)
Phone: (+47)-22-97-98-00
Email: post@grip.no

Norwegian Institute for Air Research (NILU)
Web: http://www.nilu.no/index.cfm?lan_id=3 (English)
Web: http://www.nilu.no (Norwegian)

The Norwegian Institute for Air Research (NILU) is an independent research institute that conducts environmental research with emphasis on the sources of airborne pollution, atmospheric transport, transformation and deposition and is also involved in the assessment of the effects of pollution on ecosystems, human health, and materials. A main priority for NILU is to provide scientific facts on the quantitative relationships between these factors, and at the same time make the results available in user-friendly manners for decision-makers.
Address: P.O. Box 100, NO-2027, Kjeller
Visiting address: Instituttveien 18
Phone: (+47)-63-89-80-00
Email: nilu@nilu.no

Norwegian Institute for Nature Research (NINA)
Web: http://www.nina.no (Norwegian; Click on 'English' to see English version)

The Norwegian Institute for Nature Research (NINA) is Norway's leading institution for applied ecological research. NINA is responsible for long-term strategic research and commissions applied research to facilitate the implementation of international conventions, decision-support systems, and management tools, as well as to enhance public awareness and promote conflict resolution.
Address: N-7485, Trondheim
Visiting address: Tungasletta 2
Phone: (+47)-73-80-14-00
Email: mail@nina

Norwegian Institute for Water Research
Web: http://www.niva.no/symfoni/infoportal/portenglish.nsf (English)
Web: http://www.niva.no (Norwegian)

The Norwegian Institute for Water Research (NIVA) is Norway's leading multidisciplinary research institute in the field of use and protection of water bodies and water quality, in fresh and marine waters.
Address: Gaustadalléen 21, NO-0349, Oslo
Visiting address: Gaustadalléen 21
Phone: (+47)-22-18-51-00
Email: niva@niva.no

Norwegian Water Network
Web: http://www.water-norway.org (English only)

The Norwegian Water Network connects institutions and programs involved in integrated water management.

Offshore.no
Web: http://www.offshore.no (Norwegian only)

Norwegian site dedicated to the offshore industry.
Address: P.O. Box 1335 Vika, NO-0112, Oslo
Visiting address: Strandgaten 193, Bergen
Phone: (+47)-22-83-83-68
Email: redaksjonen@offshore.no

The Polar Environmental Centre
Web: http://www.polarenvironment.no/index.cfm?lid=2 (English)
Web: http://www.polarenvironment.no (Norwegian)

The Centre for the Environment and co-operation in the Polar Areas and the Barents region (The Polar Environmental Centre) is Norway's center of research, environmental monitoring, and advisory services in the Northern Region and the Arctic/Antarctic. The bodies of the Polar Environmental Centre are: The Norwegian Polar Institute, Akvaplan-niva, the Norwegian Institute for Air Research, the Norwegian Institute for Nature Research, the Norwegian Institute for Cultural Heritage Research, the Geological Survey of Norway, the Norwegian Radiation Protection Authority, the Norwegian Mapping Authority's Tromsø office, and the National Coastal Administration.
Address: Polarmiljøsenteret, NO-9296, Tromsø
Visiting address: Hjalmar Johansensgt. 14
Phone: (+47)-77-75-00-00
Email: pmas@npolar.no

Research Council of Norway
Web: http://www.forskningsradet.no (Norwegian; Click on 'English' to see English version)

The mandate of the Council is to promote and support basic and applied research in all areas of science, technology, medicine, and the humanities. Important goals include raising the general level of the understanding of research in society as a whole and supporting innovation in all sectors and branches of industry. The

Research Council of Norway is a strategic body which identifies areas of special effort, allocates research funds and evaluates the resulting research. The Council is the principal research policy adviser to the government, and it acts as a meeting-place and network-builder for Norwegian research.

Address: P.O.Box 2700 St. Hanshaugen, NO-0131 OSLO
Visiting address: Stensberggata 26
Phone: (+47)-22-03-70-00
Email: post@forskningsradet.no

UNEP/GRID-Arendal
Web: http://www.grida.no (English)

GRID-Arendal is an official United Nations Environment Programme (UNEP) center. The mission of GRID-Arendal is to provide environmental information, communications, and capacity-building services for information management and assessment. GRID-Arendal provides analysis and supports communication on issues such as climate change, environment and poverty, environment and security, the urban environment and sustainable development through education.
Email: grid@grida.no

CHAPTER

100

Poland

MAREK BANASIK AND TODD STEDEFORD

INTRODUCTION

The foundations of toxicology in Poland date back to the first academic lectures in this field beginning in 1783–86. The lectures were given at the Main Crown School (established in 1364 as the Studium Generale and presently called the Jagiellonian University) in Cracow (Kraków) by a physician and pharmacist named Jan Szaster (1746–1793). Another important figure was Józef Sawiczewski (1762–1825), who lectured on toxicology to students of pharmacy at the former Kraków University (Jagiellonian University). Further developments in the field of toxicology in Poland were slowed down due to political reasons. Poland's independence as a State was compromised by its partitioning among Russia, Prussia, and Austria in 1772, 1793, and 1795, which ultimately dissolved the State. In addition, the minimal amount of industrialization and lack of scientific laboratories didn't favor the development of toxicology.

After Poland regained its independence in 1918, the teaching of toxicology together with forensic medicine took place as part of medical and pharmaceutical education. Outside Warsaw (Warszawa), the teaching of toxicology was restricted to methods of detection and identification of chemicals causing poisonings in people. Toxicological analysis was the most often practiced toxicology activity in Poland. This speciality was represented mostly by toxicological chemistry and forensic departments of pharmaceutical university faculties that worked on the needs of forensic medicine. Laboratory analyses outside academic centers were mostly performed by pharmacists. The development of experimental methods and testing equipment for toxicological analyses were more often conducted by specialist institutions, such as the National Institute of Hygiene (http://www.pzh.gov.pl), the Institute of Forensic Research (at present, The Prof. Dr. Jan Sehn Institute of Forensic Research; http://www.ies.krakow.pl), as well as university departments of forensic medicine.

After World War II, Poland underwent intensive industrialization that resulted in new problems, especially in the field of industrial toxicology. Unfortunately, after the war, there was a lack of laboratory space, laboratory equipment, and most importantly independent scientists, as the majority of researchers were killed by German and Soviet invaders or had fled the country. As a result, the redevelopment of Poland progressed, unguided by scientific influence, and the importance of basic research became an absent priority. However, with the progressive use of chemicals in agriculture, especially plant protection chemicals, fertilizers, and veterinary medicines, a revival in the need for toxicological research began with the Ministry of Health (present name; http://www.mz.gov.pl), Ministry of Agriculture and Rural Development (present name; http://www.minrol.gov.pl), Ministry of Economy (present name; http://www.mgip.gov.pl), Ministry of Justice (http://www.ms.gov.pl), and Ministry of National Defence (http://www.wp.mil.pl) founding their own research units. Institutes for occupational medicine and safety were established in Lublin (http://www.imw.lublin.pl), Łódź (http://www.imp.lodz.pl), Sosnowiec (http://www.imp.sosnowiec.pl), and Warszawa (http://www.ciop.pl). An additional developmental stimulus came from strong co-operation between toxicology research institutions and industry in the 1970s.

Toxicology research is undertaken largely at medical colleges and governmental medical institutions, such as e.g. the Nofer Institute of Occupational Medicine (NIOM; http://www.imp.lodz.pl) in Łódź established in 1954. Its scientific division deals mostly with industrial toxicology and occupational pathology. In 1975, NIOM became a World Health Organization Collaborating Centre in Occupational Health (http://www.whoocchealthccs.org). Nowadays, it provides background research and expertise to the Ministry of Health and serves as an advisory body to the Ministry of the Environment (http://www.mos.gov.pl) and various governmental agencies, as well as to local administration, trade unions, and industry. In addition, NIOM organizes numerous courses for toxicologists.

The first organization of Polish toxicologists was the Toxicological Section of the Polish Pharmacological Society (PPS; http://pharmacology.slam.katowice.pl – click the Polish flag) formed in 1966. The main toxicological interests of PPS were acute and chronic poisonings, pharmacodynamic and pharmacokinetic interactions of medicines, drug addiction, clinical research of medicine poisonings, and toxicological evaluation of new medicines. In the course of time, the scope of research and toxicological problems began to exceed the interests of the Toxicological Section of PPS. Therefore, on March 8, 1978 the Polish Society of Toxicology (PST; http://www.imp.lodz.pl/nowy_pttox) was established. PST is an interdisciplinary scientific society working under the aegis of the Polish Academy of Sciences (http://www.pan.pl). It comprises 11 (http://www.imp.lodz.pl/nowy_pttox/oddzialy.htm) regional sections gathering over 300 members – persons working in experimental and practical toxicology. PST is a member of the Federation of European Toxicologists & European Societies of Toxicology (EUROTOX; http://www.eurotox.com) and the International Union of Toxicology (IUTOX; http://www.iutox.org). In Poland, toxicologists are recruited mostly from pharmacists, physicians, chemists, veterinarians, and graduates of medical analytics.

After the collapse of Communism and the recovery of Poland's full independence in 1989, research in toxicology began to flourish. The information that follows in the resources section is reflective of Poland's commitment to toxicological research and continued growth.

RESOURCES

Books

Ball S (1998)
Food Toxicology without Secrets (Toksykologia żywności bez tajemnic)
Oficyna Wydawnicza Medyk: Warszawa
ISBN: 83-87340-55-3

Bogdanik T (Ed.) (1988)
Clinical Toxicology (Toksykologia kliniczna)
Państwowy Zakład Wydawnictw Lekarskich: Warszawa
ISBN: 83-200-1326-7

Brandys J (Ed.) (1999)
Toxicology – Select Problems (Toksykologia – wybrane zagadnienia)
Wydawnictwo Uniwersytetu Jagiellońskiego: Kraków
ISBN: 83-233-1267-2

Brodecki Z (Ed.) (2005)
Environmental Protection (Ochrona środowiska)
Wydawnictwo Prawnicze LexisNexis, Warszawa
ISBN: 83-7334-389-X

Chomiczewski K, Kocik J, Szkoda MT (2002)
Bioterrorism – Principles of Medical Procedure (Bioterroryzm – zasady postępowania lekarskiego)
Wydawnictwo Lekarskie PZWL: Warszawa
ISBN: 83-200-2684-9

Grzesiak M, Domańska W (Eds.) (2006)
Environmental Protection 2006 (Ochrona środowiska 2006)
Statistical Publishing Establishment (Zakład Wydawnictw Statystycznych): Warszawa
ISSN: 0687-3217
Web: http://www.stat.gov.pl/gus/45_1523_PLK_HTML.htm (Main download site with an archive)
Web: http://www.stat.gov.pl/cps/rde/xbcr/gus/PUBL_ochrona_srodowiska_2006.pdf (Text)
Web: http://www.stat.gov.pl/cps/rde/xbcr/gus/PUBL_ochrona_srodowiska_2006-wykr.pdf (Figures)

Gubała W (1997)
Toxicology of Alcohol – Select Problems (Toksykologia alkoholu – wybrane zagadnienia)
Wydawnictwo Instytutu Ekspertyz Sądowych: Kraków
ISBN: 83-87425-05-2

Hanke J, Piotrowski JK (1984)
Biochemical Principles of Toxicology (Biochemiczne podstawy toksykologii)
Państwowy Zakład Wydawnictw Lekarskich: Warszawa
ISBN: 83-200-0745-3

Jakubowski M, et al. (1994)
Dictionary of Toxicological Terms – Polish Definitions and Their English Counterparts (Słownik terminów stosowanych w toksykologii – definicje polskie i odpowiedniki angielskie)

Wydawnictwo i Drukarnia "Secesja": Kraków
ISBN: 83-86077-32-8

Jasińska-Zubelewicz EJ (1996)
Ergonomics – Industrial and Environmental Toxicology – Choice of Texts (Ergonomia – toksykologia przemysłowa i środowiskowa – wybór tekstów), 2nd Edn. (improved)
Oficyna Wydawnicza Politechniki Warszawskiej: Warszawa
ISBN: 83-86569-56-5

Łebkowska M, Załęska-Radziwiłł M, Słomczyńska B (2004)
Environmental Toxicology – Laboratory Exercises – Collective Work (Toksykologia środowiska – ćwiczenia laboratoryjne – praca zbiorowa), 2nd Edn.
Oficyna Wydawnicza Politechniki Warszawskiej: Warszawa
ISBN: 83-7207-102-0

Mazur E (1999)
Dictionary of Ecology and Environmental Protection (Słownik ekologii i ochrony środowiska), 2nd Edn.
Wydawnictwo Naukowe Uniwersytetu Szczecińskiego: Szczecin
ISBN: 83-85798-74-9

Nikonorow M, Urbanek-Karłowska B (1987)
Food Toxicology (Toksykologia żywności), 2nd Edn. (improved and updated)
Państwowy Zakład Wydawnictw Lekarskich: Warszawa
ISBN: 83-200-1108-6

Piotrowski JK (Ed.) (2006)
Principles of Toxicology – Compendium for College Students – Collective Work (Podstawy toksykologii – kompendium dla studentów szkół wyższych – praca zbiorowa)
Wydawnictwa Naukowo-Techniczne: Warszawa
ISBN: 83-204-3122-0

Piotrowski JK, Byczkowska Z (Eds.) (1993)
Toxicometry and Organ Toxicology (Toksykometria i toksykologia narządowa)
Vol. 1 of Industrial Toxicology (Toksykologia przemysłowa), Indulski JA, Piotrowski JK (Eds.)
Instytut Medycyny Pracy im. prof. dra med. J. Nofera: Łódź
ISBN: 83-86052-007

Seńczuk W (Ed.) (1990)
Toxicology – Textbook for Pharmacy Students (Toksykologia – podrecznik dla studentów farmacji)
Państwowy Zakład Wydawnictw Lekarskich: Warszawa
ISBN: 83-200-1515-4

Seńczuk W (Ed.) (1994)
Toxicology (Toksykologia), 2nd Edn.
Wydawnictwo Lekarskie PZWL: Warszawa
ISBN: 83-200-1807-2

Seńczuk W (Ed.) (2002)
Toxicology – Textbook for Students, Physicians, and Pharmacists (Toksykologia – podręcznik dla studentów, lekarzy i farmaceutów), 4th Edn.
Wydawnictwo Lekarskie PZWL: Warszawa
ISBN: 83-200-2648-2

Seńczuk W (Ed.) (2005)
Contemporary Toxicology (Toksykologia współczesna)
Wydawnictwo Lekarskie PZWL: Warszawa
ISBN: 83-200-3128-1

Starek A (2007)
Organ Toxicology (Toksykologia narzadowa)
Wydawnictwo Lekarskie PZWL: Warszawa
ISBN: 83-200-3314-4

Strzałko J, Mossor-Pietraszewska T (Eds.) (2003)
Compendium of Knowledge about Ecology (Kompendium wiedzy o ekologii), 3rd Edn.
Wydawnictwo Naukowe PWN: Warszawa
ISBN: 83-01-13589-1

Zwoździak J (Ed.) (2002)
Man, Environment, Threat (Człowiek, środowisko, zagrożenie)
Oficyna Wydawnicza Politechniki Wrocławskiej: Wrocław
ISBN: 83-7085-632-2

A collective study of the Central Statistical Office published annually since 1972.

Journals

Acta Biochimica Polonica (1954–)
Polish Academy of Sciences Committee of Biochemistry and Biophysics (Komitet Biochemii i Biofizyki Polskiej Akademii Nauk): Warszawa
ISSN: 0001-527X
Email: abp@nencki.gov.pl
Web: http://www.actabp.pl

A quarterly journal of the Polish Biochemical Society (http://www.ptbioch.edu.pl) and the Committee of Biochemistry and Biophysics of the Polish Academy of Sciences (http://www.pan.pl/index.php?option=com_content&task=view&id=1016&Itemid=162) covering enzymology and metabolism, membranes

and bioenergetics, gene structure and expression, protein, nucleic acid, and carbohydrate structure and metabolism. It publishes research articles, short communications, review articles, and book reviews. This journal is supported by the Polish Ministry of Science and Higher Education.

Acta Poloniae Pharmaceutica – Drug Research (1990–)
Polish Pharmaceutical Society: Warszawa
ISSN: 0001-6837
Web: http://www.ptfarm.pl/?pid=33

A bimonthly journal that publishes peer-reviewed articles on all pharmaceutical topics. It is a continuation of 'Acta Poloniae Pharmaceutica' (ISSN: 0001-6837; 1937–1939 and 1947–1989).

Acta Toxicologica (2003–)
Nofer Institute of Occupational Medicine, Publishing House: Łódź
ISSN: 1731-6383
Email: oficyna@imp.lodz.pl
Web: http://www.imp.lodz.pl/nowy_pttox/dzialalnosc_publikacje_acta_toxi.htm

A biyearly journal of the Polish Society of Toxicology (http://www.imp.lodz.pl/nowy_pttox). It is a continuation of 'Acta Poloniae Toxicologica' (ISSN: 1230-6967; 1993–2002). This is the only journal published in Poland and the whole of Central Europe devoted entirely to the field of toxicology. The major research topics of the journal are: experimental and clinical toxicology, ecotoxicology, metabolism of xenobiotics, and toxicological analytics. This journal is financially supported by the Polish Ministry of Science and Higher Education.

Annals of Agricultural and Environmental Medicine (AAEM) (1994–)
Institute of Agricultural Medicine: Lublin
ISSN: 1232-1966
Email: aaem@galen.imw.lublin.pl
Web: http://www.aaem.pl

AAEM is published semi-annually. It publishes peer-reviewed articles on the following research topics: diseases associated with agriculture, forestry, and the food-industry; health effects of chemical pollutants; work-related accidents; problems of occupational hygiene; occupational disease prevention; methods of monitoring biohazards; and occupational and non-occupational environmental factors of importance for human health and disease.

Bromatology and Toxicological Chemistry (Bromatologia i Chemia Toksykologiczna) (1968–)
Polish Pharmaceutical Society (Polskie Towarzystwo Farmaceutyczne): Warszawa
ISSN: 0365-9445
Web: http://www.ptfarm.pl/?pid=34

A quarterly journal, in Polish with English versions of the abstracts, devoted to problems of health and environmental protection.

Environmental Medicine (Medycyna Środowiskowa (MŚ)) (1998–)
Institute of Occupational Medicine and Environmental Health (Instytut Medycyny Pracy i Zdrowia Środowiskowego): Sosnowiec
ISSN: 1505-7054
Email: pms@imp.sosnowiec.pl
Web: http://www.imp.sosnowiec.pl/modules.php?name=Content&pa=showpage&pid=26

A biyearly journal of the Polish Society of Environmental Medicine (http://www.imp.sosnowiec.pl/modules.php?name=Content&pa=showpage&pid=27) published in Polish with English versions of the abstracts. Articles address a broad range of issues relating to environmental medicine.

International Journal of Occupational Medicine and Environmental Health (1994–)
Nofer Institiute of Occupational Medicine and Polish Association of Occupational Medicine: Łódź
ISSN: 1232-1087
Email: redakcja@imp.lodz.pl
Web: http://www.imp.lodz.pl/oficyna/ofic_pages/journal/journ_ang/journal_ang_n.htm

First published under the title 'Polish Journal of Occupational Medicine' (ISSN: 0860-6536; 1988–1990), and then as 'Polish Journal of Occupational Medicine and Environmental Health' (ISSN: 0867-8383; 1991–1993). This quarterly journal publishes peer-reviewed articles addressing a variety of issues including, but not limited to the following: occupational and environmental health policy, toxicology and mutagenesis, epidemiology, carcinogenesis, etc.

International Journal of Occupational Safety and Ergonomics (JOSE) (1995–)
Central Institute for Labour Protection – National Research Institute: Warszawa
ISSN: 1080-3548
Email: jose@ciop.pl
Web: http://www.ciop.pl/757.html

A peer-reviewed quarterly journal that publishes articles on a broad range of issues relating to occupational safety and ergonomics, including: hazardous chemical, physical, and biological agents; new technologies for collective and individual protection; criteria and requirements of occupational safety and ergonomics

and quality; studies of human psychophysical abilities; etc. Volumes 1 and 2 were published under the same title and ISSN by Ablex Publishing Corporation (Norwood, NJ, USA).

Journal of Environmental Protection Science (2007–)
Wrocław University of Technology: Wrocław
Email: jeps.editor@gmail.com
Web: http://www.jeps.us

An open access, peer-reviewed journal with multidisciplinary coverage on the following topics: environmental science/protection/engineering, industrial hygiene, risk assessment/management, toxicology, and epidemiology.

Occupational Medicine (Medycyna Pracy) (1950–)
Nofer Institute of Occupational Medicine and Polish Association of Occupational Medicine (Instytut Medycyny Pracy im. prof. J. Nofera i Polskie Towarzystwo Medycyny Pracy): Łódź
ISSN: 0465-5893
Email: edytor@imp.lodz.pl
Web: http://www.imp.lodz.pl/english/niom.htm (click 'structure', then 'publishing house')

This bimonthly journal, published in Polish with English versions of the abstracts, is primarily addressed to occupational physicians and industrial hygienists. It covers the following topics: occupational pathology, physical, chemical and biological hazards, toxicology and mutagenesis, health policy, management and organization of healthcare, and epidemiology.

Polish Journal of Ecology (1998–)
Institute of Ecology Publishing Office (Oficyna Wydawnicza Instytutu Ekologii): Dziekanów Leśny
ISSN: 1505-2249
Email: pol.j.ecol@cbe-pan.pl
Web: http://www.pol.j.ecol.cbe-pan.pl

A quarterly journal that until 1997 appeared under the title 'Ekologia Polska' (ISSN: 0420-9036; 1953–1997). It is an open access, peer-reviewed journal that publishes original scientific papers dealing with all aspects of ecology: both fundamental and applied, physiological ecology, ecology of population, community, landscape as well as global ecology.

Polish Journal of Environmental Studies (1992–)
HARD: Olsztyn
ISSN: 1230-1485
Email: office@pjoes.com
Web: http://www.pjoes.com

A bimonthly peer-reviewed journal that publishes original papers and critical reviews on a wide range of topics, including the following: environmental pollution research, environmental engineering, determination of harmful substances, analytical methods, circulation of pollutants, hazards to human health and safety, land reclamation, etc.

Organizations (government)

Central Statistical Office
al. Niepodległości 208
00-925 Warszawa
Phone: +48-22-608-3161
Web: http://www.stat.gov.pl

Ministry of Agriculture and Rural Development
ul. Wspólna 30
00-930 Warszawa
Phone: +48-22-623-1000
Fax: +48-22-623-2750/48-22-623-2751
Email: kancelaria@minrol.gov.pl
Web: http://www.minrol.gov.pl

General Veterinary Inspectorate
ul. Wspólna 30
00-930 Warszawa
Phone: +48-22-623-2088
Fax: +48-22-623-1408
Email: wet@wetgiw.gov.pl
Web: http://www.wetgiw.gov.pl

Ministry of Economy
pl. Trzech Krzyży 3/5
00-507 Warszawa
Phone: +48-693-5000
Fax: +48-22-693-4012
Web: http://www.mgip.gov.pl

Central Laboratory for Radiological Protection
ul. Konwaliowa 7
03-194 Warszawa
Phone: +48-22-811-0011~16
Fax: +48-22-811-1616
Email: dyrektor@clor.waw.pl
Web: http://www.clor.waw.pl

Institute of Atomic Energy
05-400 Otwock-Świerk
Phone: +48-22-718-0001
Fax: +48-22-779-3888
Email: iea@cyf.gov.pl
Web: http://www.cyf.gov.pl

"MANHAZ" Management of Health and Environmental Hazards
Phone: +48-22-718-0132
Web: http://manhaz.cyf.gov.pl

Pharmaceutical Research Institute
ul. L. Rydygiera 8

01-793 Warszawa
Phone: +48-22-456-3900
Fax: +48-22-456-3838
Email: kontakt@ifarm.waw.pl
Web: http://www.ifarm.waw.pl

Ministry of Health
ul. Miodowa 15
00-952 Warszawa
Phone: +48-22-634-9600
Email: kancelaria@mz.gov.pl
Web: http://www.mz.gov.pl

Bureau for Chemical Substances and Preparations
ul. św. Teresy od Dzieciątka Jezus 8
91-348 Łódź
Phone: +48-42-631-4687
Fax: +48-42-631-4679
Email: biuro@chemikalia.gov.pl
Web: http://www.chemikalia.gov.pl
http://www.chemikalia.mz.gov.pl

Chief Sanitary Inspectorate
ul. Długa 38/40
00-238 Warszawa
Phone: +48-22-536-1300
Fax: +48-22-635-6194
Email: inspektorat@gis.gov.pl
Web: http://www.gis.gov.pl

Health Care Information Systems Centre
Al. Jerozolimskie 155
02-326 Warszawa
Phone: +48-22-597-0927
Fax: +48-22-597-0937
Email: biuro@csioz.gov.pl
Web: http://www.csioz.gov.pl

Institute of Agricultural Medicine
ul. K. Jaczewskiego 2
20-950 Lublin
Phone: +48-81-718-4400
Fax: +48-81-747-8646
Web: http://www.imw.lublin.pl

Institute of Occupational Medicine and Environmental Health
ul. Kościelna 13
41-200 Sosnowiec
Phone: +48-32-266-0885
Fax: +48-32-266-1124
Web: http://www.imp.sosnowiec.pl

National Bureau for Drug Prevention
ul. Dereniowa 52/54
02-776 Warszawa
Phone: +48-22-641-1501
Fax: +48-22-641-1565
Email: kbpn@kbpn.gov.pl
Web: http://www.narkomania.gov.pl

National Food and Nutrition Institute
ul. Powsińska 61/63
02-903 Warszawa
Phone: +48-22-550-9771
Fax: +48-22-842-3742
Web: http://www.izz.waw.pl

National Institute of Hygiene
ul. Chocimska 24
00-791 Warszawa
Phone: +48-22-542-1400
Fax: +48-22-849-3513/48-22-849-7484
Web: http://www.pzh.gov.pl

National Medicines Institute
ul. Chełmska 30/34
00-725 Warszawa
Phone: +48-22-851-4369/48-22-851-4496
Fax: +48-22-841-0652
Email: sekretariat@il.waw.pl
Web: http://www.nizp.edu.pl

Nofer Institute of Occupational Medicine
ul. św. Teresy od Dzieciątka Jezus 8
91-348 Łódź
Phone: +48-42-631-4502/48-42-655-2505
Fax: +48-42-656-8331
Email: impx@imp.lodz.pl
Web: http://www.imp.lodz.pl

Office for Registration of Medicinal Products, Medical Devices, and Biocides
ul. Ząbkowska 41
03-736 Warszawa
Phone: +48-22-492-1100
Fax: +48-22-492-1109
Web: http://www.urpl.gov.pl

The Main Pharmaceutical Inspectorate
ul. Długa 38/40
00-238 Warszawa
Phone: +48-22-831-4281
Fax: +48-22-831-0244
Email: gif@gif.gov.pl
Web: http://www.gif.gov.pl

The State Agency for Prevention of Alcohol Related Problems
ul. Szańcowa 25
01-458 Warszawa
Phone: +48-22-532-0320, 48-22-532-0325, 48-22-532-0326
Fax: +48-22-836-8166
Email: parpa@parpa.pl
Web: http://www.parpa.pl

Ministry of Justice
Al. Ujazdowskie 11
00-950 Warszawa
Phone: +48-22-521-2888
Web: http://www.ms.gov.pl

The Prof. Dr. Jan Sehn Institute of Forensic Research
ul. Westerplatte 9
31-033 Kraków
Phone: +48-12-422-8755
Fax: +48-12-422-3850
Email: ies@ies.krakow.pl
Web: http://www.ies.krakow.pl

Ministry of Labour and Social Policy
ul. Nowogrodzka 1/3/5
00-513 Warszawa
Phone: +48-22-661-1000
Fax: +48-22-661-1223
Email: info@mps.gov.pl
Web: http://www.mps.gov.pl

Central Institute for Labour Protection – National Research Institute
ul. Czerniakowska 16
00-701 Warszawa
Phone: +48-22-623-3698
Fax: +48-22-623-3693/48-22-840-2462
Email: oinip@ciop.pl
Web: http://www.ciop.pl

Ministry of National Defence
ul. Klonowa 1
00-909 Warszawa
Phone: +48-22-628-0031–34
Fax: +48-22-845-5378
Email: dpimon@wp.mil.pl
Web: http://www.wp.mil.pl

Military Institute of Chemistry and Radiometry
ul. gen. A. Chruściela-Montera 105
00-910 Warszawa
Phone: +48-22-516-9909/48-22-673-5180/48-22-681-4120
Fax: +48-22-516-9909/48-22-673-5180/48-22-681-4120
Email: sekretariat@wichir.waw.pl
Web: http://www.wichir.waw.pl

Military Institute of the Health Services
ul. Szaserów 128
00-909 Warszawa
Phone: +48-22-681-7666
Email: poczta@wim.mil.pl
Web: http://www.cskwam.mil.pl

The General Karol Kaczkowski Military Institute of Hygiene & Epidemiology
ul. Kozielska 4
01-163 Warszawa
Phone: +48-22-838-0129
Fax: +48-22-838-1069
Email: wihie@wihe.waw.pl
Web: http://www.wihe.waw.pl

Ministry of the Environment
ul. Wawelska 52/54
00-922 Warszawa
Phone: +48-22-579-2900
Email: info@mos.gov.pl
Web: http://www.mos.gov.pl

Environmental Information Center
ul. Wawelska 52/54
00-922 Warszawa
Phone: +48-22-579-2211
Email: centrum@cios.gov.pl
Web: http://www.ekoportal.pl

Forest Research Institute
ul. Braci Leśnej 3
Sękocin Stary
05-090 Raszyn
Phone: +48-22-715-0300/48-22-715-0301
Fax: +48-22-720-0397
Email: ibl@ibles.waw.pl
Web: http://www.ibles.waw.pl

Institute for Ecology of Industrial Areas
ul. S. Kossutha 6
40-844 Katowice
Phone: +48-32-254-0164/48-32-254-6031
Fax: +48-3232-254-1717
Email: ietu@ietu.katowice.pl
Web: http://www.ietu.katowice.pl

Institute of Environmental Protection
ul. Krucza 5/11d
00-548 Warszawa
Phone: +48-22-625-1005
Fax: +48-22-629-5263
Email: sekretariat@ios.edu.pl
Web: http://www.ios.edu.pl

Institute of Meteorology and Water Management
ul. Podleśna 61
01-673 Warszawa
Phone: +48-22-569-4100
Fax: +48-22-834-1801/48-22-834-5466
Email: webmaster@imgw.pl
Web: http://www.imgw.pl

Integrated Pollution Prevention and Control
ul. Wawelska 52/54
00-922 Warszawa
Phone: +48-22-579-2314
Fax: +48-22-579-2217

Email: Departament.Instrumentow.Ochrony.Srodowiska@mos.gov.pl
Web: http://ippc.mos.gov.pl/preview/en/ippc-ps_index.html

National Atomic Energy Agency
ul. Krucza 36
00-522 Warszawa
Phone: +48-22-628-2722/48-22-629-0164/48-22-695-9800
Fax: +48-22-628-2722/48-22-629-0164/48-22-695-9800
Web: http://www.paa.gov.pl

Polish Geological Institute
ul. Rakowiecka 4
00-975 Warszawa
Phone: +48-22-849-5351
Fax: +48-22-849-5342
Email: sekretariat@pgi.gov.pl
Web: http://www.pgi.gov.pl

State Inspectorate for Environmental Protection
ul. Wawelska 52/54
00-922 Warszawa
Phone: +48-22-579-2900
Email: gios@gios.gov.pl
Web: http://www.gios.gov.pl

The National Fund for Environmental Protection and Water Management
ul. Konstruktorska 3a
02-673 Warszawa
Phone: +48-22-459-0000, 48-22-459-0001
Fax: +48-22-459-0101
Email: fundusz@nfosigw.gov.pl
Web: http://www.nfosigw.gov.pl

Polish Academy of Sciences (PAS)
Pałac Kultury i Nauki
pl. Defilad 1
P.O. Box 24
00-901 Warszawa
Phone: +48-22-620-4970
Fax: +48-22-620-4910
Email: akademia@pan.pl
Web: http://www.pan.pl

Centre for Ecological Research PAS
ul. M. Konopnickiej 1
Dziekanów Leśny
05-092 Łomianki
Phone: +48-22-751-3046
Fax: +48-22-751-3100
Email: cbe@cbe-pan.pl
Web: http://www.cbe-pan.pl

Institute of Environmental Engineering PAS
ul. M. Skłodowskiej-Curie 34
41-819 Zabrze
Phone: +48-32-271-6481
Fax: +48-32-271-7040
Email: ipis@ipis.zabrze.pl
Web: http://www.ipis.zabrze.pl

Institute of Nature Conservation PAS
al. A. Mickiewicza 33
31-120 Kraków
Phone: +48-12-632-0549, 48-12-634-4865
Fax: +48-12-632-2432
Web: http://www.iop.krakow.pl

Institute of Pharmacology PAS
ul. Smętna 12
31-343 Kraków
Phone: +48-12-637-4022, 48-12-662-3220
Fax: +48-12-637-4500
Email: ifpan@if-pan.krakow.pl
Web: http://www.if-pan.krakow.pl

International Centre for Ecology PAS
ul. Tylna 3
90-364 Łódź
Phone: +48-42-681-7007
Fax: +48-42-681-3069
Email: mcepan@mcepan.lodz.pl
Web: http://www.mcepan.lodz.pl

Mineral and Energy Economy Research Institute PAS
ul. J. Wybickiego 7
31-261 Kraków
Phone: +48-12-632-3300
Fax: +48-12-632-3524
Email: centrum@min-pan.krakow.pl
Web: http://www.min-pan.krakow.pl

Research Institute of Agricultural and Forest Environment PAS
60-809 Poznań
ul. Bukowska 19
Phone: +48-61-847-5601
fax: +48-61-847-3668
Email: zbsril@man.poznan.pl
Web: http://www.zbsril.poznan.pl

Organizations (non-government)

Institute for Sustainable Development
ul. L. Nabielaka 15/1
00-743 Warszawa
Phone: +48-22-851-0402 ~ 04
Fax: +48-22 851-0400
Email: ine@ine-isd.org.pl
Web: http://www.ine-isd.org.pl

An independent, non-governmental and non-profit organization, whose main target of activity is implementation and dissemination of the sustainable development concept in Poland. It focuses on economic, legal, social, and political issues in connection with environmental protection; it collaborates with the Polish parliament, with state administrations as well as local governments and non-governmental ecological movements.

Institute of Public Health and Environmental Protection
ul. Batystowa 1B/2
02-835 Warszawa
Phone: +48-22-648-3712
Fax: +48-22-648-3712
Email: iphep.office@gmail.com, iphep.office@yahoo.com

A not-for-profit organization devoted to the development of cutting-edge methods in risk assessment. It also produces health assessments that address the first two components of a risk assessment – that is, hazard identification and dose–response assessment. Its health assessments contain qualitative descriptors and quantitative values for non-cancer and cancer endpoints.

Klon/Jawor Association (Stowarzyszenie Klon/Jawor)
ul. Szpitalna 5/5
00-031 Warszawa
Phone: 022-828-9128
Email: klon@klon.org.pl
Web: http://www.klon.org.pl

A non-governmental organization that supports the Polish voluntary sector by collecting and disseminating information. The Association administrates the portal 'ngo.pl – Portal of Non-Government Organizations' (ngo.pl – Portal Organizacji Pozarządowych; http://www.ngo.pl).

League of Nature Conservation (Liga Ochrony Przyrody)
Zarząd Główny (Head Office)
ul. Tamka 37/2
00-355 Warszawa
Phone: +48-22-828-8171
Fax: +48-22-828-6580
Email: zg@lop.org.pl
Web: http://www.lop.org.pl

An independent organization established in 1928, that promotes the protection of nature.

Polish Association of Cosmetics and Home Care Products Producers
ul. Wilcza 46/404
00-679 Warszawa
Phone: +48-22-625-5782
Fax: +48-22-629-3469
Email: biuro@czystepiekno.pl
Web: http://czystepiekno.pl

A public interest organization that promotes, develops, and protects the business of the cosmetics and home care industry in Poland.

Polish Chamber of Chemical Industry
ul. Śniadeckich 17
00-654 Warszawa
Phone: +48-22-828-7506, 48-22-828-7507
Fax: +48-22-627-2154
Email: pipc@pipc.org.pl
Web: http://www.pipc.org.pl

Represents chemical companies towards domestic and foreign government and non-government organizations. The Chamber is authorized to represent the chemical industry on an international forum.

Polish Chamber of Parmaceutical Industry and Medical Devices POLFARMED
ul. Łucka 2/4/6
00-845 Warszawa
Phone: +48-22-654-5351, 48-22-654-5352
Fax: +48-22-654-5420
Email: office@polfarmed.com.pl
Web: http://www.polfarmed.pl

Voluntary and self-governing organization of enterprises operating in the fields of production of medicinal products, medical devices as well as introducing medicaments and medical devices on the territory of Poland and operating in the fields of manufacturing raw materials, appliances to their production and servicing of medical devices.

Polish Ecology Chamber
ul. Warszawska 3
40-009 Katowice
Phone: +48-32-253-5155, 48-32-253-7281
Fax: +48-32-253-5155
Email: pie@pie.pl
Web: http://www.pie.pl

A voluntary, self-governing organization of enterprises operating in the field of environmental protection in Poland.

Polish Environmental Partnership Foundation
Mailing Address:
ul. Św. Krzyża 5/6
31-028 Kraków
Phone: +48-12-430-2443, 48-12-430-2465
Fax: +48-12-429-4725
Email: biuro@epce.org.pl
Web: http://www.epce.org.pl

Partnership that helps the public sector and civil society groups implement sustainable development in specific regions, promote the development of sustainable tourism, support local authorities with establishing initiatives aimed at reducing green house gases, etc.

Polish Foundation for Energy Efficiency
ul. Wierzbowa 11
40-169 Katowice
Phone: +48-32-203-5114, 48-32-203-5120
Fax: +48-32-203-5114, 48-32-203-5120
Email: office@fewe.pl
Web: http://www.fewe.pl

An independent, non-governmental and not-for-profit organization. Undertakes the mission of promoting the efficient use of energy and environmentally friendly energy production. Initiates and participates in drafting policy goals in the field of efficient energy use.

Polish Green Network
ul. Sławkowska 26A
31-014 Kraków
Phone: +48-12-431-2808
Fax: +48-12-431-2808
Email: info@zielonasiec.pl
Web: http://www.zielonasiec.pl

Promotes sustainable development through a variety of activities, including: co-ordinating the work of regional information centres; participating in creating laws, politics, strategies, and programs; carrying out public monitoring of management of public funds and access to information; and organizing seminars, workshops, conferences.

Waste Prevention Association 3R
P.O. Box 54
30-961 Kraków
Phone: +48-12-654-9986
Fax: +48-12-654-9986
Email: office@otzo.most.org.pl
Web: http://www.otzo.most.org.pl

A registered, non-governmental and non-profit environmental organization. Promotes clean production methodology, waste reduction at source, and environmentally friendly waste management, including segregation and recycling, as well as rational utilization of 'historical' waste.

Universities

AGH University of Science and Technology
al. A. Mickiewicza 30
30-059 Kraków
Phone: +48-12-617-3390 (Rector's Secretary)
Fax: +48-12-633-4672 (Rector's Office)
Web: http://www.agh.edu.pl/ http://www.uci.agh.edu.pl

Chair of Environmental Biotechnology and Ecology (Katedra Biotechnologii Środowiskowej i Ekologii)
Department of Environmental Sciences (http://home.agh.edu.pl/~knos)
Department of Geology and Environmental Protection (Zakład Geologii Podstawowej i Ochrony Środowiska)

Agricultural University in Lublin
ul. Akademicka 13
20-950 Lublin
Phone: +48-81-445-6066/48-81-445-6677, 48-81-445-6868 (Rector's Office)
Fax: +48-81-533-3549
Email: poczta@ar.lublin.pl
Web: http://www.ar.lublin.pl

Chair of Agricultural and Environmental Chemistry (Katedra Chemii Rolnej i Środowiskowej)
Chair of Agricultural Ecology (Katedra Ekologii Rolniczej)
Chair of Biochemistry and Food Chemistry (Katedra Biochemii i Chemii Żywności)
Chair of Biochemistry and Toxicology (Katedra Biochemii i Toksykologii)
Department of Analysis and Evaluation of Food Quality (Zakład Analizy i Oceny Jakości Żywności)

Gdańsk University of Technology
ul. G. Narutowicza 11/12
80-952 Gdańsk-Wrzeszcz
Phone: +48-58-347-1100
Fax: +48-58-341-5821
Email: rektor@pg.gda.pl (Rector's Office)
Web: http://www.pg.gda.pl

Centre for Environmental Studies (Centrum Ochrony Środowiska)
Centre of Excellence in Environmental Analysis and Monitoring (http://www.pg.gda.pl/chem/ CEEAM)

Jagiellonian University in Kraków
ul. Gołębia 24
31-007 Kraków
Phone: +48-12-422-1033
Fax: +48-12-422-3229 (Rector's Office)
Email: rektor@adm.uj.edu.pl (Rector's Office)
Web: http://www.uj.edu.pl

Chair of Occupational Medicine and Environmental Diseases (http://www.cm-uj.krakow.pl/pliki/struktura.php?kod=000424&w=a)
Chair of Toxicology (Katedra Toksykologii)

Environmental Chemistry Research Group (http://www.chemia.uj.edu.pl/zespol_en.php?id=10029)
Department of Bromatology (Zakład Bromatologii)
Department of Ecotoxicology (http://www.eko.uj.edu.pl/ecotox/en/index.html)
Department of Environmental Health (Zakład Zdrowia i Środowiska)
Department of Toxicological Biochemistry (Zakład Biochemii Toksykologicznej)

Kazimierz Wielki University in Bydgoszcz
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85-064 Bydgoszcz
Phone: +48-52-341-9100
Fax: +48-52-341-3533 (Rector's Office)
Email: rektor@ukw.edu.pl (Rector's Office)
Web: http://www.ukw.edu.pl

Department of Ecology (Zakład Ekologii)
Department of Environmental Protection (Zakład Ochrony Środowiska)
Department of Physiology and Toxicology (Zakład Fizjologii i Toksykologii)

Kielce University of Technology
al. Tysiąclecia Państwa Polskiego 7
25-314 Kielce
Phone: +48-41-342-4444
Fax: +48-41-344-2997
Email: promocja@tu.kielce.pl
Web: http://www.tu.kielce.pl

Division of Environmental Protection (Samodzielny Zakład Ochrony Środowiska)

Koszalin University of Technology
ul. Śniadeckich 2
75–453 Koszalin
Phone: +48-94-342-7881/48-94-347-8399
Fax: +48-94-347-8619 (Rector's Office)
Email: jmr@tu.koszalin.pl (Rector's Office)
Web: http://www.tu.koszalin.pl

Laboratory of Toxicology (http://www.wbiis.tu.koszalin.pl/labtox)

Maria Curie-Skłodowska University in Lublin
pl. M. Curie-Skłodowskiej 5
20–031 Lublin
Phone: +48-81-537-5100
Fax: +48-81-533-3669 (Rector's Office)
Email: rector@umcs.lublin.pl (Rector's Office)
Web: http://www.umcs.lublin.pl

Department of Ecology (Zakład Ekologii)
Department of Environmental Chemistry (Zakład Chemii Środowiskowej)
Department of Environmental Microbiology (Zakład Mikrobiologii Środowiskowej)
Department of Environmental Protection (Zakład Ochrony Środowiska)
Department of Nature Protection (Zakład Ochrony Przyrody)

Medical University of Białystok
ul. J. Kilińskiego 1
15-089 Białystok
Phone: +48-85-748-5400, 48-85-748-5501
Fax: +48-85-748-5501 (English Division)
Email: rektor@amb.edu.pl (Rector's Office)
Web: http://www.amb.edu.pl

Department of Bromatology (Zakład Bromatologii)
Department of Toxicology (http://www.amb.edu.pl/wydzialy/farmacja-english/Zaklad%20Toksykologii.htm)

Medical University of Gdańsk
ul. M. Skłodowskiej-Curie 3a
80-210 Gdańsk
Phone: +48-58-349-2222
Fax: +48-58-520-4038 (Rector's Office)
Email: rektor@amg.gda.pl (Rector's Office)
Web: http://www.amg.gda.pl

Chair and Department of Bromatology (Katedra i Zakład Bromatologii)
Chair and Department of Toxicology (Katedra i Zakład Toksykologii)
Department of Environmental Toxicology (Zakład Toksykologii Środowiska)

Medical University of Lublin
Al. Racławickie 1
20-059 Lublin
Phone: +48-81-532-0061
Fax: +48-81-532-4633 (Rector's Office)
Email: biuro.rektora@am.lublin.pl (Rector's Office)
Web: http://www.am.lublin.pl

Chair and Department of Bromatology (Katedra i Zakład Bromatologii)
Chair and Department of Toxicology (Katedra i Zakład Toksykologii)
Chair of Pharmacology (Katedra Farmakologii)

Medical University of Łódź
al. T. Kościuszki 4
90-419 Łódź
Phone: +48-42-632-2347, 48-42-639-3976
Fax: +48-42-632-2347
Email: rektor@rkt.am.lodz.pl (Rector's Office)
Web: http://www.umed.lodz.pl

Chair of Toxicology and Bromatology (Katedra Toksykologii i Bromatologii)

Medical University of Silesia in Katowice
ul. Warszawska 14
40-006 Katowice
Phone: +48-32-208-3600
Fax: +48-32-208-3561 (Rector's Office)
Email: rektor@sum.edu.pl (Rector's Office)
Web: http://www.slam.katowice.pl

Chair and Department of Hygiene, Bioanalysis, and Environment (Katedra i Zakład Higieny, Bioanalizy i Badania Środowiska)
Chair and Department of Toxicology (Katedra i Zakład Toksykologii)
Department of Environmental Safety and Toxicology (Zakład Bezpieczeństwa Środowiskowego i Toksykologii)
Department of Forensic and Medical Toxicology (Zakład Toksykologii Sądowo-Lekarskiej)

Medical University of Warsaw
ul. Żwirki i Wigury 61
02-091 Warszawa
Phone: +48-22-572-0913
Fax: +48-22-572-0161 (Rector's Office)
Email: rektor@am.edu.pl (Rector's Office)
Web: http://www.am.edu.pl

Chair and Department of Bromatology (Katedra i Zakład Bromatologii)
Chair and Department of Toxicology (Katedra i Zakład Toksykologii)
Department of Environmental Health Sciences (Zakład Badania Środowiska)

Nicolaus Copernicus University
ul. J. Gagarina 11
87-100 Toruń
Phone: +48-56-611-4010
Fax: +48-56-654-2944 (Rector's Office)
Email: kontakt@umk.pl
Web: http://www.umk.pl

Chair and Department of Bromatology (Katedra i Zakład Bromatologii)
Chair and Department of Toxicology (Katedra i Zakład Toksykologii)
Department of Ecology and Environmental Protection (Zakład Ekologii i Ochrony Środowiska)
Department of Environmental Chemistry and Ecoanalytics (http://www.chem.uni.torun.pl/en/ezaklady.html)
Department of Gene Toxicology (Zakład Genotoksykologii)

Pomeranian Medical University
ul. Rybacka 1
70-204 Szczecin
Phone: +48-91-480-0700, 48-91-480-0800
Fax: +48-91-480-0705 (Rector's Office)
Email: rector@sci.pam.szczecin.pl (Rector's Office)
Web: http://www.pam.szczecin.pl

Department of Forensic Medicine (http://www.pam.szczecin.pl/index_en.php?cid=227&unroll=186)

Poznań University of Medical Sciences
ul. A. Fredry 10
61-701 Poznań
Phone: +48-61-854-6000
Fax: +48-61-852-0455 (Rector's Office)
Email: info@ump.edu.pl
Web: http://ump.edu.pl/http://amp.edu.pl

Chair and Department of Bromatology (Katedra i Zakład Bromatologii)
Chair of Biology and Environmental Protection (Katedra Biologii i Ochrony Środowiska)
Department of Toxicology (http://www.toksykologia.amp.edu.pl/english/index_en.htm)

The John Paul II Catholic University of Lublin
Al. Racławickie 14
20-950 Lublin
Phone: +48-81-445-4101
Fax: +48-81-445-4123 (Rector's Office)
Email: oinfo@kul.pl
Web: http://www.kul.pl/uk/ http://www.kul.lublin.pl/uk/ http://www.kul.pl/ http://www.kul.lublin.pl

Environmental Protection Institute (Instytut Ochrony Środowiska)

The Silesian University of Technology
ul. Akademicka 2
44-100 Gliwice
Phone: +48-32-237-1000, 48-32-237-2100
Fax: +48 32-237-1655 (Rector's Office)
Email: R-BR@polsl.pl (Rector's Office)
Web: http://www.polsl.pl

Environmental Biotechnology Department (http://kbs.ise.polsl.pl/etomite)

University of Agriculture in Szczecin
ul. Janosika 8
71-424 Szczecin
Phone: +48-91-422-0851
Fax: +48-91-423-2417 (Rector's Office)
Email: rektor@ar.szczecin.pl (Rector's Office)
Web: http://www.ar.szczecin.pl

Chair of Toxicology (Katedra Toksykologii)

University of Gdańsk
ul. J. Bażyńskiego 1a
80-952 Gdańsk

Phone: +48-58-523-2043, 48-58-523-2407 (Rector's Office)
Fax: +48-58-552-0311 (Rector's Office)
Email: rekug@univ.gda.pl (Rector's Office)
Web: http://www.ug.gda.pl/, http://www.univ.gda.pl

Chair of Environmental Analysis (Katedra Analizy Środowiska)
Division of Environmental Chemistry and Ecotoxicology (Zakład Chemii Środowiska i Ekotoksykologii)

University of Łódź
ul. G. Narutowicza 65
90-131 Łódź
Phone: +48-42-635-4000
Fax: +48-42-635-4043, 48-42-665-5771
Email: rektoratul@uni.lodz.pl (Rector's Office)
Web: http://www.uni.lodz.pl
Division of Environmental Chemistry (http://www.phys.uni.lodz.pl/ktchos/index_environment_en.html)

University of Silesia
ul. Bankowa 12
40-007 Katowice
Phone: +48-32-359-1956 ~58, 48-32-359-2400
Fax: +48-32-359-2055 (Rector's Office)
Email: info@us.edu.pl
Web: http://www.us.edu.pl

Chair of Animal Physiology and Ecotoxicology (Katedra Fizjologii Zwierząt i Ekotoksykologii)

University of Warmia and Mazury in Olsztyn
ul. M. Oczapowskiego 2
10-719 Olsztyn
Phone: +48-89-523-4913
Fax: +48-89-523-4456 (Rector's Office)
Email: rektor@uwm.edu.pl (Rector's Office)
Web: http://www.uwm.edu.pl

Chair of Botany and Nature Protection (Katedra Botaniki i Ochrony Przyrody)
Chair of Ecology and Environmental Protection (Katedra Ekologii i Ochrony Środowiska)
Chair of Environmental Engineering (Katedra Inżynierii Środowiska)
Chair of Environment Protection Engineering (Katedra Inżynierii Ochrony Środowiska)
Department of Agricultural Chemistry and Environment Protection (Katedra Chemii Rolnej i Ochrony Środowiska)
Department of Air Protection and Environmental Toxicology (Katedra Ochrony Powietrza i Toksykologii Środowiska)
Department of Environmental Biotechnology (Katedra Biotechnologii w Ochronie Środowiska)
Department of Environmental Chemistry (http://www.uwm.edu.pl/kchemsr/eng_ver.htm)

University of Wrocław
pl. Uniwersytecki 1
50-137 Wrocław
Phone: +48-71-343-6847, 48-71-375-2212 (Rector's Office)
Fax: +48-71-344-3421 (Rector's Office)
Email: rektor@adm.uni.wroc.pl (Rector's Office)
Web: http://www.uni.wroc.pl

Department of Ecology and Nature Protection (http://culex.biol.uni.wroc.pl/instbot/ecology)
Section for Environmental Chemistry and Protection (Zakład Chemii i Ochrony Środowiska)

Warsaw Agricultural University
ul. Nowoursynowska 166
02-787 Warszawa
Phone: +48-22-593-1000
Fax: +48-22-593-1087, 48-22-593-1089 (Main Office)
Email: kancelaria@sggw.pl
Web: http://www.sggw.waw.pl

Division of Pharmacology and Toxicology

Warsaw University of Technology
pl. Politechniki 1
00-661 Warszawa
Phone: +48-22-234-7211
Fax: +48-22-621-6892 (Rector's Office)
Email: pw@pw.edu.pl (Rector's Office)
Web: http://www.pw.edu.pl

Department of Environmental Biology (Zakład Biologii Środowiska)
Department of Environmental Chemistry (Zakład Chemii Środowiska)

Wrocław Medical University
ul. L. Pasteura 1
50-367 Wrocław
Phone: +48-71-784-0001 (Rector's Office)
Fax: +48-71-784-0109 (Rector's Office)
Email: rektor@am.wroc.pl (Rector's Office)
Web: http://www.am.wroc.pl

Chair and Department of Bromatology
Chair and Department of Toxicology

Wrocław University of Environmental and Life Sciences
ul. C. K. Norwida 25/27
50-375 Wrocław
Phone: +48-71-320-5020

Fax: +48-71-320-5404 (Rector's Office)
Email: jmr@ozi.ar.wroc.pl (Rector's Office)
Web: http://www.ar.wroc.pl

Department of Biochemistry, Pharmacology, and Toxicology (Katedra Biochemii, Farmakologii i Toksykologii)

Wrocław University of Technology
Wybrzeże S. Wyspiańskiego 27
50-370 Wrocław
Phone: +48-71-320-2600
Fax: +48-71-322-3664 (Rector's Office)
Email: promocja@pwr.wroc.pl
Web: http://www.pwr.wroc.pl

Department of Biology and Ecology (Zakład Biologii i Ekologii)

Professional Societies

Polish Association of Industrial Hygienists
Mailing Address:
ul. św.Teresy od Dzieciątka Jezus 8
91-348 Łódź
Phone: +48-42-631-4701
Fax: +48-42-631-4702
Email: malgo@imp.lodz.pl
Web: http://www.imp.lodz.pl/pthp/pthp.htm

A professional and scientific organization registered in 1992. Its objectives include promoting progress in the area of occupational hygiene, upgrading the professional and scientific qualifications of its members, supporting research work, and developing appropriate forms of training and post-graduate education. The Association has over 300 members.

Polish Association of Occupational Medicine (Polskie Towarzystwo Medycyny Pracy)
Zarząd Główny PTMP (Head Office)
ul. Św. Teresy od Dzieciątka Jezus 8
91-348 Łódź
Fax: +48-42-631-4719
Web: http://www.imp.lodz.pl/ptmp/ptmp.htm

Established in 1969, the Association promotes development of occupational medicine in Poland. It co-publishes with the Nofer Institute of Occupational Medicine (http://www.imp.lodz.pl) 'International Journal of Occupational Medicine and Environmental Health' (ISSN: 1232-1087) and 'Medycyna Pracy' (ISSN: 0465-5893). The Association has over 1800 members.

Polish Association of Public Health (Polskie Towarzystwo Zdrowia Publicznego)
Zarząd Główny PTZP (Head Office)
ul. św. Teresy od Dzieciątka Jezus 8
91-348 Łódź
Phone: +48-42-631-4846
Fax: +48-42-631-4849
Web: http://www.imp.lodz.pl/ptzp

Established in 1993, the Association promotes progress in the area of public health in Poland. The Association comprises seven regional sections.

Polish Biochemical Society
Zarząd Główny PTBioch (Head Office)
Instytut Biologii Doświadczalnej im. M. Nenckiego
ul. L. Pasteura 3
02-093 Warszawa
Phone: +48-22-589-2499
Email: ptbioch@nencki.gov.pl
Web: http://www.ptbioch.edu.pl

Founded in 1958, the Society promotes and supports all aspects of biochemistry in Poland by: holding national and international scientific conferences, symposia, meetings, etc.; publishing scientific journals, books and monographs; and maintaining close links with related societies in Poland and abroad. It co-publishes with the Committee of Biochemistry and Biophysics, Polish Academy of Sciences 'Acta Biochimica Polonica' (ISSN: 0001-527X) and publishes 'Postępy Biochemii' (ISSN: 0032-5422). The Society has about 1200 members.

Polish Chemical Society
ul. Freta 16
00-227 Warszawa
Phone: +48-22-831-1304
Email: ZGPTChem@chemix.ch.pw.edu.pl
Web: http://www.ptchem.lodz.pl

Established in 1919, the Society aims to promote chemical sciences and spread chemical knowledge in society through a host of activities, including the following: organizing meetings, sessions, and conferences of chemists; organizing public lectures and scientific courses; and publishing journals connected with the Society's activities (e.g., 'Polish Journal of Chemistry', ISSN: 0137-5083).

Polish Medical Association (Polskie Towarzystwo Lekarskie)
Al. Ujazdowskie 22
00-478 Warszawa
Phone: +48-22-628-2988/48-22-628-8699
Fax: +48-22-628-8699
Email: ptl@interia.pl
Web: http://ptl.org.pl

Established in 1951, the Society organizes continuing education for physicians and promotes the maintenance of the highest professional standards in the field.

The Association comprises 43 regional sections and has about 22 000 members. It publishes 'Polski Merkuriusz Lekarski' (ISSN: 1426-9686), 'Przegląd Lekarski' (ISSN: 0033-2240), and 'Wiadomości Lekarskie' (ISSN: 0043-5147).

Polish Medical Society of Radiology
President
Katedra Radiologii Medycyny Nuklearnej
Śląska Akademia Medyczna
ul. Medyków 14
40-752 Katowice
Phone: +48-32-252-5566
Fax: +48-32-252-5566
Email: gwawrzonek@csk.katowice.pl
Web: http://www.polradiologia.org (click 'Radiology in Poland')

With its origin dating back to 1925, the Society has a history of providing an atmosphere for professional exchange among radiologists through meetings, scientific publications, and continuing education. The Society publishes 'Polish Journal of Radiology' (ISSN: 1733-134X).

Polish Pharmaceutical Society (Polskie Towarzystwo Farmaceutyczne)
Zarząd Główny PTFarm (Head Office)
ul. Długa 16
00-238 Warszawa
Phone: +48-22-831-1542
Fax: +48-22-831-1542
Email: zarzad@ptfarm.pl
Web: http://www.ptfarm.pl

Established in 1947, the Society promotes the development of pharmaceutical sciences in Poland. It publishes 'Acta Poloniae Pharmaceutica – Drug Research' (ISSN: 0001-6837), 'Bromatologia i Chemia Toksykologiczna' (ISSN: 0365-9445), and 'Farmacja Polska' (ISSN: 0014-8261). The Society has about 7000 members.

Polish Pharmacological Society
Zarząd Główny PTF (Head Office)
Katedra i Zakład Farmakologii Doświadczalnej i Klinicznej
ul. Krakowskie Przedmieście 26/28
00-927 Warszawa
Phone: +48-22-826-2116
Fax: +48-22-826-2116
Email: phawar@hotmail.com
Web: http://pharmacology.slam.katowice.pl (click the Polish flag)

The Society was established in 1965 and promotes the development of pharmacology and toxicology in Poland.

Polish Society of Environmental Medicine (Polskie Towarzystwo Medycyny Środowiskowej)
Zarząd Główny PTMŚ (Head Office)
Institute of Occupational Medicine and Environmental Health
ul. Kościelna 13
41-200 Sosnowiec
Web: http://www.imp.sosnowiec.pl/modules.php?name=Content&pa=showpage&pid=27

The Society promotes progress in environmental medicine and environmental health in Poland. It co-publishes with the Institute of Occupational Medicine and Environmental Health (http://www.imp.sosnowiec.pl) 'Medycyna Środowiskowa' (ISSN: 0465-5893).

Polish Society of Toxicology
Mailing address:
Zarząd Główny PTTox (Head Office)
ul. św.Teresy od Dzieciątka Jezus 8
91-348 Łódź
Phone: +48-42-631-4502/48-42-655-2505
Fax: +48-42-656-8331
Email: impx@imp.lodz.pl
Web: http://www.imp.lodz.pl/nowy_pttox/, http://www.pttox.farm.amwaw.edu.pl

Created in 1978, the Society's aims and objectives are as follows: organizing and supporting all activities in furtherance of toxicological research; associating all toxicologists; disseminating cutting-edge scientific achievements in toxicological research; informing the public about current toxicological problems; and representing Polish toxicology nationally and abroad. The Society comprises 10 regional sections gathering over 300 members. It publishes 'Acta Toxicologica' (ISSN: 1731-6383). The Society is a member of EUROTOX (http://www.eurotox.com) and IUTOX (http://www.iutox.org).

Polish Society of Veterinary Sciences
Zarząd Główny PTNW (Head Office)
ul. Nowoursynowska 159c
02-776 Warszawa
Phone: +48-22-593-1606
Fax: +48-22-593-1606
Email: ptnw@sggw.pl
Web: http://www.ptnw.pl

The Society was founded in 1952 and directs activities towards: developing and propagating veterinary sciences in Poland; motivating scientific research; encouraging and supporting educational and specialization programs; and representing Polish veterinary sciences internationally. The Society co-publishes 'Medycyna Weterynaryjna' (ISSN: 0025-8628).

Poison Control Centers

Gdańsk
1st Department of Internal Diseases and Acute Poisonings
Institute of Internal Diseases
Medical University of Gdańsk
ul. Dębinki 7
80-211 Gdańsk
Phone: +48-58-301-6516
Fax: +48-58-301-6516
Email: klintox@amg.gda.pl
Web: http://etox.2p.pl/IKlinikaGdansk.html

Kraków
Department of Toxicology and Environmental Diseases (Oddział Toksykologii i Chorób Środowiskowych)
Ludwik Rydygier Memorial Provincial Specialist Hospital
Os. Złotej Jesieni 1
31-826 Kraków
Phone: +48-12-646-8404, 48-12-646-8985
Fax: +48-12-646-8985
Email: mfpach@cyf-kr.edu.pl
Web: http://www.rydygier.tpnet.pl/toksykologia.html

Lublin
Department of Internal Medicine and Cardiology with Regional Centre for Clinical Toxicology (Oddział Internistyczno-Kardiologiczny z Regionalnym Ośrodkiem Toksykologii Klinicznej)
Independent Public Provincial Jan Boży Memorial Hospital in Lublin
ul. M. Biernackiego 9
20-089 Lublin
Phone: +48-81-740-2675
Email: toksykologia.janbozy@wp.pl
Web: http://www.top.lublin.pl/janbozy/o_kartox.htm

Łódź
Department of Clinical Toxicology
Nofer Institute of Occupational Medicine
ul. św.Teresy od Dzieciątka Jezus 8
91-348 Łódź
Phone: +48-42-631-4752, 48-42-631-4753
Email: zbiko@imp.lodz.pl
Web: http://www.imp.lodz.pl (click 'English', then 'structure')

Poznań
Department of Toxicology and Internal Diseases (Oddział Toksykologii i Chorób Wewnętrznych im. dr Wandy Błeńskiej)
Independent Public Health Care Institution Poznań-Jeżyce
Franciszek Raszeja Memorial Hospital in Poznań
ul. A. Mickiewicza 2
60-834 Poznań
Phone: +48-61-848-1011 ext. 268, 48-61-848-1351
Email: toksy@interia.pl
Web: http://www.raszeja.poznan.pl (click 'Oddziały szpitalne')

Rzeszów
Department of Anesthesiology and Intensive Care with Centre for Acute Poisonings (Oddział Anestezjologii i Intensywnej Terapii z Ośrodkiem Ostrych Zatruć)
Provincial Hospital No 2 in Rzeszów
ul. Lwowska 60
35-301 Rzeszów
Phone: 48-17-866-4402
Web: http://www.szpital2.rzeszow.pl (click 'Oddziały', in 'Menu Oddziały' click 'Oddziały', and then 'Intensywnej Terapii')

Sosnowiec
Regional Centre for Clinical Toxicology (Regionalny Ośrodek Toksykologii Klinicznej)
Institute of Occupational Medicine and Environmental Health
ul. Kościelna 13
41-200 Sosnowiec
Phone: +48-32-266-1145
Web: http://www.imp.sosnowiec.pl/modules.php?name=Content&pa=showpage&pid=79

Tarnów
2nd Department of Internal Diseases and Acute Poisonings (Oddział Wewnętrzny II i Ostrych Zatruć)
St. Łukasz Provincial Hospital SPZOZ in Tarnów
ul. Lwowska 178A
33-100 Tarnów
Phone: +48-14-631-5497
Web: http://www.tarnow.net.pl/dane_firm/202/?pokaz=towar &tid=4536&fid=202

Warszawa
3rd Department of Internal Diseases (III Oddział Chorób Wewnętrznych)
Praski Hospital SPZOZ
al. Solidarności 67
03-401 Warszawa
Phone: +48-22-818-5061 ext. 1240
Web: http://www.praski.waw.pl (click 'Oddziały')

Wrocław
Department of Toxicology (Oddział Toksykologiczny)
Lower Silesian Specialist Tadeusz Marciniak Memorial Hospital – Centre of Rescue Medicine
ul. R. Traugutta 116

50-420 Wrocław
Phone: +48-71-7890342
Email: ooz.ww@interia.pl
Web: http://www.szpital-marciniak.wroclaw.pl (click 'Oddziały', then 'Tokykologiczny')

Legislation

CIS Centres: Legislation – Poland
Web: http://www.ciscentres.org/en/legislation/POL

Governmental Centre for Legislation (Rządowe Centrum Legislacji)
Web: http://www.rcl.gov.pl

This is the editorial office of the following journals: 'Journal of Laws of the Republic of Poland' (Dziennik Ustaw Rzeczypospolitej Polskiej; ISSN: 0867-3411) and the Official Journal of the Republic of Poland 'Monitor Polski' (ISSN: 0209-214X).

Law Library of Congress: Poland
Web: http://www.loc.gov/law/guide/poland.html

The World Law Guide: Legislation Poland
Web: http://www.lexadin.nl/wlg/legis/nofr/eur/lxwepol.htm

World Legal Information Institute: Poland
Web: http://www.worldlii.org/catalog/2250.html

Miscellaneous Resources

AIRCLIM-NET
Web: http://www.ietu.katowice.pl/airclim-net/index.htm

Polish thematic network for problems of air pollution and climate change. It has been established to cluster scientific and research potential active in the field of air pollution and climate change in order to strengthen the position of research work in the development of the European Research Area (http://ec.europa.eu/research/era/index_en.html).

Baltic Sea Network on Occupational Health and Safety: Poland
Web: http://www.balticseaosh.net/poland/index.shtml

The Baltic Sea Network is an expert information network. Its purpose is to strengthen peer-to-peer networking and collaboration of expert institutions and respective bodies in occupational health and safety, between and within countries in the Baltic Sea region.

Clinical Toxicology Internet Service (Internetowy Serwis Toksykologii Klinicznej)
Web: http://www.etox.2p.pl

An interactive, region-specific, directory of toxicologists in Poland.

EcoFund Foundation
Web: http://www.ekofundusz.org.pl

EcoFund is a foundation called into being in 1992 by the Ministry of Finance of the Republic of Poland to efficiently administer the money derived from the conversion of a part of the foreign debt of Poland into a fund intended to support environmental protection projects.

ekoinfo.pl – Environmental Protection Information Service (ekoinfo.pl – Serwis Informacyjny Ochrony środowiska)
Web: http://www.ekoinfo.pl

eko-net.pl – Service for Specialists of Environmental Protection (eko-net.pl – Serwis dla Specjalistów Ochrony Środowiska)
Web: http://www.eko-net.pl

A site designed to provide professional advice to environmental managers in Polish companies and public administration aimed at: facilitating the access to information needed by those running a business with respect to law and good practices, and preventing negative impacts on the environment.

Ekopartner
Web: http://www.ekopartner.com.pl

A monthly magazine (ISSN: 1230-2961) on the environment and sustainable development, published since 1991 by Green Park Foundation (http://www.fundacjagreen.net). Presents views, opinions, and practical knowledge on how to manage the environment.

Environment Protection in Poland
Web: http://www.geo.uw.edu.pl/LINKI/ECO/eco.html

An alphabetically arranged database of Polish environmental resources available on the Internet.

ENVITECH-Net
Web: http://www.envitech-net.org

Its mission is to integrate applied research with the needs of industry and facilitate development of innovative environmental technologies for building sustainable future.

European Association of Poisons Centres and Clinical Toxicologists (EAPCCT)
Web: http://www.eapcct.org

A website of the European Association of Poisons Centres and Clinical Toxicologists.

European Chemicals Agency (ECHA)
Web: http://ec.europa.eu/echa

An Agency established with aiding countries with the implementation of the regulation concerning the

Registration, Evaluation and Authorisation of Chemicals (REACH; http://ec.europa.eu/environment/chemicals/reach/reach_intro.htm).

European Chemicals Bureau (ECB)
Web: http://ecb.jrc.it

A Bureau that provides scientific and technical support for the conception, development, implementation, and monitoring of European Union policies related to dangerous chemicals.

European Ecological Natura 2000 Network
Web: http://natura2000.mos.gov.pl/natura2000

A website prepared with financial support of the European Union in the framework of the Poland and Hungary: Assistance for Restructuring their Economies (PHARE) Twinning Project 'Implementation of the European Ecological Natura 2000 Network in Poland'.

European Environment Information and Observation Network (EIONET)
Web: http://www.eionet.europa.eu

A partnership network of the European Environment Agency (EEA; http://www.eea.europa.eu) and its members and participating countries. The network supports the collection and organization of data and the development and dissemination of information concerning Europe's environmental information.

EIONET: Poland
Web: http://www.eionet.europa.eu/Countries/Poland

National Focal Point – Poland
Web: http://nfp-pl.eionet.eu.int

The Chief Inspectorate for Environmental Protection is the Polish National Focal Point of the EEA and the EIONET in Poland.

State of the Environment Reporting Information System (SERIS): Poland
Web: http://www.eionet.europa.eu/seris/view_on_coverage? country=pl

An open-access database with recent publications (1995 onwards) on the state of the environment in Poland.

Foundation for Polish Science
Web: http://www.fnp.org.pl

An independent, self-financing non-profit organization established in 1991 as a result of the system transformation in Poland. The Foundation's mission is to provide assistance and support to the scientific community in Poland.

Health Market (Rynek Medyczny)
Web: http://www.rynekmedyczny.pl

A multilingual, open access, interactive directory of Polish healthcare providers.

INFOBAZA – National Information Service of Databases and Software for Science (INFOBAZA – Krajowy Informator o Bazach Danych i Oprogramowaniu dla Nauki)
Web: http://infobaza.task.gda.pl

A search engine for locating Polish scientific databases and computer programs.

Journals Showcase
Web: http://witryna.czasopism.pl

Matters of Science – Bulletin of the Minister of Science and Higher Education (Sprawy Nauki – Biuletyn Ministra Nauki i Szkolnictwa Wyższego)
Web: http://www.sprawynauki.waw.pl

Medical Sites and Portals
Web: http://www2.bg.am.poznan.pl/inne/serwisy

ngo.pl – Portal of Non-Government Organizations (ngo.pl – Portal Organizacji Pozarządowych)
Web: http://www.ngo.pl

A compilation of resources available to non-governmental organizations (NGOs), including: a database of NGOs, the Polish voluntary sector, statistics and reports, and European Union funds in Poland. It is administered by Klon/Jawor Association (http://www.klon.org.pl).

Office of the Committee for European Integration
Web: http://www.ukie.gov.pl

It co-ordinates the works of all ministries and institutions directly engaged in the process of Poland's integration with the European Union.

Polish Clinical Toxicology
Web: http://www.poltox.net

An online resource with information on Polish toxicology centers.

Polish Portal of Environmental Protection (Ogólnopolski Portal Ochrony Środowiska)
Web: http://www.ppozbhp.pl/?3

Polish Portal of Occupational Safety and Health (Ogólnopolski Portal Bezpieczeństwa i Higieny Pracy)
Web: http://www.ppozbhp.pl/?2

Science in Poland
Web: http://www.staff.amu.edu.pl/~zbzw/ph/sci/naupol.htm

An overview of science in Poland, with topics covering: Nobel Prize laureates; famous discoverers, travelers, and scientists; a directory of scientific institutions; and searchable databases.

Science & Scholarship in Poland
Web: http://www.naukawpolsce.pl

An open-access service providing information on the achievements of over 60000 Polish scientists and scholars, their discoveries and inventions, and their inquiries into man, nature, and space. It reports on the life of Polish universities and research institutes as well as the most interesting events in the field both in Poland and worldwide.

The Central Medical Library (Główna Biblioteka Lekarska im. Stanisława Konopki)
Web: http://www.gbl.waw.pl

An online gateway providing access to resourses of the Central Medical Library. The Library, established in 1945, collects Polish medical and related literature as well as important titles of World medical literature.

The Internet Public Library: Poland
Web: http://www.ipl.org/div/news/browse/PL

A collection of links to Polish resources indexed by the University of Michigan's School of Information, USA.

The National Library
Web: http://www.bn.org.pl

The Researcher's Mobility Portal – Poland
Web: http://www.eracareers-poland.gov.pl

A collection of online resources intended to aid researchers planning on conducting research in Poland.

UNEP/GRID-Warsaw
Web: http://www.gridw.pl

Established in 1991 pursuant to the official agreement signed between the Director of the United Nations Environment Programme (UNEP; http://www.unep.org) and the Ministry of the Environment, Forestry, and Natural Resources of the Republic of Poland, UNEP/GRID (Global Resource Information Database) is a specialized center in charge of collecting and processing environmental information concerning Poland and Central and Eastern Europe.

University Accreditation Commission
Web: http://uka.amu.edu.pl

Provides standards and guidelines for quality assurance in the Polish higher education area.

Word Heath Organization (WHO)
Web: http://www.who.int

IPCS Directory of Poison Centres: European Region
Web: http://www.who.int/ipcs/poisons/centre/directory/euro/en (click 'Poland')

Country-specific listings of Poison Control Centres compiled by the International Programme on Chemical Safety.

WHO: Countries: Poland
Web: http://www.who.int/countries/pol/en

WHO Regional Office for Europe: Poland
Web: http://www.euro.who.int/countryinformation/CtryInfoRes?COUNTRY=POL

Online Databases

Biodiversity Clearing House Mechanism in Poland
Web: http://www.biodiversity-chm.org.pl

The main goal of this service is to ensure the mechanism of efficient exchange of information on biological diversity in Poland between involved persons and institutions.

Genetically Modified Organisms
Web: http://gmo.mos.gov.pl

Geological Cartography of Poland – Map Series
Web: http://www.pgi.gov.pl/mapy

Integrated Pollution Prevention and Control Poland (IPPC Poland)
Web: http://ippc.mos.gov.pl/preview/pl/ippc-ps_index.html

Internet Database of Treaties (Internetowa Baza Traktatowa)
Web: http://www.msz.gov.pl/apps/apps/?portlet=bpt/ linki

A site managed by the Ministry of Foreign Affairs of the Republic of Poland that contains lists and texts of all international treaties for which Poland is or was a party since January 1, 1950.

Internet System of Legal Acts (Internetowy System Aktów Prawnych)
Web: http://isip.sejm.gov.pl

An information resource managed by the Polish parliament, which contains bibliographic descriptions of all legislation since 1919.

Occupational Safety and Health Online (BHP Online)
Web: http://www.ciop.pl/7501.html

An access site for several databases managed by the Central Institute for Labour Protection – National Research Institute.

On-line Database on National Air Emission Inventories
Web: http://emissions.ios.edu.pl

Polish Environmental Impact Assessment Information and Communication System – INFOOS (Polski System Informacyjny Ocen Oddziaływania na Środowisko)
Web: http://www.mos.gov.pl:1090/fsystem

A publicly accessible list of data on documents containing information on the environment and its protection. User ID: gosc; password: gosc.

Polish Science (Nauka Polska)
Web: http://nauka-polska.pl

A searchable database of Polish science.

Polish Scientific Journal Contents
Web: http://psjc.icm.edu.pl

A searchable database of life science journals indexed by Index Copernicus.

Public Information Bulletin (Biuletyn Informacji Publicznej)
Web: http://www.bip.gov.pl

An easy access portal to important public information.

The National Library Computer Catalog
Web: http://alpha.bn.org.pl/screens/mainmenu.html

WebOPAC catalog of the National Library in Warsaw, Poland.

CHAPTER

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Russia

B.A. KURLYANDSKIY, KH.KH. KHAMIDULINA, AND K.K. SIDOROV

HISTORY AND CURRENT STATE OF TOXICOLOGY IN RUSSIA

The history of toxicology in Russia is believed to date back to the late 18th and early 19th centuries. Toxicological studies were pursued more intensively at the Medical Surgical (Military Medical) Academy in St. Petersburg during the 19th century. As in other countries, the science of toxicology in Russia had its origin in forensic medicine and pharmacology.

During the early 20th century the growth of the chemical and military industries greatly contributed to the development of toxicology. Military toxicology advanced in parallel with military chemistry in the wake of World War I and for decades thereafter. It played an important role in the development of all the branches of classical toxicology: theoretical (fundamental principles), prophylactic, and chemical.

The most authoritative school in military toxicology emerged in today's St. Petersburg (formerly Petrograd and Leningrad). Later two other prominent schools in military toxicology were founded in Moscow and in Kiev.

The expansion of industrial toxicology dates from 1920s. In 1923 in Moscow the Research Institute of Occupational Diseases (now Research Institute of Occupational Health) was founded. Years later similar institutes were established in Kharkov (1923), Leningrad (1924), Baku (1924), Donetsk (1925), Sverdlovsk (now Ekaterinburg) in 1925 and others. Thanks to a wide range of research activities, for the first time basic principles for regulation of industrial poisons were formulated. The founders of Russian industrial toxicology were N.V. Lazarev (1895–1974) and N.S. Pravdin (1882–1954).

By the end of the 1960s basic principles of studying exposures to chemicals became clearly defined. During that period monographs summarizing the outcome of various studies were published by outstanding Soviet toxicologists.

A new stage in the history of toxicology was the rapid development of clinical and pharmacological toxicology. A specialized center for treatment of acute poisonings was opened under the auspices of the N.V. Sklifosovskiy Research Emergency Aid Institute in Moscow in 1963. E.A. Luzhnikov was a leader in the formation of the center. Around the same period, in Leningrad a similar center was established at the Military Medical Academy and on the basis of a military field hospital and a municipal emergency care center. Currently Russia has more than 46 poison centers.

The modern history of Russian toxicology is characterized by a number of important theoretical generalizations. Among them is the idea of common mechanisms of toxic actions of chemicals based on common biological concepts concerning the universal responses of living organisms to toxic exposures.

Another important achievement of Russian toxicology was the principle of natural detoxification which emerged from biochemical toxicology. Natural detoxification was considered the basis of adaptation and compensation mechanisms exhibited by organisms exposed to chemicals.

The emergence of extensive pesticide use in the 1960s and 1970s dictated increased investigations into the toxicology of these chemicals. Since the mid-1960s

and up to now chronic effects, such as carcinogenicity, mutagenicity, and teratogenicity have been intensively studied.

During the last two decades environmental toxicology and risk assessment have emerged as new and rapidly developing areas of toxicology. In recent years priority has been given to the toxicology of acute poisonings, drug toxicology, food toxicology, prophylactic toxicology, behavioral toxicology, toxicology of reproductive and endocrine systems, and genetic, reproductive, and developmental toxicology.

STATE REGISTRATION OF CHEMICAL AND BIOLOGICAL SUBSTANCES IN THE RUSSIAN FEDERATION

One of the major forms of activities in the field of protection of human health and the environment consists in collecting information sufficient for securing safety in production and use of chemical substances. For this purpose obligatory state registration of potentially hazardous chemical and biological substances was implemented in Russia by the Government's Act N869 of November 12th 1992. The necessity of this procedure was highlighted subsequently in Federal Law N52 of 1999 and in the Government's Act N554 of 2000.

In accordance with these Government's Acts all industrial chemicals, including ingredients in mixtures, which are manufactured in Russian or imported for use in production and daily life, must be registered. If the substance is well-known and has necessary hygienic and ecological standards, this chemical is registered on a permanent basis. The designation of a state registration number and issuing a state certificate to a substance confirm the adequacy and quality of information necessary to judge about its hazardous properties and recommended safety measures. If at the time of registration a minimum information is available but it allows to consider the hazard of the compound insignificant, the state registration is valid for a 3-year term with a special note in the registration certificate. In this case the applicant is officially notified of the reasons for temporary registration.

In Russia the denial of registration means that toxicological and hygienic data on a given substance are insufficient for its safe production and use and therefore the substance should be further studied, otherwise its production and use shall be prohibited.

Since 2004 state registration certificates have been issued by the Federal Service for surveillance on Consumer Rights Protection and Human Well-being, basing on toxicological and hygienic expertise carried out by the Russian Register of Potentially Hazardous Chemical and Biological Substances (RRPHCBS). The Russian Register of Potentially Hazardous Chemical and Biological Substances is a scientific and practical health establishment.

In the course of the expertise RRPHCBS develops and issues to the applicant the Information card of potentially hazardous chemical and biological substances which contains sufficient data about substances needed for their safe handling.

The 'Information card' is the most comprehensive and systematized inventory of data on all known physical and chemical, toxicological, environmental and other properties of hazardous substances.

The development of a clear set of characteristics, necessary for the state registration, made it possible to set up and put into operation a computerized information system 'Hazardous substances'. This database has 270 fields and is widely used by the sanitary and epidemiological surveillance bodies, enterprises and companies, manufacturers and consumers of chemical products.

RESOURCES

Books

Note: Books published in Russia can be obtained at request through the Russian State Library.
Web: http://www.RSL.ru. To visit the English Web page, click on 'English version'.

Akhmadulina LG (2006)
Biology and ecology basic principles
'RIOR', M

Alekseyeva TI (Ed.)
Anthropoecology in Central Asia
Nauchnyi Mir

Badyugin IS (2006), Luzhnikov EA (Ed.)
Extremity toxicology. Practical guidance
'GEOTAR-Media' M

Barsegyants LO (2005)
Medico-forensic physical evidences. Blood, discharges, hair
Meditsina: Moscow

Chernyshov AK, Lubis BA, Gusev VK (Ed.), Kurlyandskiy BA,Yegorov BF (2004)
Hazard Indicators of Substances and Materials, Vols. 1–4
I.D. Sytin Foundation: Moscow

Chirko VV, Dyomina MV (2002)
Essays on Clinical Drug Addiction Treatment: Drug Addiction and Toxicomania: Clinical Picture, Course of the Disease, Therapy
Medpraktika: Moscow

Collection of Abstracts. 2nd Congress of Toxicologists of Russia. Russian Register of Potentially Hazardous Chemical and Biological Substances (2003)
Ministry of Health of Russia: Moscow

Department of the Research Institute of Industrial Enzymes
Sanitary-Epidemiological Regulation of Industrial Microorganisms
Russian Academy of Sciences: Chernogolovka (2003)

Ellenhorn MJ, Barceloux DG (2003) (Translated into Russian)
Medical Toxicology. Diagnosis and Treatment of Human Poisoning
Meditsina: Moscow

Federal Center for State Sanitary and Epidemiological Surveillance (2004)
Guidelines for Risk Assessment of Population's Health at Exposure to Environmental Pollutants
RF Ministry of Health: Moscow

Fedorovskaya NM (2004)
Indirect electrochemical detoxication. Blood and plasma oxidation in the treatment of surgical endotoxicosis
Text-book (training books series for postgraduates)
Meditsina: Moscow

Filov VA (Editor-Compiler) (2004), Filov VA, Ivin BA, Musiychuk YI (Eds.)
Harmful Substances in the Environment. Oxygen-containing organic compounds. (Reference and Encyclopedic Edition). Parts I, II, III
Publishing House 'Professional': St. Petersburg

Galperin MV (2006)
General Ecology
Text-book for high vocational education.
Forum-Infra: Moscow

Gofman AG (2003)
Clinical Drug Addiction Treatment
Miklosh: Moscow

Guskova TA (2003)
Toxicology of Medicinal Preparations
Russkiy Vrach: Moscow

Ilyin VI (2005)
Ecology of Humans. Series of lectures
Perspectiva: Moscow

Izmerov NF, Denisov EI (Eds.)
Occupational Risk to Workers' Health
Guidance.
Trovant: Moscow

Kurlyandskiy BA, Filov VA (Eds.) (2002)
General Toxicology
Publishing House 'Meditsina': Moscow

Kutsenko SA (2004)
Basic Principles of Toxicology, Scientific and Methodological Edition
Foliant: St. Petersburg

Kutsenko SA (Ed.) (2004)
Examination tests in military toxicology, radiobiology and medical protection
Foliant: St. Petersburg

Kutsenko SA (Ed.) (2004)
Military Toxicology, Radiobiology and Medical Protection
Textbook.
Foliant: St. Petersburg

Kvesitadze GI (2005)
Metabolism of Anthropogenic Toxicants in Higher Plants
Nauka: Moscow

Ling LJ, et al (2005)
Toxicology Secrets (Translated into Russian)
Binom: Moscow

Loshadkin NA, Kurlyandskiy BA, Bezhenar GV, Daryina LV (2006) (Kurlyandskiy BA, Ed.)
Military Toxicology
Curriculum literature for medical universities.
Meditsina: Moscow

Luck E, Yager M (2003)
Chemische Lebensmittelkonservierung: Stoffe, Wirkung, Methodes (Translated into Russian)
GIORD: St. Petersburg

Lykov IN, Shestakova GA (2006)
Man-made systems and environmental risk
Textbook for universities.
Globus: Moscow

Marinchenko AV (2006)
Ecology
Textbook for universities.
Dashkov i K°: Moscow

Medical and Biological Problems Related to Destruction of Chemical Weapons
Abstracts of the International Workshop, Volgograd, 26–28 August 2003
Volgograd (2003)

Murashova AA (2005)
Eco-economic and information tools in the management system for the use of nature in the region
Dalnauka: Vladivostok

Onishchenko GG, Novikov SN, Rakhmanin et al (2002), Rakhmanin YA, Onishchenko GG (Eds.)
Basic principles of risk assessment to population's health at exposure to chemicals polluting the environment
A.N. Sysin Research Institute for Human Ecology and Environmental Health, Russian Academy of Medical Sciences

Pletnyova TV (Ed.) (2005)
Toxicological Chemistry
Textbook for higher schools.
GEOTAR-MEDIA: Moscow

Pyatnitskaya IN, Naydyonova NG (2002)
Juvenile Drug Addiction Treatment
Guidelines for physicians.
Meditsina: Moscow

Sanotskiy IV (Ed.) (2004)
Selenium Compounds and Health
Moscow

Shabanov PD (2003)
Drug Addiction Treatment: Practical Guide for Physicians
GEOTAR-MED: Moscow

Shkodich PYe, Zheltobryukhov VF, Klauchek VV (2004)
Ecologo-Hygienic Aspects of Utilization of Chemical Weapons
Publishing House of the Volgograd State University: Volgograd

Sivolap YuP, Savchenkov VA (2004)
Abuse of Opioids and Opioid Dependence
Meditsina: Moscow

Spigel AS (2004)
Conclusive Medicine: Perspectives for Homotoxicology
Arnebia: Moscow

Trakhtenberg IM, Tychinin VA, Sova Rye, et al (2001), Trakhtenberg IM (Ed.)
Main Physiological Standard Indicators in Humans
Guidelines for toxicologists.
Avitsenna: Kiev

Trushkina LYu, Trushkin AG, Demyanova LM (2006)
Hygiene and Ecology of Humans, 4th Edition
Textbook for high vocational schools.
TK Velbi: Moscow

Tsygankov BD (Ed.) (2002)
Emergent State in Drug Addiction Treatment
Medpraktika: Moscow

Yufit SS (2002)
Poisons Around Us. Challenge to the Mankind
Classic Stil: Moscow

Journals

Experimental and Clinical Pharmacology
Moscow
Web: http://www.folium.ru/ru/journals/ekf/editorial.htm

Hygiene and Sanitary
Moscow
Web: www.medlit.ru/medrus/gigien.htm

Medicine of Labor and Industrial Ecology
Moscow
Fax: 7(495)366-05-83
Email: izmerov@rinet.ru

Toxicological Review
Moscow
Web: www.rpohbv.ru

Regulatory Documents

Addendum 1. ГН 2.1.6.1765-03 to Hygienic norms No ГН 2.1.6.1338-03. Federal Center for the State Sanitary and Epidemiological Surveillance, Ministry of Health of RF. Moscow, 2004

Addendum 1 ГН 2.2.5.1827-03 to Hygienic Norms No ГН 2.2.5.1313-03: Federal Center for the State Sanitary and Epidemiological Surveillance, Ministry of Health of RF, Moscow, 2004

Hygienic Norms ГН 1.2.1323-03 for concentrations of pesticides in the environment media (Inventory). Federal Center for the State Sanitary and Epidemiological Surveillance, Ministry of Health of RF, Moscow, 2003

Hygienic Norms ГН 2.1.5.1315-03: Maximum Allowable Concentrations (MACs) of chemical substances in water of water bodies used for drinking, domestic and recreation purposes, Russian Register of Potentially Hazardous Chemical and Biological Substances, Ministry of Health of RF. Moscow, 2003

Hygienic Norms ГН 2.1.5.1316-03: Tentative Permissible Exposure Levels (TPELs) of Chemicals in water of water bodies used for drinking, domestic and recreation purposes, Moscow, 2008

Hygienic Norms No ГН 2.1.5.1373-03 for Maximum Allowable Concentrations (MACs) of chemicals in water used for drinking, domestic and recreation purposes in zones where protective measures are taken in relation to chemical weapons storage and destruction facilities. Ministry of Health of Russia, Moscow, 2003

Maximum Allowable Concentrations (MACs) of Pollutants in the Air of Residential Settings. Hygienic Norms No ГН 2.1.6.1338-03: Russian Register of Potentially Hazardous Chemical and Biological Substances, Ministry of Health of RF, Moscow, 2003

Tentative Safe Exposure Levels (TSELs) of Pollutants in the Air of Residential Settings. Hygienic Norms No ГН 2.1.6.2309.7, Moscow, 2008

Hygienic Norms ГН 2.1.6.1181-02: Emergency Exposure Limits of Toxic Agents in the Air of Residential Settings. Ministry of Health of Russia, Moscow, 2003

Hygienic Norms No ГН 2.1.6.1372-03 for Tentative Safe Exposure Levels (TSELs) of Pollutants in the Air of Residential Settings in Areas where Protective Measures are Provided in relation to Chemical Weapons Storage and Destruction Facilities. Ministry of Health of Russia, Moscow, 2003

Maximum Allowable Concentrations (MACs) of Harmful Substances in Workplace Air. Hygienic Norms No ГН 2.2.5.1313-03. Russian Register of Potentially Hazardous Chemical and Biological Substances, Ministry of Health of RF, Moscow, 2003

Tentative Safe Exposure Levels (TSELs) of Harmful Substances in Workplace Air. Hygienic Norms No ГН 2.2.5.1314-03. Moscow, 2008

Hygienic Norms No ГН 2.2.5.1371-03: Maximum Allowable Concentrations (MACs) of Chemicals in Workplace Air at Installations of Storing and Destruction of Chemical Weapons. Ministry of Health of Russia, Moscow, 2003

Hygienic Norms ГН 2.2.5.1374-03 for Maximum Allowable Levels (MALs) of Contamination of Production Equipment by Harmful Substances at Installations for Storing and Destruction of Chemical Weapons. Ministry of Health of Russia, Moscow, 2003

Methodological Documents

Guidance for hygienic assessment of factors in workplace and labor processes. Criteria and classification for working conditions. P 2.2.2006-05

Federal Center for Hygiene and Epidemiology, Rospotrbnadzor M (2005)

Guidance for assessment of occupational risk to workers' health. Organizational and methodological basic principles. Assessment criteria. P 2.2. 1766-05

Federal Center for Hygiene and Epidemiology, Rospotrbnadzor M (2005)

Databases

Biochemistry

Biochemistry of xenobiotics
Owner: VINITI, Moscow
Fax: 7-(495)-943-0060
Email: dir@viniti.ru

Outcome of screening of chemical compounds for pesticide activity
Owner: Limited liability company 'Biokhiminformatika'
Fax: 7-(495)-155-7514
Email: rozhkova@biochem.msk.ru

Ecotoxicology

International safety data sheets of chemicals
Owner: A.N. Sysin Research Institute for Human Ecology and Environmental Health, Russian Academy of Medical Sciences
Fax: 7(495)-245-0314/247-0428
Email: sysin@elnet.msk.ru

Maximum allowable concentrations (MACs) and interim standards (TSEL, TPL, TPC) for substances in water, air, soil (Russian and foreign standards)
Owner: A.N. Sysin Research Institute for Human Ecology and Environmental Health, Russian Academy of Medical Sciences
Fax: 7(495)-245-0314/247-0428
Email: sysin@elnet.msk.ru

Measurements of heavy metals concentrations at geochemical contamination of soil in Moscow
Owner: Karfidova YeA, Moscow
Phone: 7(499)-372-9120
Email: ekaterina_karfidova@yahoo.com

Monitoring of Contaminants Releases to Water Bodies
Owner: State Committee for the Environment Protection of the Kaluga Region, Kaluga
Fax: 7(4842)-53-3154
Email: ecologia@kaluga.ru

Pesticides
Owner: Novgorod Region Federal State-Owned Enterprise of Sanitary and Epidemiological Surveillance, Velikiy Novgorod
Fax: 7(8162)-17-1434
Email: post@novgsen.natm.ru

Reference Handbook on Hazardous Substances (Electronic version)
Owner: State Committee for the Protection of the Environment of the Perm Region
Fax: 7(3422)-90-1888
Email: ecol@permreg.ac.ru

Watertox. Ecological and hygienic properties of environmental pollutants (toxicity and hazard of substances)
Owner: A.N. Sysin Research Institute for Human Ecology and Environmental Health, Russian Academy of Medical Sciences
Fax: 7(495)-245-0314/247-0428
Email: sysin@elnet.msk.ru

Industrial Wastes

Programme 'Determination of hazard classes of industrial wastes'
Owner: Scientific and Production Enterprise 'Logus', Krasnogorsk, Moscow Region
Fax: 7(495)-562-0118
Email: ecology@logus.ru

State Report – Toxic Wastes
Owner: Natural Resources and Environment Protection Department of the Murmansk Region, RF Ministry of Natural Resources
Fax: 7(8152)-25-0915
Email: lomakine@taiga,mur.mansk.ru

Pollutants

Comprehensive List of Maximum Allowable Concentrations (MACs) and Tentative Safe Exposure Levels (TSELs) of Pollutants in the Air of Residential Settings
Owner: Scientific and Production Enterprise 'Logus'
Fax: 7(495)-562-0118
Email: ecology@logus.ru

Concentration of contaminants in ground deposits in the Black Sea (BDCHMORG)
Owner: Federal State-owned Research Institute 'AzNIIRKH': Rostov-on-Don
Fax: 7(8632)-62-0505
Email: riasfp@comm.ru/tn@azovfish.ru

Concentration of contaminants in ground deposits in the Azov Sea (BDAZMORG)
Owner: Federal State-owned Research Institute 'AzNIIRKH': Rostov-on-Don
Fax: 7(8632)-62-0505
Email: riasfp@comm.ru; tn@azovfish.ru

Concentrations of contaminants in the water of the Azov Sea (BDAZMORW)
Owner: Federal State-owned Research Institute 'AzNIIRKH': Rostov-on Don
Fax: 7(8632)-62-0505
Email: riasfp@comm.ru; tn@azovfish.ru

Concentration of contaminants in the water of the Black Sea (BDCHMORW)
Owner: Federal State-owned Research Institute 'AzNIIRKH': Rostov-on-Don
Fax: 7(8632)-62-0505
Email: riasfp@comm.ru; tn@azovfish.ru

Monitoring of Contamination Sources of the Environment
Owner:
Natural Resources and the Environment Protection Department, Republic of Northern Ossetia and Alania
Fax: 7(8672)-74-8048
Email: cnr@globalalania.ru

Particularly Hazardous Pollutions of the Sea Floor
Owner: Research Institute of Biotechnical Systems, St. Petersburg
Fax: 7(812)-277-1319
Email: nikti@home.ru

Programme 'Toxicity'
Owner: Scientific and Production Enterprise 'Logus'
Fax: 7(495)-562-0118
Email: ecology@logus.ru

Pollution of the Environment

Anomalies of Toxic Chemical Elements on the Territory of St. Petersburg and Leningrad Region
Owner: Regional Geoecological Center, Branch of the State-owned Enterprise 'Nevskgeologia', St. Petersburg
Fax: 7(812)-541-5700
Email: galit@rgec.spb.su

Concentration of 'heavy metals' in soils of St. Petersburg
Owner: Regional Geoecological Center – Division of the State-Owned Enterprise 'Nevskgeologia', St. Petersburg
Fax: 7(812)-540-5700

Email: galit@rgec.spb.su

Program BOILERS 'Estimation of gross emissions of pollutants from boiler units'
Owner: Scientific and Production Enterprise 'Logus'
Fax: 7(495)-562-0118
Email: ecology@logus.ru

Program BUILDING MATERIALS 'Estimation of emissions from non-organic sources in the industry of building materials'
Owner: Scientific and Production Enterprise 'Logus'
Fax: 7(495)-562-0118
Email: ecology@logus.ru

Program 'DIESELS'. Estimation of gross emissions of harmful substances from stationary diesel sources
Owner: Scientific and Production Enterprise 'Logus'
Fax: 7(495)-562-0118
Email: ecology@logus.ru

Standards for Contamination of the Environment by Enterprises
Owner: Natural Resources and the Environment Protection Department for the North-Ossetia and Alania Republic, RF Ministry of Natural Resources, Vladikavkaz
Fax: 7(8672)-74-8048
Email: cnr@globalalania.ru

Testing of soils and grounds for the Presence of Organic Toxicants on the Territory of St. Petersburg and Leningrad Region
Owner: Regional Geoecological Center-Division of the State-owned Enterprise 'Nevskgeologia', St. Petersburg
Fax: 7(812)-540-5700
Email: galit@rgec.spb.su

Toxic substances and physical and chemical characteristics of transboundary sources of air pollution in seas in Russia (sea aerosol, surface microlevel and surface water)
Owner: State Institute of Oceanography
Fax: 7(495)-246-7288
Email: adm@soi.msk.ru

Protection of the Environment

Consolidated List of Maximum Allowable Concentrations (MACs) of harmful substances in water
Owner: Scientific and Production Enterprise 'Logus'
Fax: 7(495)-562-0118
Email: ecology@logus.ru

Ecology and Protection of the Environment in Russia
Owner: State Public Scientific and Technical Library
Fax: 7(495)-921-9862/925-0750
Email: gpntb@gpntb.ru

Ecology and Protection of the Nature in Western Siberia
Owner: State Public Scientific and Technical Library, Siberian Division, Russian Academy of Sciences, Novosibirsk
Fax: 7(3832)-66-2585/32-1637
Email: elepov@spsl.nsc.ru

Toxicology

Concentrations of metals in biomedia
Owner: Federal State-owned Scientific Establishment 'Toxicology Institute', St. Petersburg
Fax: 7(812)-567-5566

Concentration of PCB in maternal breast milk of feeding mothers and other biological media
Owner: Federal State-owned Scientific Establishment 'Toxicology Institute', St. Petersburg
Fax: 7(812)-567-5566

Concentration of PCBs in soils in different districts of St. Petersburg and Leningrad region
Owner: Federal State-owned Scientific Establishment 'Toxicology Institute', St. Petersburg
Fax: 7(812)-567-5566

Concentrations of PCB in water of the Neva River, its tributaries and Gulf of Finland in different areas of St. Petersburg and Leningrad Region
Owner: Federal State-owned Scientific Establishment 'Toxicology Institute' , St. Petersburg
Fax: 7(812)-567-5566

Information retrieval system 'Hazardous Substances'
Owner: Russian Register of Potentially Hazardous Chemical and Biological Substances, Rospotrebnadzor
Fax: 7(495)-633-16-84
Email: root@regchem.msk.ru

Government Agencies

Russian Federation Ministry of Agriculture
1/11, Orlikov per., 107 139 Moscow
Fax: 7(495)-207-8362
Web: www.mcx.ru

Federal Agency on Fishery 12, Rozhdestvenskiy bulvar, 107996
Phone: 7(495)-628-2320
Fax: 7(495)-628-19-04
Web: www.fishcom.ru

Federal Service for Veterinary and Phytosanitary Surveillance 1/11,
Orlikov per., 107 139 Moscow
Fax: 7(495)-607-51-11
Web: http://fsups.ru

Russian Federation Ministry of Health and Social Development
3, Rakhmanovskiy per., 127 994 Moscow
Phone: 7(495)-928-4453
Web: www.mzsrrf.ru

Federal Service for Surveillance on Consumer Rights Protection and Human Well-being
18/20, Vadkovskiy per., 127 994 Moscow
Fax: 7(499)-973-1802
Web: www.gsen.ru

Russian Register of Potentially Hazardous Chemical and Biological Substances
18/20, Vadkovskiy per., 127 994 Moscow
Phone/Fax: 7(495)-633-1684
Email: root@regchem. msk.ru
Web: www.rpohv.ru

Russian Federation Ministry of Industry and Trade
7, Kitaygorodskiy pr., 109 074 Moscow
Phone: 7(495)-710 -5500
Fax: 7(495)-710-5722
Web: www.minprom.gov.ru

Federal Agency on Technical Regulation and Metrology, 9, Leninskiy pr., 119 991 Moscow
Phone: 7(495)-236-0300
Fax: 7(495)-236-6231
Email: info@gost.ru
Web: www.gost.ru

Federal Service of Hydrometeorology and Monitoring of the Environment 12, Novovagankovskiy per, 123 995 Moscow
Phone: 7(495)-252-1368/1486
Fax: 7(495)-252-5504
Email: media@metecom.ru
Web: www.meteorf.ru.

Russian Federation Ministry of Natural Resources
4/6, Bolshaya Gruzinskaya, 123 242 Moscow
Phone: 7(495)-254-4800
Fax: 7(495)-254-4319
Email: admin@mnr.gov.ru
Web: www.mnr.gov.ru

Federal Supervisory of Natural Resources Management Service
4/6, Bolshaya Gruzinskaya, 123 995 Moscow
Phone: 7(495)-254-1600
Web: www.control.mnr.gov.ru

Organizations (Non-Governmental)

All-Russian Society of Nature Protection

Founded in 1924 in the former USSR. In 1991 it was reorganized into a public organization of the Russian Federation. Its major goal is to ensure environmental safety of the population and sound use of nature. Its main activities are aimed at encouraging the solution of scientific and practical nature-protection measures, public monitoring of observance of nature-protection legislation and participation in the law-making process; organization of public club-like environmental movements in different environmental fields and in different regions of Russia; awareness raising of ecological issues among population at large. In particular, it contributed to the development of the Federal Law 'Protection of Lake Baikal'. It is one of the co-founders of the newspaper 'Green World' published since 1991.

3, Bogoyavlenskiy per. Building 3, 109 012, Moscow
Phone: 7(495)-624-7765
Fax: 7(495)-621-2812
Email: info@voop.ru
Web: http://voop.ru

ECO-Accord, Center for the Environment and Sustainable Development

'ECO-Accord' was established in 1992 as a non-governmental and non-commercial organization of the RF citizens. Its main goal is to promote the process of transition to the sustainable development by searching new approaches and solutions of environmental, economic, and social problems at global, national, and local levels, public awareness raising on issues of the environment and sustainable development. 'Eco-Accord' collaborates with a wide range of stakeholders from Russia and New Independent States on the territory of the former USSR as well as from all over the world. 'Eco-Accord' takes an active part in international processes, 'Environment for Europe', 'Environment and Health', co-operation for the environment and sustainable development in the Asia-Pacific Region. It promotes the implementation of international conventions and agreements on chemical management and safety in Russia. A special attention is drawn to the implementation of WSSD decisions and recommendations.

P.O. Box 43, 129090 Moscow
Phone: 7(495)-514-3748
Email: accord@leadnet.ru
Web: www.ecoaccord.org/english/index.htm

ECO-Defense

ECO-Defense is an ecological public organization, created in 1990, it is a member of the Social and Ecological Union; at present it has its sub-divisions in Moscow, Kaliningrad, Voronezh, and Ekaterinburg. Its goal is to contribute to the solution of ecological problems, to provide the population with ecological information and to promote right to know, to encourage the involvement of citizens in ecological campaigns aimed

at the protection of the environment; to enhance education of children and adults in ecology. ECO-Defense is particularly active in preventing the pollution of the Baltic Sea. ECO-Defense is editing a number of periodicals.

Moscow Office: 70/2-5, Nizhegorodskaya str., 109052, Moscow
Phone: 7(495)-278-4642
Email: accord@defense@online.ru
Web: www.ecodefense.ru
Moscow Office: email:ecodefense@online.ru

Green Cross. Russian National Organization

Russian Green Cross is a public organization, created in 1994, and has its representations in 23 RF subjects. It is one of the most influential ecology-protection movements in this country. Its goal is improving health of the environment and setting up safe conditions for humans. It promotes ecological education of the population, encourages conservation of forest and animal reservations, organizes events for cleaning up soil and water bodies in different Russian regions; it initiates convocation of ecological forums and round tables.

3, Krasina street, 123056, Moscow
Phone: 7(495)-252-2130
Fax: 7(495)-254-6102
Email: gcrus@online.ru
Web: http://rpvita.ru/partners/grcross

Greenpeace (Russian Branch of the international organization)

A Greenpeace office in Russia was established in 1989 and in 1992 it was given the name of Greenpeace Russia. In 2001 a Greenpeace subdivision was opened in Saint Petersburg. Greenpeace Russia seeks to protect biodiversity; prevent the pollution of oceans, land, air and fresh water; end all nuclear threats, promotes peace and non-violence; conducts campaigns for the use of renewable energy sources, elimination of toxic chemicals, against the release of genetically modified organisms to the environment.

6, str. Novaya Bashilovka, 127 994, Moscow
Phone/Fax: 7(495)-626-5045
Email: join@greenpeace.org
Web: http://www.greenpeace.org/russia/en/about

Guild of Ecologists, Ecology in Russian Regions: Moscow and Moscow Region

Guild of Ecologists is a non-commercial association unifying reliable ecological companies and organizations giving priority to conservation of the environment, health, and human well-being. The main target of the Guild is to defend the interests of righteous undertakers-ecologists, to encourage high-quality ecological services, to promote best ecological technologies and initiatives. It closely co-operates with the Government of the Moscow City. It actively participates in home events dedicated to chemicals and waste management, clean air in workplaces and residential settings. It publishes a journal 'Ecological Review of the Moscow Region'.

15, Street Novyi Arbat, suite 626,119019 Moscow
Phone/Fax: 7(495)-291-5261
Email: admin@ecoguild.ru
Web: http://www.ecoguild.ru; http://ecoguild.narod.ru/mosobl/

International Social and Ecological Union

This organization was set up about 50 years ago. Officially established in Russia in 1988, it unifies activists of the ecological movement in Russia and ensures links between them and experts in different branches of science, jurists, with bodies responsible for the protection of the environment, mass-media and public organizations in foreign countries as well. Its main goal is conservation of the environment and ensuring its safety. Its scope covers a great number of fields including climate changes, urban ecology, conservation of unique natural ecosystems and recovery of affected territories; biological safety, chemical disarmament, contribution to the law -making process and monitoring of law-abidance in ecology; human health. The Union is a founder of a number of experts centers, initiates different programs, and supports initiatives of its members. Among its programs there is a program 'Chemical Pollution and Chemical Safety' (email: lefed@online.ru)

P.O. 211, 119019 Moscow
Phone: 7(494)-963-5420
Web: http://www.seu.ru/about/

Russian National Division of the World Wide Fund

The Russian representation of WWF was opened in 1994 and in 2004 it received the status of the WWF Russian National Organization. Its priority objectives are the development and conservation of especially protected natural zones in Russia (national parks, animal, and plant reservations, etc.); conservation of rare species of animals and plants; creation of economic tools to conserve biological diversity; promotion of nature-protection legislation; support of education in nature protection.

19, str. Nikoloyamskaya, building 3, 109240 Moscow
Phone: 7(495)-727-0939
Fax: 7(495)-727-0938
Email: russia@wwf.ru
Web: http://www.wwf.ru/

UNEP National Committee for Russia (UNEPCOM)

UNEP National Committee for Russia (UNEPCOM) was created in 1994. Its founders were the Russian Academy of Sciences, RF Foreign Office, Russian Academy of Natural Sciences, Union of Journalists of Russia and other stakeholders. UNEPCOM ensures interaction between UNEP and the civil society of Russia, contributes to the implementation of UN international agreements and programs in Russia, promotes WSSD recommendations for the environment protection and sustainable development in Russia.

Str. Novyi Arbat, building 1, Suite 1819, 119 019 Moscow
Phone: 7(495)-293-5584
Fax: 7(495)-203-6049
Email: unepcom@online.ru
Web: www.unepcom.ru

Universities

In Russia, the teaching of basic principles of toxicology and its specialties has been traditionally conducted within a medical school curriculum. Thus, particular fields within toxicology may fall under various departments or 'chairs,' for example: chairs of pharmacology (general principles of toxicology); chairs of general hygiene (methodological principles of toxicometry and hygienic regulation); chairs of nutrition (food toxicology); chairs of communal hygiene (toxicology of chemicals contaminating water, atmospheric air and soil); chairs of military and emergency medicine. Recently, chairs on toxicology and related disciplines also have been established in a number of medical universities. Among these are the following.

Bashkir State Medical University, Ufa
3, Lenin str., 450 000, Yfa, Republic of Bashkorostan
Web: http://www.bsmu.anrb.ru/common

Irkutsk State Medical University
1, str. Krasnogo Vosstaniya, 664 003 Irkursk
Email: administrator@ismu.baikal.ru

Novosibirsk State Medical University
52, Krasniy prospekt, 830 091, Novosibirsk
Web: http://ru.medin.nsc.ru

Perm State Medical Academy
39, str. Kuybysheva, 814 090, Perm
Web: http://www/psma.ru

I.M. Sechenov Russian State Medical Academy, Moscow
8, Str. Trubetskkaya, building 2, 119 992 Moscow
Web: http://www.mma.ru

Russian State Medical University
1, str. Ostrovityaniva, 117 997, Moscow
Web: http://www.rsmu.ru

Ural State Medical Academy, Ekaterinburg
3, str. Repina, 620 219 Ekaterinburg
Web: www.usma.ru

Postgraduate education of physicians specializing in toxicology is conducted via internships, residentships, and postgraduate courses, through thematic specializations (e.g. in clinical toxicology, industrial toxicology, etc.). Russian academic institutions which provide in-depth postgraduate education in different branches of medicine, including toxicology, include:

Nizhny Novgorod State Medical Academy
10/1 street Minina and Pozharskogo, 603005 Nizhny Novgorod
Web: www.n-nov.mednet.com

Russian Academy of Advanced Medical Studies, Moscow
2/1, str. Barrikadnaya, 123 836 Moscow
Web: http://www.rmapo.ru

Russian Military Medical Academy, Saint-Petersburg
8, str.Lebedeva, 194 044 Saint-Petersburg
Web: http://www.vmeda.spb.ru/

Saint Petersburg Medical Academy of Postgraduate Education
41, str. Kirochnaya, 191 015 Saint Petersburg
Web: //www.maps.spb.ru; www.mapo.spb.ru

Professional Societies

Russian Toxicology Society
Email: root@regchem.msk.ru.
Web: rpohbv,ru

Key Research Centers

All-Russian Research and Testing Institute of Medical Equipment
3, ul. Kasatkina, 129 301 Moscow
Fax: 7(495)-187-3734
Email: wniiimt@comail.ru

A.N. Sysin Research Institute for Human Ecology and Environmental Health, Russian Academy of Medical Sciences
10/15, Pogodinskaya ul., 119992 Moscow
Fax: 7(495)-245-0314
Email: sysin@elnet.msk.ru

Ekaterinburg Medical Scientific Center for Health Promotion and Prophylaxis of Industrial Workers

Ekaterinburg
Web: www.ymrc.ru

Federal State-owned Scientific Establishment 'Toxicology Institute'
1, Bekhtereva street, 192019 Saint-Petersburg
Web: www.toxicology.ru

F.F. Erisman Federal Research Center of Hygiene
2, ul.Semashko, 141 000 Mytishch, Moscow Region
Fax: 7(495)-582-9294
Email: pesticide@yandex,ru

Hygiene Research Institute of Novosibirsk
7, ul. Parkhomenko, 630 108 Novosibirsk
Phone/Fax: 7(383)-343-3401
Email: gigsan@mail.ru

Institute of Occupational Health
Moscow
Web: http://www.niimt.ru

National Research Center of Drug Addiction
Moscow
Email: nn_ivanets@bk.ru
Web: www.nrca.ru

North-West Scientific Center for Hygiene and Public Health
St. Petersburg
Web: www.sznc.sp.ru/contacts/

Research Institute of Hygiene and Occupational Pathology of Nizhniy Novgorod
20, ul. Semashko, 603 950 Nizhniy Novgorod
Fax: 7(831)-236-3593
Email: ipz@sandy.ru

Research Institute of Occupational Health and Human Ecology of Ufa
94, ul. Stepana Kuvykina . 450106, Ufa
Fax: 7(3472)-55-5684
Email: bakirov@anrb.ru

Research Institute of Radiation Hygiene of St. Petersburg
8, ul. Mira, 197101 St. Petersburg
Phone/Fax: 7(812)-233-2612
Email: irh@EK6663.spb.edu

Saratov Research Institute of Rural Hygiene
1 A, Zarechnaya ul., District 16, 410 022 Saratov
Fax: (8452)-92-7890
Email: odo@overta.ru; spirinv@rol.ru

Scientific Research Disinfectology Institute
Moscow
Web: http://www.niid.ru

State Establishment 'Nutrition Institute'
Russian Academy of Medical Sciences
2/14 Ustyinskiy per., 109240 Moscow
Phone/Fax: 7(495)-698-5379
Email: mail@ion.ru

State Research Center 'Institute of Biophysics'
46, Zhivopisnaya ul., 123 182 Moscow
Phone: 7(495) 190 56 51
Email: ibphgen@srcibph.ru

Toxicology Information and Advisory Center
3, Sukharevskaya str., building 7, 129090 Moscow
Web: http://www.rtiac.narod.ru

Poison Information/Control Centers

State-owned Institution 'Toxicology Information and Advisory Center'
RF Ministry of Health and Social Development
3, Sukharevskaya str., Building 7, 120090 Moscow
Phone/Fax: 7(495)-921-6885
Web: http://www.rtiac.narod.ru

Astrakhan
Acute Poisonings Treatment Department, Research and Practical Medical Complex 'Ecological Medicine', Joint-Stock Company 'Astrakhangazprom'
1, Kubanskaya ul., 414 057 Astrakhan

Barnaul
City Clinical Hospital No 3
Altai Territory Toxicological Center
29, ul. Titova, 656 023 Barnaul

Blagoveshchensk
3rd Municipal Hospital
Toxicological Department
1, per. Uralova., 675 000 Blagoveshchensk

Cheboksary
City Hospital of Emergency Medical Care
Republican Center for Acute Poisonings Treatment
47, Moskovskiy prospekt
428017 Cheboksary

Chelyabinsk
City Toxicological Center
City Clinical Hospital No 3
287, Prospekt Pobedy
454 021 Chelyabinsk

Regional Toxicological Center
Regional Clinical Hospital no 3
Ul. Voroovskogo, 'Medgorodok', 454 076 Chelyabinsk

Chita
Poisonings Treatment Center
City Clinical Hospital No 1
8, ul. Lenina, 672 010 Chita

Ekaterinburg
City Toxicological and Psychiatric Center
City Clinical Hospital No 14
15в, ul. 22nd Partsyezda
620 039 Ekaterinburg

Regional Center for Poisonings Treatment
Regional Association 'Psychiatry'

Building 10, 8th kilometer
Siberian tract, 620 030 Ekaterniburg

Irkutsk
Regional Center for Acute Poisonings Treatment
Health Care Establishment
9, ul. Zhukova, 664 022 Irkutsk

Kazan
City Center for Acute Poisonings
City Clinical Hospital No 1
5, ul. Kalinina, 420 043 Kazan

Kemerovo
Regional Center for Acute Poisonings Treatment
M.A. Podgorbunskiy City Clinical Hospital No 3
22, ul. Ostrovskogo, 650099 Kemerovo

Khabarovsk
Territory Toxicological Center
Clinical Hospital No 10
1, Ulchskiy pereulok, 680 000 Khabarovsk

Krasnoyarsk
Toxicology Division
City Hospital of Emergency Medical Care
17, ul. Kurchatova, 660062 Krasnoyarsk

Kurgan
Toxico-Therapeutic Division
City Clinical Hospital of Emergency Medical Care
63, ul. Kirova, 640001 Kurgan

Kursk
Regional Center for Acute Poisonings Treatment and Efferent Therapy
City Hospital of Emergency Medical Care
4, ul. Pirogova, 305 035 Kursk

Kysil
Republican Toxicological Base
Republican Hospital
4, ul. Gagarina, 667 000 Kysil, Republic of Tyva

Lipetsk
Toxicological Center
Regional Clinical Hospital No 1
6a, ul. Moscovskaya, 398 055 Lipetsk

Makhachkala
Toxicological room
Republican Association of Emergency Medical Care
3, ul. Pirogova, 367 003 Makhachkala

Moscow
Children's City Toxicological Center
N.F. Filatov Children's City Hospital No 13
15, ul. Sadovo-Kudrinskaya, Building 6, 103 001 Moscow

Moscow Center for Treatment of Acute Poisonings
N.V. Sklifosovskiy Research Institute of Emergency Medical Care.
3, Sukharevskaya pl. Building 7, 129 010 Moscow

Toxicological Department
A.A. Ostroumov City Clinical Hospital No 33
7, ul. Stromynka, 107014 Moscow

Nizhniy Novgorod
Poisonings Treatment Center
City Clinical Hospital No 33
54, prospect Lenina, 603 076 Nizhniy Novgorod

Novosibirsk
Regional Acute Poisonings Treatment Center
City Clinical Hospital No 34
18, ul. Titova, 630 054 Novosibirsk

Omsk
Acute Poisonings Treatment Center
City Clinical Hospital No 1
9, ul. Perelyota, 644 112 Omsk

Orenburg
Division of Resuscitation of Acute Poisonings
City Clinical Hospital of Emergency Medical Care No 1
23, pr. Gagarina, 460 021 Orenburg

Penza
Acute Poisonings Division
G.A. Zakharyin Central City Hospital No 6
7, ul. Stasova, 440071 Penza

Perm
Toxicological Division
M.A. Tverye Medico-Sanitary Unit No 9
2, ul. Bratyev Ignatovykh, 614 990 Perm

Rostov-on-Don
Regional Center for Acute Poisonings Treatment
City Hospital of Emergency Medical Care No 2
88/35, ul. Bodraya, 344 068 Rostov-on-Don

Samara
Poisonings Treatment Center
M.I. Kalinin Regional Clinical Hospital
159, ul. Tashkentskaya, 443 002 Samara

Smolensk
Division of Hemodialysis and Acute Poisonings

Clinical Hospital No 1
40, ul. Frunze, 214 001 Smolensk

St. Petersburg
Poisonings Treatment Center
I.I. Dzhanelidze Resarch Institute of Emergency Medical Care
St. Petersburg
Web: www.emergency.spb.ru

Tambov
Toxicological and Therapeutic Division
City Hospital No 3
234/365, ul. Karla Marxa, 392 020 Tambov

Tomsk
Toxicology Division
Regional Clinical Hospital
96, ul. Ivana Chernykh, 634 063 Tomsk

Tula
Poisonings Treatment Center
N.A. Semashko City Hospital of Emergency Medical Care
13, ul. Pervomayskaya, 300 008 Tula

Tyumen
Acute Poisonings Division
Regional Clinical Hospital
55, ul. Kotovskogo, 625 023 Tyumen

Ulyanovsk
Poisonings Treatment Center
City Hospital of Emergency Medical Care
30a, ul. Ryleyeva, 432 700 Ulyanovsk

Ufa
Poisonings Treatment Center
City Clinical Hospital No 21
3, ul. Lesnoy Proyezd, 450 076 Ufa

Vladivostok
Poisonings Treatment Center
City Clinical Hospital of Emergency Medical Care No 2
57, Russkaya ul., 690 105 Vladivostok

Volgograd
City Toxicological Center
Drug Addiction Rehabilitation Center
16, ul. Bureyskaya, 400 081 Volgograd

Voronezh
Division of Acute Poisonings Treatment
Regional Clinical Hospital
151, Moskovskiy pr. 394 082 Voronezh

Hygiene and Epidemiological Centers Having Toxicological Divisions in their Structure

Federal Center
Federal Hygiene and Epidemiological Center
19a, Varshavskoye Shosse, 117105 Moscow
Email: gsen@fcgsen.ru
Web: http://www.fcgsen.ru

Federal Hygiene and Epidemiological Center for the Railway Transport
8, building 2, Perviy Basmanniy per., 107066 Moscow

Altai Territory
Hygienic and Epidemiological Center in the Altai Territory
Fax: 7(3852)-26-6075
Email: Barnaul CGSEN@mail.ru

Amur Region
Hygienic and Epidemiological Center in the Amur Region
30, ul. Pervomayskaya, 675 002 Blagoveshchenks
Fax: 7(4162)-52-5624
Email:cgsen@amur.ru

Arkhangelsk Region
Hygienic and Epidemiological Center in the Arkhangelsk Region
164, building 1, Troitskiy proyezd, 163 045 Arkhangelsk
Fax: 7(8182)-27-6483
Email: arkhgsn@atnet.ru.

Astrakhan Region
Hygienic and Epidemiological Center in the Astrakhan Region
89, ul. Kirova, 414 057 Astrakhan
Fax: 7(8512)-34-1494
Email:astrfguz@yandex.ru.

Belgorod Region
Hygienic and Epidemiological Center in the Belgorod Region
48, ul. Gubkina, 308 036 Belgorod
Fax: 7(4722)-51-6253
Email:belfguz@belgtts.ru

Bryansk Region
Hygienic and Epidemiological Center in the Bryansk Region
72, Pr. Lenina, 241 000 Bryansk
Fax: 7(4832)-74-0508
Email: bgcsen@online.debryansk.ru

Chelyabinsk
Hygienic and Epidemiological Center in the Chelyabinsk Region
147, ul. Svobody, 454 091 Chelyabinsk
Fax: 7(351)-237-9058
Email: sane@chel.surnet.ru

Irkutsk Region
Hygienic and Epidemiological Center in the Irkutsk Region
51, ul. Trilissera, 664 047 Irkutsk
Fax: 7(3952)-22-8204
Email: main@sesoirk.baikal.ru

Ivanov Region
Hygienic and Epidemiological Center in the Ivanov Region
12, ul.Voronina, 153 035 Ivanovo
Fax: 7(4932)-23-0606
Email: cgsn@tpi.ru

Kabardino-Balkarian Republic
Hygienic and Epidemiological Center in the Kabardino-Balkarian Republic
33, ul. Baysultanova, 360 017 Nalchik
Fax: 7(8662)-74-2828
Email: nasip@kbrnet.ru

Kaliningrad Region
Hygienic and Epidemiological Center in the Kaliningrad Region
5, ul. Polkovnika Ivannikova, 236 040 Kaliningrad
Fax: 7(4012)-46-3481
Email:root@gsan.koenig.su
Web: http://www.ocgsen.kaliningrad.ru

Kaluga Region
Hygienic and Epidemiological Center in the Kaluga Region
181 ul. Barrikadnaya, 248 018 Kaluga
Fax: 7(4842)-57-4675
Email: gorsanepid@kaluga.ru

Kemerovo Region
Hygienic and Epidemiological Center in the Kemerovo Region
8, ul. Nogradskaya, 650 025, Kemerovo
Fax: 7(3842)-25-1736
Email: centrgigiena@kemnet.ru

Kostroma Region
Hygienic and Epidemiological Center in the Kostroma Region
23, ul. Sverdlova, 156 000 Kostroma
Fax: 7(4942)-31-2313
Email:cgsn@kosnet.ru

Krasnodar Territory
Hygienic and Epidemiological Center in the Krasnodar Territory
Krasnodar
Web: www.cgekuban.ru/contacts

Krasnoyarsk Region
Hygienic and Epidemiological Center in the Krasnoyarsk Region
38, ul. Sopochnaya, 660 100 Krasnoyarsk
Fax: 7(3912)-43-7940
Email: root@cgsn.krasnoyarsk.ru

Kursk Region
Hygienic and Epidemiological Center in the Kursk Region
3, ul. Pochtovaya, 305 000 Kursk
Fax: 7(4712)-51-1236
Email: gy@ses.kursk.ru

Leningrad Region
Hygienic and Epidemiological Center in the Leningrad Region
7, ul. Olminskogo, 192 029 St. Petersburg
Fax: 7(812)-265-0006
Email: lomtev@cgsninlo.spb.ru
Web: cgsninlo.spb.ru

Lipetsk Region
Hygienic and Epidemiological Center in the Lipetsk Region
80a, ul. Oktyabrskaya, 398 001 Lipetsk
Fax: 7(4742)-77-0413
Email: gorses@lipetsk.ru

Maritime Territory (Kray)
Hygienic and Epidemiological Center in the Maritime Territory
36, ul. Utkinskaya, 690 091 Vladivostok
Fax: 7(4232)-40-2185
Email: vladivostok@pkcgsen.ru
Web: www.pkcgsen.ru, click on 'Обращение граждан'

Moscow
Hygienic and Epidemiological Center in the City of Moscow
Email: mgcses@asvt.ru
Web: http://www.mossanepid.ru

Moscow Region
Hygienic and Epidemiological Center in the Moscow Region
2, ul. N.A. Semashko, 141014 Mytishchi
Fax: 7(495)-586-1268
Email: centr@mosoblses.ru

Murmansk Region
Hygienic and Epidemiological Center in the Murmansk Region
11, ul. Kommuny, 183038 Murmansk
Fax: 7(8152)-47-3425
Email: fguzmo@polarnet.ru

Novgorod Region
Hygienic and Epidemiological Center in the Novgorod Region
Web: http://www.novgsen.natm..ru, click on 'Как нас найти'

Novosibirsk Region
Hygienic and Epidemiological Center in the Novosibirsk Region
84, ul. Frunze, 630099 Novosibirsk
Fax: 7(3832)-224-5838
Email: mailmaster@sanepid-nso.ru

Omsk Region
Hygienic and Epidemiological Center in the Omsk Region
42a, ul. 27 Severnaya, 644116 Omsk
Fax: 7(3812)-68-0977
Email:oblcgsen@omskcity.com

Orenburg Region
Hygienic and Epidemiological Center in the Orenburg Region
48, ul. Kirova, 460 000 Orenburg
Fax: 7(3522)-77-2923
Email: fguz@mail.orenburg.ru

Pskov Region
Hygienic and Epidemiological Center in the Pskov Region
21, ul. Gogolya, 180000 Pskov
Email: gigiena@pskov.ru

Republic of Bashkortostan
Hygienic and Epidemiological Center in the Republic of Bashkortostan
7, ul. Shafiyeva, 450054 Ufa
Fax: 7(3472)-37-4248
Email:brcgsen@ufanet.ru

Republic of Chuvashia
Hygiene and Epidemiological Center in the Republic of Chuvashia
17, ul. Gladkova, 428 020 Cheboksary
Fax: 7(8352)-21-2916
Email:chebsan @root.ru

Republic of Daghestan
Hygienic and Epidemiological Center in the Republic. of Daghestan
174, ul. Kazbekova, 367 005 Makhachkala
Fax: 7(8722)-64-4868
Email: oit@dagsen.ru

Republic of Karelia
Hygienic and Epidemiological Center in the Republic. of Karelia
12, ul. Pirogova, 185002 Petrozavodsk
Fax: 7(8142)-56-0189
Email:cge@sampo.ru

Republic of Komi
Hygienic and Epidemiological Center in the Komi Republic
3/3, ul. Dmitrova, 167000 Syktyvkar
Fax: 7(8212)-43-0537
Email: cgsen@parma.ru

Republic of Mariy-El
Hygienic and Epidemiological Center in the Republic of Mariy-El
121, ul.Mashinostroiteley, 424 007 Ioshkar Ola
Fax: 7(8362)-68-1930
Email: all@san.mari.su

Republic of North Ossetia-Alania
Hygienic and Epidemiological Center in the Republic of North Ossetia-Alania
26a, ul. Nikolayeva, 362 021 Vladikavkaz
Fax: 7(8672)-76-8900
Email: Vladses@mail.ru

Republic of Sakha (Yakutia)
Hygienic and Epidemiological Center in the Sakha Republic (Yakutia)
60.2, ul. Petra Alekseyeva, 677 005 Yakutsk
Fax: 7(4112)-22-5791
Email: gsen@list.ru

Republic of Tatarstan
Hygienic and Epidemiological Center in the Republic of Tatarstan
18, ul. Ippodromnaya, 420 049 Kazan
Fax: 7(8432)-77-2373
Email: fgus@csen.ru

Rostov Region
Hygienic and Epidemiological Center in the Rostov Region
Web: www.donses.ru/about/about6.shtml

Samara Region
Hygienic and Epidemiological Center in the Samara Region
1, proyezd Georgia Mitireva, 443 079 Samara
Fax: 7(846)-260-3799
Email:sancntr@bee-s.com

St. Petersburg
Hygienic and Epidemiological Center in the city of St. Petersburg
1, ul. Malaya Sadovaya, 191 023 St. Petersburg
Fax: 7(812)-571-1447
Email fguzcgie@mail.ru

Sakhalin Region
Hygienic and Epidemiological Center in the Sakhalin Region
45, ul. Khabarovskaya, 693000 Yuzhno-Sakhalinsk
Fax: 7(4242)-42-2222
Email: gorses@sakhalin.ru

Saratov Region
Hygienic and Epidemiological Center in the Saratov Region
69, ul. Bolshaya Gornaya, 410031 Saratov
Fax: 7(8452)-28-8038
Email: gorses@rol.ru

Smolensk Region
Hygienic and Epidemiological Center in the Smolensk Region
12, Tulskiy per., 214013 Smolensk
Fax: 7(4812)-66-2494
Email: sanepid@sci..smolensk.ru

Stavropol Territory (Kray)
Hygienic and Epidemiological Center in the Stavropol Territory
4, ul. Fadeyeva, 355008 Stavropol
Fax: 7(8652)-94-6854
Email: stavgsen@avn.skiftel.ru

Sverdlovsk Region
Hygienic and Epidemiological Center in the Sverdlovsk Region
4, pereulok Otdelniy, 620078 Ekaterinburg
Fax: 7(343)-374-4703
Email: root@ocsen.utk.ru

Tver Region
Hygienic and Epidemiological Center in the Tver Region
13, ul. Darvina, 170034 Tver
Fax: 7(4822)-42-3546
Email:ocgsen@tvcom.ru

Tula Region
Hygienic and Epidemiological Center in the Tula Region
114, ul. Oboronnaya, 300 045 Tula
Fax: 7(4872)-21-6131
Email: sanita@tula.net

Tyumen Region
Hygienic and Epidemiological Center in the Tyumen Region
57, ul. Kholodilnaya, 625000 Tyumen
Fax: 7(3452)-20-5006
Email: tocgsen@telesib.ru

Vladimir Region
Hygienic and Epidemiological Center in Vladimir Region
5, ul. Tokoreva, 600005 Vladimir
Fax: 7(4922)-23-7896
Email: sgm@vladses.elcom.ru

Volgograd Region
Hygienic and Epidemiological Center in the Volgograd Region
13, ul. Angarskaya, 400049 Volgograd
Fax: 7(8442)-37-2674
Email: cgsvolgag@tele-kom.ru

Voronezh Region
Hygienic and Epidemiological Center in the Voronezh Region
21, ul. Kosmonavtov, 394 038 Voronezh
Fax: 7(4732)-63-6228
Email: asu@sanep.vrn.ru

Yamalo-Nenets Autonome Area
Hygiene and Epidemiological Center in the Yamalo-Nenets Area
10, ul. Titova, 626 608 Salekhard

Yaroslavl Region
Hygiene and Epidemiological Center in the Yaroslavl Region
4, ul. Chkalova, 150024 Yaroslavl
Fax: 7(4852)-73-29-52
Email: karpov@cgsen.yar.ru

Legislation Concerning Chemical Safety

Note: Up-to-date information about RF Laws can be obtained at the Company 'ConsultantPlus'.
Web: http://www.consultant.ru/english or at the company 'Garant'. This company can also provide English translation of RF laws. Web: http://www.garant.ru/english.

Federal Law concerning Entering Addenda and Modifications to the Federal Law concerning Technical Regulation of Production and Traffic of Ethanole and Alcohol Products. No 18, 1999.01.07

Federal Law concerning Industrial Safety of Hazardous Production Entities (declaration and expertise of hazardous production facilities, hazard classification of chemicals) 1999.07.21, No 116

Federal Law concerning the Protection of Atmospheric Air, No 109. 2002.07.24, (state registration of harmful substances (contaminants), registration testing of harmful substances (contaminants), which exert or can exert harmful exposure to humans and the environment; authorization to release harmful substances (contaminants) to the atmospheric air and to exert a certain harmful physical impact on the atmospheric air)

Federal Law concerning the Protection of Consumers' Rights, (with further addenda and modifications). No 2300- 1992.02.07

Federal Law concerning the Protection of the Environment, No 7, 2002.01.10

Federal Law concerning Quality and Safety of Food Products, No 29, 2000.01.02

Federal Law concerning Ratification of ILO Convention 162 on Labor Protection in the handling of Asbestos, No 50, 2000.04.08

Federal Law concerning Technical Regulation, No 184, 2002.12.27 (under revision)

Federal Law concerning Industry and Consumption wastes. No 89, 06.24. 1998

Federal Law on Sanitary and Epidemiological Well-being of the Population, No 52, 1999.03.30 (state registration of potentially hazardous chemical and biological substances, as well as other certain products; sanitary and epidemiological requirements for chemicals harmful to humans and for some other certain products)

Federal Law concerning Safe Handling of Pesticides and Agrochemicals, No 109, 1997.07.19

RF Basic Legislative Principles for the Protection of Population's Health. New version of 2005.03.07

Federal Law No 197, 2001.12.26.: RF Labor Code

IFCS Russian Focal Point

Russian Register of Potentially Hazardous Chemical and Biological Substances, Federal Service for Surveillance on Consumer Rights and Human Well-being, RF Ministry of Health and Social Development
Email: root@regchem.msk.ru
Web: www.rpohbv.ru

CHAPTER

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South Africa

MARY GULUMIAN

INTRODUCTION

Toxicology, as a distinct discipline, is not recognized in South Africa. It is taught at different universities as a subject in the overall syllabus within a number of scientific disciplines including Forensic Medicine, Pharmacology, Marine and Veterinary sciences, Environmental Health, and Occupational Hygiene. The level of toxicology taught in these syllabi may be basic and biased towards that particular sub-discipline. There is a need for these tertiary institutions to recognize Toxicology as a discipline in its own right and create opportunities to study and obtain higher degrees in one or more of the many sub-disciplines of toxicology.

The presence of toxicants in the environment, workplace and food products is increasingly being recognized in South Africa. The widespread use of biomass fuel and coal in South Africa as well as significant industrial activity has led to increased indoor and outdoor air pollution (Brent and Rogers 2002, Coetzee et al 1986) with increased levels of harmful particulate matter (Engelbrecht et al 2001, Naidoo and Chirkoot 2004). There is well-documented toxic metal contamination of soil and groundwater in the vicinity of industrial and mining sites (Grobler 1999, Oosthuizen and Ehrlich 2001). South Africa is also the largest user of pesticides in sub-Saharan Africa and rivers, wetlands and wildlife have been shown to be contaminated (Dalvie et al 2003, Fatoki and Awofolu 2004, van Wyk et al 2001). Traditional medicine is widely practiced in South Africa but the toxicity to humans and livestock of only a limited number of these herbal remedies has been investigated (Stewart et al 2002). Unfortunately, there is a severe shortage of adequately trained professionals to carry out the much-needed basic and applied research: toxicology testing and risk assessment of the toxic substances associated with industrial, mining, and other activities.

Against this background and with the support of the International Union of Toxicology (IUTOX), the Toxicology Society of South Africa (TOXSA) was established in 2001 in Stellenbosch by some one hundred interested scientists to promote and advance the study and application of toxicology in South Africa. TOXSA was admitted as a full national member society of IUTOX in 2004, having complied with all criteria of membership. TOXSA will be the host of the 7th Congress of the Toxicology in Developing Countries (7CTDC) to be held in South Africa in 2009.

RESOURCES

While most scientific work on toxicology and its allied disciplines is routinely published in international peer-reviewed journals, a substantial part of work emanating from these disciplines is published in local South African journals. Material published locally and internationally can be accessed via the appropriate websites on the Internet. Scientific work that may be of relevance to toxicology is also published in books by international publishing houses as well as by local publishers.

It seems that toxicological subjects investigated in the country concentrate mainly on issues pertaining to the environment where strong core institutes and research units that have been established over the years have mostly investigated the effects of metals, pesticides, and other pollutants on the ecosystem but

also have occasionally studied the effects of these pollutants on humans.

Books

Books on nutrition, medicinal and poisonous plants, pesticides, water research, mycotoxins and animal poisons have been published by local and international publishers.

Animal Poisons

Dippenaar-Schoeman AS (2002)
The Spider Guide of Southern Africa
ARC-Plant Protection Research Institute (CD-ROM series 2.1.2002)
ISBN: 1-86849249-4
Contact: Dr. A.S. Dippenaar-Schoeman
Phone: +27(0)12-329-3269
Fax: +27(0)12-329-3278
Email: rietasd@plant2.agric.za

Visser J, Chapman DS (1978)
Snakes and Snakebite – Venomous Snakes and Management of Snakebite in Southern Africa
Purnell and Sons: Cape Town, South Africa

Medicinal and Poisonings Plants

Kellerman TS, Coetzer JAW, Naude TW, Botha CJ (2005)
Plant Poisonings and Mycotoxicosis of Livestock in Southern Africa, 2nd Edition
Oxford University Press: Southern Africa
ISBN: 978-0 19-57613-4

Kellerman TS, Naude TW, Fourie N (1996)
The Distribution, Diagnoses and Estimated Economic Impact of Plant Poisonings and Mycotoxicoses in South Africa
ARC-Onderstepoort Veterinary Institute: South Africa
ISBN: 0030-2465
Web: http://www.arc.agric.za/home.asp?pid=373&toolid=65&itemid=843

van Wyk B-E, Gericke N (2000)
People's Plants, 2000
Briza Publications: South AfricaISBN: 1875093-19-2
Email: books@briza.co.za
Web: www.briza.co.za
Postal address: P O Box 56569, Arcadia 0007, South Africa
Tel: +27(0)12-329-3896.

van Wyk B-E, van Heerden F, van Oudtshoorn B (2002)
Poisonous Plants of South Africa
Briza Publications: South Africa
ISBN: 187509303
Email: books@briza.co.za
Web: www.briza.co.za.
Contact:
Postal address: P O Box 56569, Arcadia 0007, South Africa
Phone: +27(0)12-329-3896

van Wyk B-E, van Oudtshoorn B, Gericke N (1997)
Medicinal Plants of South Africa
Briza Publications : South Africa
ISBN: 1875093095
Email: books@briza.co.za
Web: www.briza.co.za
Postal address: P O Box 56569, Arcadia 0007, South Africa
Phone: +27(0)12-329-3896.

Von Ahlefeldt D, Crouch NR, Nichols G, et al (2003)
Medicinal Plants Traded on South Africa's Eastern Seaboard
Porcupine Press: Johannesburg
Ethekwini Parks Department and University of KwaZulu-Natal, Durban
ISBN: 0-620-31569-5
Web: http://www.sanbi.org

Watt JM, Breyer-Brandwijk MG (1962)
The Medicinal and Poisonous Plants Of Southern And Eastern Africa. Being an Account of Their Medicinal and Other Uses, Chemical Composition, Pharmacological Effects and Toxicology in Man and Animal, 2nd Edition
E & S Livingstone: Edinburgh

Mycotoxins

Bryden WL, Marasas WFO (2000)
Fumonisins – Occurrence, Toxicology, Metabolism and Risk Assessment
Fusarium. Paul E Nelson Memorial Symposium
APS Press: St Paul, Minnesota

Crous PW, Phillips AJL, Baxter AP (2000)
Phytopathogenic Fungi from South Africa
University of Stellenbosch Printers, Department of Plant Pathology Press: South Africa

Marasas WFO (2000)
Fumonisin Toxicosis in Pigs
Piva G (Ed.) Proceedings of the 5th International Feed Production Conference, Piacenza, Italy

Marasas WFO (2001)
Fusarium
In: Hui YH, Smith RA, Spoerke DG (Eds.) Foodborne Disease Handbook. Vol 3, Plant Toxicants, 2nd Edition, Revised and Expanded
Marcel Dekker: New York

Marasas WFO, Miller JD, Riley RT, Visconti A (Eds.) (2000)
Fumonsin B_1. Environmental Health Criteria 219
World Health Organization: Geneva

Marasas WFO, Miller JD, Riley RT, Visconti A (2001)
Fumonisins – Occurrence, Toxicology, Metabolism and Risk Assessment
In: Summerell RA, Leslie JF, Backhouse D, Bryden WL, Burgess LW (Eds.) Fusarium. Paul E Nelson Memorial Symposium
APS Press: St Paul, Minnesota

Marasas WFO, Vismer HF (2003)
Food for Thought about Mycotoxins, Organic and Genetically Modified Foods
In: Credland PF, Armitage DM, Bell CH, Cogan PM, Highly E (Eds.) Advances in Stored Product Protection. Proceedings of the 8th International Working Conference on Stored Product Protection, York, UK, 22–26 July 2002
CABI Publishing: Oxon, UK

Viljoen JH, Marasas WFO (2003)
A Review of Proposed Maximum Tolerated Levels for Fumonisins in Maize and Maize Products
In: Credland PF, Armitage DM, Bell CH, Cogan PM, Highly E (Eds.) Advances in Stored Product Protection. Proceedings of the 8th International Working Conference on Stored Product Protection, York, UK, 22–26 July 2002
CABI Publishing: Oxon, UK

Nutrition

Faber M, Laurie S, Venter S (2006)
Home-gardens to Address Vitamin A Deficiency in South Africa: A Food-based Approach
ARC-Roodeplaat Vegetable & Ornamental Plant Institute
ISBN: 1-86849-314-8
Web: http://www.arc.agric.za/home.asp?PID=1&ToolID=65&ItemID=3125

Pesticides

Leslie AJ, Taplin LE (2000)
Chapter 21. Recent Developments in Osmoregulation of Crocodilians
In: Grigg GC, Seebacher F, Franklin CE (Eds.) Crocodilian Biology and Evolution
Surrey Beatty and Sons: Chipping Norton, Australia

London L, Rother HA (2002)
Hazard Labelling
In: Pimental D (Ed.) Encyclopedia of Pest Management
Marcel Dekker Inc.: New York
Web: http://dekker.com

London L, Rother HA (2003)
Failing Laws: Assumptions and Realities for Women in South African Agriculture
In: Jacobs M (Ed.) Silent Invaders. Pesticides, Livelihoods And Women's Health
Zed Books, in association with the Pesticides Action Network UK: London

Lubke RA, Avis AM, Steinke TD, Boucher C (1997)
Chapter 13. Coastal Vegetation
In: Cowling RM, Richardson (Eds.) The vegetation of South Africa
Oxford University Press

Ngowi AVN, Wesseling C, London L (2006)
Pesticide Health Impacts in Developing Countries
In: Pimental D (Ed.) Encyclopedia of Pest Management
Marcel Dekker Inc.: New York
Web: http://dekker.com

Water Research

Wepener V, Smolders R, Bervoets L, Voets J, Blust R (2005)
Active Biomonitoring (ABM) by Translocation of Bivalve Molluscs
In Lehr JH, Keeley J (Eds.) Water Encylcopedia, Volume 2: Water Quality and Resource Development
Wiley Publishers
ISBN: 0-471-44164-3

Journals

The Department of Education (DE) in South Africa encourages research productivity by rewarding quality research output at public higher education institutions. Research output is defined as textual output that is original and peer-reviewed and is published either in the Department of Education accredited journals or in those listed in the ISI journal lists.

African Journal of Aquatic Science
ISSN: 1608-5914; EISSN: 1727-9364

Published semiannually in association with Southern African Society of Aquatic Scientists, the journal serves as a reference source for those interested in understanding the valuable aquatic resources of Africa. Amongst the topics covered in this journal are ecology, conservation, biomonitoring, management,

water quality, ecotoxicology, biological interactions, physical properties, and human impacts on aquatic systems. This journal is on the approved accredited list of the DE.

Web: http://www.nisc.co.za/journals?id=2; http://www.dwaf.gov.za/iwqs/sasaqs/Journal.htm
Phone: +27(0)33-344-2789
Email: mdcoke@futurenet.co.za

African Zoology
ISSN: 1562-7020

African Zoology is the official journal of the Zoological Society of Southern Africa. It is published online and can be accessed on the Internet at http://www.journals.co.za/ej/ejour_afzoo.html.

Postal address: School of Botany and Zoology, University of KwaZulu-Natal, Private Bag X01, Scottsville, 3209 South Africa
Phone: +27-(0)12-420-3232

Bothalia
ISSN: 0006-8241

Bothalia is listed on the ISI journal list and published semiannually by the South African National Biodiversity Institute (SANBI). It is devoted to botanical science, and covers taxonomy, ecology, anatomy, and cytology.

Web: http://www.sanbi.org/products/publications/bothalia.htm
Postal address: National Botanical Institute, Private Bag X101, Pretoria, South Africa
Phone: +27(0)12-843-5000
Fax: +27(0)12-804-3211

Journal of the South African Veterinary Association
ISSN: 0038-2809

The *Journal of the South African Veterinary Association* publishes reviews on various topics, clinical and non-clinical articles, research articles, and short communications as well as case reports and letters. It is included on the ISI Journal list and can be accessed at http://www.journals.co.za/ej/ejour_savet.html/.

Postal address: P.O. Box 25033, Monument Park 0105, South Africa

Koedoe
ISSN: 0075-6458

It is published semiannually by the South African National Parks of S.A. Currently it does not have a website. The journal is on the list of DE-accredited journals.

Postal address: P.O. Box 787, Pretoria 0001, South Africa

Occupational Health South Africa
ISSN: 1024-6274

Occupational Health South Africa is the official journal of the Mining Medical and Other Health Care Professionals Association (MMOA), South African Society of Occupational Health Nursing Practitioners (SASOHN), South African Society of Occupational Medicine (SASOM), and Southern African Institute for Occupational Hygiene (SAIOH). It is published bimonthly and can be accessed at http://ohsa.sheafrica.info/. The journal is on the approved accredited journal list of DE.

Postal address: Safety First, P.O. Box 14402, Club View 0014, South Africa
Phone: +27(0)12-654-8349

Onderstepoort Journal of Veterinary Research
ISSN: 0030-2465

The *Onderstepoort Journal of Veterinary Research* is published quarterly by the Agricultural Research Council and the University of Pretoria. The journal is ISI listed and publishes papers reporting on original research covering all aspects of veterinary science. It can be accessed at http://www.journals.co.za/ej/ejour_opvet.html.

Postal address: Bag X5, Onderstepoort 0110, South Africa

Ostrich
ISSN: 0030-6525, EISSN: 1727-947X

This journal is published semiannually by the National Inquiry Services Centre (NISC) in association with BirdLife South Africa. *Ostrich* is listed on the ISI journal list and publishes papers in the general field of ornithology in sub-Saharan Africa and its islands on subjects related to the behavior, biology, breeding, ecology, migrations, and movements and systematics of birds. It can be accessed at http://www.nisc.co.za/journals?id=6.

Postal address: BirdLife South Africa, P.O. Box 515, Randburg 2125, South Africa
Phone: +27(0)23-541-1828
Email: lycium@mweb.co.za

South African Journal of Animal Science

This journal is ISI listed and is published electronically by NISC SA triennially at approximately 3–4-month intervals and can be accessed on the Internet at http://www.nisc.co.za/ or through http://www.sasas.co.za/.

Postal address: P.O. Box 13884, Hatfield 0028, Pretoria, South Africa
Phone: +27(0)12-420-5017
Email: secretary@sasas.co.za

South African Journal of Botany
ISSN: 0254-6299

The *South African Journal of Botany* is the official journal of the South African Association of Botanists and publishes papers in any field of Botany. It is ISI listed and can be accessed on the Internet at http://www.ajol.info/journal_index.php?jid=118 or

http://www.ajol.info/journal_index.php?jid=118&tran=0&ab=0.

Postal address: Research Centre for Plant Growth and Development, University of Natal Pietermaritzburg, Private Bag X01 Scottsville 3209, South Africa
Phone: +27(0)46-622-9698

South African Journal of Clinical Nutrition
ISSN 0038-2469

The *South African Journal of Clinical Nutrition* is published quarterly and is the official joint publication of the Association for Dietetics in South Africa, the Nutrition Society of South Africa, and the South African Society of Parenteral and Enteral Nutrition. It is a peer-reviewed scientific journal and is published quarterly. It can be accessed at the http://www.sajcn.com/. It is one of the accredited journals by DE.

Postal address: c/o Dept of Human Nutrition, Stellenbosch University and Tygerberg Academic Hospital Fransie Van Zijl Avenue, Clinical Building, Tygerberg 7505, South Africa

South African Journal of Science
ISSN 0038-2353

This journal is published monthly and is the official publication of the Academy of Science of South Africa (ASSAf). It is an ISI listed journal and can be accessed on the Internet at http://www.sajs.co.za/.

Postal address: PO Box 72135, Lynwood Ridge 0040, South Africa
Phone: +27(0)12-420-4956/4965

South African Journal of Wildlife Research
ISSN: 0379-4369

Published biannually by the Southern African Wildlife Management Association (SAWMA) online and can be accessed on the Internet at http://www.sawma.co.za/. It is listed on the ISI journal list.

Postal address: P O Box 217, Bloubergstrand 7437, South Africa
Phone: +27(0)21-554-1297

South African Medical Journal
ISSN 0038-2469

The *South African Medical Journal* is published by the South African Medical Association, which represents most medical professionals in South Africa. It can be accessed at the https://www.ajol.info/journal_index.php?jid=76&ab=samj website. It is on the DE accredited journal list.

Postal address: Private Bag X1, Pinelands, 7430, South Africa
Phone: +27(0)21-530-6520.

Water South Africa
ISSN: 1816-7950

Water SA is published quarterly by the Water Research Commission (WRC). It contains original research articles and review articles on all aspects of water science, technology, and engineering. It can be accessed on the Internet at http://www.wrc.org.za/publications_watersa.htm.

Postal address: Private Bag X03, Gezina 0031, South Africa
Phone: +27(0)12-330-0340

Technical Reports and other Documents

A number of governmental and non-governmental organizations as well as tertiary education institutions publish technical reports on subjects that are of relevance to toxicology. These emanating from post-graduate work conducted at the latter institutions have also been included in this section as they may be considered as important contributions to subjects of relevance to toxicology.

Technical Reports

The following reports are available from the Water Research Commission (WRC).
Web: http://www.wrc.org.za/
Postal address: Private Bag X03, Gezina 0031, South Africa
Phone: +27(0)12-330-0340
Fax: +27(0)12-331-2565
Email: info@wrc.org.za

2006

Wepener V, Cyrus D, Vermeulen LA, O'Brien GC (2006)
Development of a Water Quality Index for Estuarine Water Quality Management in South Africa
WRC Report No. 1163/1/06

Venter SN, Mjoli NP (2006)
A Strategic Framework for Water-Related Human Health Research
WRC Report No: TT 257/06 (ISBN: 1-77005-404-9)

2005

Barclay S, Buckley C (2005)
Applicability of Waste Minimisation Clubs in South Africa: Results from Pilot Studies

WRC Report No: TT 161/05
ISBN: 1-86845-831-8
McConnachie AJ, Hill MP (2005)
Biological Control of Red Water Fern in South Africa
WRC Report Number: KV 158/05

Joska MAP, Day JA, Boulle J, Archibald S (2005)
Development of a Biomonitoring Method Using Protozoans for Assessment of Water Quality in Rivers and Ground Waters and Seasonal/Ephemeral Waters
WRC Report Number: 1017/1/05

van Wyk JH, Pool EJ, Hurter E, Leslie AJ (2005)
The Development and Validation of Bioassays to Detect Estrogenic and Anti-Androgenic Activity Using Selected Wildlife Species
WRC Report Number: 926-1253/1/05

Snyman HG, Herselman JE, Kasselman G, Steyn CE, Wilken JW (2005)
Guidelines for the Utilization and Disposal of Wastewater Sludge: Volume 1 of 5: Selection of Management Options
WRC Report No: TT 261/05
ISBN: 1-77005-422-7

Snyman HG, Herselman JE, Kasselman G, Steyn CE, Wilken JW (2005)
Guidelines for the Utilization and Disposal of Wastewater Sludge: Volume 2 of 5: Requirements for the Agricultural Use of Wastewater Sludge
WRC Report No: TT 262/05
ISBN: 1-77005-423-5

Malan HL, Day JA (2005)
Strategic Overview of the Research Needs for Wetland Health and Integrity
WRC Report Number: KV 171/05CD

CSIR (2005)
Water and Wastewater Management in the Oil Refining and Re-Refining Industry: NATSURV 15
WRC Report No: TT 180/05
ISBN: 1-86845-508-4

Van Zyl HD, Premlall K (2005)
Water and Waste-Water Management in the Power Generating Industry (NATSURV 16)
WRC Report No: TT 240/05
ISBN: 1-77005-270-4

Burger AEC (2005)
WRC Programme on Endocrine Disrupting Compounds (EDCs): Volume 1
WRC Report Number: KV 143/05

2004

Venter EA, Slabbert JL, Joubert A, Vorster A (2004)
Biomarker Assays for the Detection of Sub-Lethal Toxicity in Fish: Operational Manual
WRC Report Number: 952/2/04

Slabbert JL, Venter EA, Joubert A (2004)
Biomarker Assays for the Detection of Sub-Lethal Toxicity in the Aquatic Environment: A Preliminary Investigation
WRC Report Number: 952/1/04

Whitcutt JM, Emmett RA, Tseki Ramajwe, Mbatha Z, Humphries P, Wittekindt E (2004)
Biomonitoring of Waste Water
WRC Report Number: 1121/1/04

London L, Dalvie MA, Cairncross E, Adams H, Solomons A (2004)
Cost-Effective Methods for Monitoring Pesticide Pollution in Water Systems
WRC Report No: 1120/1/04
ISBN: 1-77005-117-1

Dallas HF, Day JA (2004)
The Effect of Water Quality Variables on Aquatic Ecosystems Review
WRC Report No: TT 217/04
ISBN: 1-77005-083-3

Palmer T, Berold R, Muller N (2004)
Environmental Water Quality in Water Resources Management
WRC Report No: TT 217/04
ISBN: 1-77005-083-3

Genthe B, Herold CE, Haarhoff J, Hosking S, Syke G (2004)
Feasibility of Water Fluoridation for South Africa
WRC Report No: TT 222/04
ISBN: 1-177005-108-2

Heath R, du Preez H, Genthe B, Avenant-Oldewage A (2004)
Freshwater Fish and Human Health: Reference Guide
WRC Report Number: TT 213/04

Scherman P-A, Muller WJ, Jooste S (2004)
A Further Investigation into Using a Risk-Based Approach for Setting Integrated Environmental Objectives for the Protection of Water Resources
WRC Report Number: KV 154/04

Barnes JM, Taylor MB (2004)
Health Risk Assessment in Connection With the Use of Microbiologically Contaminated Source Waters for Irrigation

WRC Report Number: 1226/1/04
Ueckermann C, Hill MP (2004)
Impact of the Herbicides Used in Water Hyacinth Control on Natural Enemies Released Against the Weed for Biological Control
WRC Report Number: 915/1/01

Grobbelaar JU, Botes E, van den Heever JA, Oberholster AM, Oberholster PJ (2004)
Toxin Production by Cyanobacteria
WRC Report No: 1029/1/04
ISBN: 1-77005-191-0
Web: http://www.wrc.org.za/downloads/report%20lists/web%20files/1029-04%20revised.pdf

2003

Claassen M (2003)
Ecological Risk Assessment: Research Priorities
WRC Report Number: 957/1/03

Carlsson FHH (2003)
Elementary Handbook of Water Disinfection
WRC Report No: TT 205/03
ISBN: 1-86845-983-7

Wood AR (2003)
The Potential of Aquatic Phythium Species for the Biological Control of Cladophora Glomerata in Irrigation Schemes in South Africa
WRC Report Number: 918/1/03

Scherman P-A, Palmer CG, Muller WJ (2003)
Use of Indigenous Riverine Invertebrates in Applied Toxicology and Water Resource-Quality Management
WRC Report Number: 955/1/03

2002

Clacherty A, Moodie P (2002)
Environmentally Responsible Mining: Water Management Guidelines for Small-Scale Mining
WRC Report No: TT 168/02
ISBN: 1-86845-842

Coubrough P (2002)
Guidelines for Legionella Levels in Water: A Code of Practice
WRC Report No: TT 174/02
ISBN: 1-86845-846-6

2001

Roux DJ (2001)
Development of Procedures for the Implementation of the National River Health Programme in the Province of Mpumalanga
WRC Report Number: 850/1/01
Claassen M, Strydom WF, Murray KJ (2001)
Ecological Risk Assessment Guidelines
WRC Report No: TT 151/01
ISBN: 1-86845-721-4

Hill L, Vos P, Moolman J, Silerbauer M (2001)
Inventory of River Health Programme Monitoring Sites on the Olifants, Sabie and Crocodile Rivers
WRC Report Number: 850/2/01

2000

Schoeman JJ, Steyn A (2000)
Defluoridation, Denitrification and Desalination of Water Using Ion – Exchange and Reverse Osmosis
WRC Report No: TT 124/00
ISBN: 1-86845-597-1

Murphy KO'H (2000)
Land-Based Effluent Disposal and Use: Development Guidelines and Expert Systems-Based Decision Support
WRC Report No: TT 125/00
ISBN: 1-86845-551-3

London L, Dalvie MA, Cairncross E, Solomons A (2000)
The Quality of Surface and Groundwater in the Rural Western Cape with Regard to Pesticides. Final report to the Water Research Commission on the Project 'An Assessment of the Quality of Water Supplies in the Rural Western Cape With Regard to Agrichemical Pollutants'
WRC Report No: K5/795

Barclay S, Buckley C (2000)
Waste Minimization Guide for the Textile Industry: A Step Towards Cleaner Production: Vol. I
WRC Report No: TT 139/00
ISBN: 1-86845-659-5

Barclay S, Buckley C (2000)
Waste Minimization Guide for the Textile Industry: A Step Towards Cleaner Production: Vol II
WRC Report No: TT 140/00
ISBN: 1-86845-659-5

Reports related to toxicological issues are also published by the Council for Scientific and Industrial Research (CSIR)

Walmsley RD, Grobler JH (1986)
An Evaluation of the Impact of Urban and Recreational Development on the Ecology and Usage of Lake Mzingazi

Occasional Report Series 6, Ecosystems Programmes, FRD, CSIR, Pretoria

Hemens J, Simpson DE, Sibbald RR (1981)
Lake Nseze, Richards Bay. Environmental Aspects of Multipurpose Water Use
CSIR Special Report No. 60

Turner JWD (1983)
Water Quality of Main Lakes in the Richards Bay Area. Final Report to Steering Committee for Limnological Research and Water Treatment
CSIR/NWIR Project 620/97548

Research Reports that were published by other institutions include those published by the University of Stellenbosch which can be accessed on the Internet at the website

http://admin.sun.ac.za/research/Research_NavVersl1997.pdf

Nel JAJ, Mouton PleFN, Cherry MI, Geertsema H (1997)
Alpha Saldanha Cement Project: Environmental Impact Assessment. Specialist Report 3
Mark Wood Consultants, Honeydew, University of Stellenbosch

Institute for Futures Research, MRC (1997)
Environmental Health Scan: Technology Foresight Project
National Research and Technology Audit, University of Stellenbosch

Doppegieter JJ, Du Toit J (1997)
Modelling Demand and Supply of Energy in South Africa – Phase 1: Investigation and Planning
Report No. EG 9605, Department of Minerals and Energy, University of Stellenbosch

Finally, a number of other reports that can be considered relevant to toxicology and published by different organizations and tertiary institutions include

Burger LW, Watson RM (2001)
Air Quality Impact Assessment for the Proposed Natural Gas Conversion of SASOL One Plant – Sasolburg
Report No: EMS/01/SRK-02 Rev 1.1
Web: http://w3.sasol.com/natural_gas/Environment/SCI_Conversion/Spec%20Rep/Air_Quality_Study.pdf

Kotzé T
The Extent of the Radiological Impacts Caused by the Diagnostic and Therapeutic Use of Nuclear Medicine
South African Medical Physics Society
Web: http://www.saapmb.org.za/Samps/Publications/SAMPS200101(Impact_NucMed)/SAMPS200101ENG.pdf

London L, Rother A, Tolosana S, Maruping M (2003)
FRIDGE/UNITAR Study into the Implications of Implementing the Globally Harmonised System of Classification and Labelling of Chemicals and Development of an Implementation Strategy for South Africa: PART 2: Chemical Hazard Communication Comprehensibility Testing – Tool and Toolkit
NEDLAC
Web: http://www.nedlac.org.za/

London L, Rother A, Tolosana S, Maruping M, Brinkhuis S, Davlie MA (2003)
FRIDGE/UNITAR Study into the Implications of Implementing the Globally Harmonised System of Classification and Labelling of Chemicals and Development of an Implementation Strategy for South Africa: PART 3: Chemical Hazard Communication Comprehensibility Testing
NEDLAC
Web: http://www.nedlac.org.za

Department of Water Affairs and Forestry (DWAF) (1995)
Jukskei River Catchment State of the Aquatic Ecosystem Health
Final Report to AECI, Modderfontein, Department of Water Affairs and Forestry, Pretoria, Report No. N/A200/00/REQ/0395

Somdyala NIM, Bradshaw D, Gelderblom WCA, Marasas WFO (2003)
Cancer Patterns in Four Districts of the Transkei Region of the Eastern Cape Province 1996–2000
PROMEC Cancer Registry Technical Report, Medical Research Council, Tygerberg, South Africa (Technical Report) 1-18
Web: http://www.mrc.ac.za/promec/cancertitle.pdf
Postal address: PROMEC Unit, P.O. Box 19070, Tygerberg 7505, South Africa
Phone: +27(0)-21-938-0518
Fax: +27(0)21-938-0260
Email: ntuthu.somdyala@mrc.ac.za

Governmental Strategies, Guidelines, Action Plans, and Reports

There are important governmental strategies, guidelines and action plans developed with the intention of controlling the impact and toxicity of different compounds on the environment. These may have an impact on the ecology and on human health.

Department of Health
Guidelines for Good Practice in the Conduct of Clinical Trials in Human Participants in South Africa
Web: http://www.doh.gov.za/docs/policy/trials/trials_01.html
Department of Environmental Affairs and Tourism (2004)
South Africa's National Biodiversity Strategy and Action Plan
Web: http://www.environment.gov.za/ProjProg/ProjProg/2004Jun10/ NBSAP/front-30.pdf

Department of Water Affairs and Forestry (2004)
Operational Policy for the Disposal of Land-Derived Water Containing Waste to the Marine Environment of South Africa Edition 1
Web: http://www.dwaf.gov.za/Dir_WQM/docs/marine/MarineWastePolicyOct04.pdf

Tladi B, Baloyi T, Schreiber-Kaya A, Mathekgana M, Mangold S, de Klerk T, Winde F (2002)
State of the Environment Report 2002, North West Province, South Africa: Chapter 13: Human Health and Well-Being
Web: http://www.nwpg.gov.za/soer/FullReport/human%20health.html

Ad Hoc Group of the States Parties to the Convention on the Prohibition of the Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction. Bwc/Ad Hoc Group/Wp.202 (1997)
Working Paper by South Africa: Organisation of the Technical Secretariat (WP.202). Geneva, 15 September–3 October, 1997
Web: http://www.brad.ac.uk/acad/sbtwc/btwc/ahg/docs/08th%20session/wp202.pdf

Databases

Agricultural Geo-Referenced Information System
Provides orientation atlas, natural resource atlas, demographic atlas and geo-references information systems
Web: http://www.agis.agric.za

Biodiversity GIS (BGIS): Highlighting the Hotspots
This is a unit within the South African National Biodiversity Institute (SANBI). It manages spatial biodiversity planning information and promotes the use of this information by making it freely available at this website: http://bgis.sanbi.org/.

Medical Research Council Health Knowledge Network is the African Trials Registry
Web: http://www.sahealthinfo.org.za

National Air Quality Information System (NAQIS)
For South Africa, this gives a multi-phased approach on the development of the national air quality information system in South Africa which will be developed by the Department of Environmental Affairs and Tourism (DEAT).
Web: http://www.environment.gov.za/HotIssues/2006/NAQIS/NAQIS%20Framework%20Document%20-%20Final%20Draft.pdf

National Chemical Monitoring Programme (NCMP)
This aim to provide regular reporting on the chemical quality of South Africa's surface waters.
Web: http://www.dwaf.gov.za/iwqs/water_quality/NCMP/default.htm

National Inquiry Services Centre (NISC SA)
Web: http://www.nisc.co.za/

This center was established in 1995 in Grahamstown in May 1995. NISC SA provides local and global information for Africa, about Africa and by Africans. By so doing, it launches African publishing and research into the world arena. It provides the following databases of relevance:

NISC Bibliographic databases
Web: http://www.nisc.co.za/databases
African HealthLine
Web: http://www.nisc.com/factsheets/qaha.asp
African Journals OnLine (AJOL)
Web: https://www.ajol.info/index.php

National Microbiological Monitoring Programme for Surface Water

This organization provides information on the status and trends of the extent of fecal pollution, in terms of the microbial quality of surface water resources in priority areas.

Web: http://www.dwaf.gov.za/iwqs/microbio/nmmp.htm

National Toxicity Monitoring Programme

This program measures, assesses, and regularly reports on the status and trends on the nature and extent of potentially toxic substances and toxic organisms in South African water resources in a manner that supports strategic management decisions in the context of fitness for use of those water resources.

Web: http://www.dwaf.gov.za/iwqs/water_quality/ntmp/index.htm

Pesticide Registration Information for South Africa
Web: http://www.pesticideinfo.org/Detail_Country.jsp?Country=South%20Africa

Plants of Southern Africa

This is an online checklist covering all southern African plants.

Web: http://posa.sanbi.org/searchspp.php

PlantZAfrica
Web: http://www.plantzafrica.com/

Has information about popular southern African plants such as plants of southern Africa:

Web: http://www.plantzafrica.com/frames/plants-fram.htm
and vegetation of southern Africa:
Web: http://www.plantzafrica.com/frames/vegfram.htm

Resource Quality Services

This is provided by the Department of Water Affairs and Forestry and lists a number of programs that give important toxicological information on water quality.

Web: http://www.dwaf.gov.za/iwqs/

South African National Biodiversity Institute (SANBI)

This provides information sources on southern Africa's biodiversity and can be accessed at http://www.sanbi.org/frames/infofram.htm. Databases on their website that are of interest to toxicology include:

South African National Bioinformatics Institute (SANBI) carries out analyses of genomes relevant to South African health research and biotechnology.
Web: http://www.sanbi.ac.za/

South African Traditional Medicines Database is developed and maintained by the South African Traditional Medicines Research Unit at the University of Cape Town, South Africa. The database contains information on the reported medicinal treatments, chemical information, pharmacological and toxicological content of a wide variety of South African Traditional medicines.
Web: http://www.mrc.ac.za/Tramed3/

Strategic Framework for Monitoring and Assessment of Water Quality and Aquatic Ecosystem Health
Web: http://www.dwaf.gov.za/iwqs/wrmais/default.htm

This programme can be accessed at:
http://www.dwaf.gov.za/iwqs/wrmais/National_Water_Resource_Quality_strategy_ed01_dr05_final.pdf

Organizations (government)

Department of Agriculture

The Department of Agriculture ensures access to sufficient safe and nutritious food and the enhanced sustainable management of natural agricultural resources and ecological systems.

Web: http://www.nda.agric.za/.
Postal address: Private Bag X250, Pretoria, 0001, South Africa
Address: 20 Beatrix Street, Arcadia, Pretoria 0002, South Africa
Phone: +27(0)12-319-6000.

Department of Education

The Department of Education, among its many other functions, gives accreditations to locally published scientific journals to reward researchers who publish in these and other journals that are listed on the ISI journal lists.

Web: http://www.education.gov.za/
Postal address: Private Bag X895, Pretoria, 0001, South Africa
Address: Sol Plaatje House, 123 Schoeman Street, Pretoria
Phone: +27(0)12-312-5911
Fax: +27(0)12-325-6260

Department of Environmental Affairs and Tourism (DEAT)
Web: http://www.environment.gov.za/
Postal address: Private Bag X447, Pretoria 0001, South Africa
Address: 315 Pretorius Street, cnr. Pretorius & van der Walt Streets, Fedsure Forum Building, North Tower, 2nd Floor (Departmental reception) OR, 1st Floor (Departmental information center), Pretoria, 0001
Phone: +27(0)12-310-3911, or Call Center number 086-111-2468

Lead projects of this Department include:
National Biodiversity Strategy and Action Plan
Web: http://www.environment.gov.za/ProjProg/ProjProg/2004Jun10/natStrategy_26052004.html
National State of the Environment Report
Web: http://www.ngo.grida.no/soesa/
National Waste Management Strategy Implementation Project
Web: http://www.environment.gov.za/nwmsi/index.html
South African Air Quality Information System (SAAQIS)
Web: http://www.environment.gov.za/HotIssues/2006/NAQIS/NAQIS.html
State of the Environment Initiative
Web: http://www.environment.gov.za/soer/overview.html

Department of Health

The Department of Health aims to improve access to health care for all and also to improve the quality of care at all levels of the health system.

Web: http://www.doh.gov.za/
Postal address: Private Bag X828, Pretoria, 0001
Phone: +27(0)12-312-0000
Fax: +27(0)12-326-4395

Department of Science and Technology

The mission of this Department includes the facilitation of the National System of Innovation for communities, researchers, industry, and government.

Web: http://www.dst.gov.za/
Postal address: Postal Address: Private Bag X894, Pretoria 0001
Address: DST Building (Building no. 53), (CSIR South Gate Entrance), Meiring Naude Road, Brummeria 0001
Phone: +27(0)12-843-6300.

Department of Water Affairs and Forestry

The Department of Water Affairs and Forestry is responsible for conserving, managing, and developing water resources and forests in a scientific and environmentally sustainable manner. Web: http://www.dwaf.gov.za/

Postal address: Private Bag X313, Pretoria 0001, South Africa
Address: Sedibeng Building, 10th Floor, R1029, 185 Schoeman Street, Pretoria, South Africa
Phone: +27(0)12-336-7500
Fax: +27(0)12-328-4254

Organizations (non-government)

AVCASA

The Association of Veterinary and Crop Association of South Africa (AVCASA) was established in 1958 to represent companies involved in the crop protection and animal health products industry in South Africa. Web: http://www.avcasa.co.za/contacts.html. Over the years it has changed identity several times. From early 2003, the AVCASA represents three affiliate associations, namely, South African Animal Health Association (SAAHA; http://www.saaha.co.za), CropLife SA (www.croplife.co.za) and the Agricultural Chemical Distribution Association of South Africa (ACDASA; http://www.acdasa.co.za).

AVCASA promotes the interest of its members by providing guidelines for the classification, labeling, responsible handling and storage of products, occupational hazards and personal protection, as well as the disposal of waste and empty containers. It also serves the farmer by providing guidelines for the safe storage and responsible use of crop protection and animal health products on the farm, stressing the personal protection of farm workers and by offering training programs in responsible product handling and usage.
Postal address: PO Box 1995, Halfway House, 1685, South Africa
Address: Lanzerac, Constantia Park 526, 16th Road, Midrand, South Africa
Phone: +27(0)11-805-2000
Fax: +27(0)11-805-2222
Email: info@saaha.co.za

Biotechnology Innovation Centres (BRICs)

The National Biotechnology Strategy was released by the Department of Science and Technology in 2001 in order to develop the South African biotechnology industry to the extent that it can begin to address national needs and become established within the global biotech industry. Four centers were established around the country to develop an active and sustainable biotechnology sector in South Africa. New projects have a strong focus on different areas of health biotechnology: diagnostics, drug discovery and development, vaccines and bioprocess technologies and nutraceuticals from Biotech processes.

BioPAD is based in Pretoria.
Web: http://www.biopad.org.za/
Postal address: P.O. Box 75887 Lynnwood Ridge 0040, South Africa
Address: The Innovation Hub, Unit 3&4, Enterprise Building, Mark Shuttleworth Street, Persequor, Pretoria
Phone: +27(0)12-844-0145
Fax: +27(0)12-844-0153

Cape Biotech is based in Cape Town.
Web: http://www.capebiotech.co.za/cat1.php?catID=2
Postal address: P O Box 13372, Mowbray 7705, South Africa
Address: 1st Floor, Minolta House, Black River Park, Fir Rd, Observatory 7925, South Africa
Phone: +27(0)21-442-3780
Fax: +27(0)21-442-3781
E-mail: info@capebiotech.co.za

LIFElab is based in Cato Manor on the East Coast.
Web: http://www.lifelab.co.za/questions.asp
Postal address: P O Box 30603, Mayville 4058
Address: 750 Francios Road, Intuthuko Junction, Pod 8, Level 2, Cato Manor
Phone: +27(0)31-261-6427
Fax: +27(0)31-261-4581

PlantBio is based in Hayfields.
Web: http://www.plantbio.org.za/about.asp
Postal address: Postnet Suite 201, P/Bag X6, Cascades 3202
Address: Suite 38, Hayfields Mall, 28 Blackburrow Road, Hayfields 3201
Phone: +27(0)33-846-1980
Fax: +27(0)33-846-1983/1990

The Medicines Control Council

The MCC operates through external experts who are members of Council. Committee structures comprise of the African Traditional Medicines Committee, Veterinary Clinical Committee, Biological Committee, Clinical Trials Committee, Pharmacovigilance Committee, Complimentary Medicines Committee, Analytical Committee, Clinical Committee, Pharmaceutical/Bioavailability Committee and the Scheduling Committee. The experts evaluate data sets submitted by the pharmaceutical industry for purposes of registration. The Council, in considering whether a medicine is suitable for use for its intended purpose, assesses its relative risk against the benefits. The Medicines and Related Substances Control Act 101 of 1965 defines a medicine.

Web: http://www.mccza.com/
Phone: Clinical Evaluation & Trials +27(0)12-312-3264; Inspectorate and Law Enforcement +27(0)12-312-0861; Medicines Evaluation & Research +27(0)12-312-0057

The National Health Laboratory Service (NHLS)

Web: http://www.nhls.ac.za/
Postal address: P.O. Box 1038, Johannesburg, South Africa, 2000
Address: 1 Modderfontein Road, Sandringham, Johannesburg, South Africa
Phone: +27(0)11-386-6000
Fax: +27(0)11-386-6002
Email: louise.blake@nhls.ac.za

The NHLS has two specialized divisions that conduct research of relevance to toxicology:

National Institute for Occupational Health (NIOH) supports the development and provision of occupational health services in South Africa. It houses the Department of Toxicology and Biochemistry which conducts research on the health effects of the exposures of biological systems and human populations to occupational and environmental contaminants within a risk assessment framework.

Web: http://www.nioh.ac.za/.
Postal address: P.O. Box 4788, Johannesburg 2000, South Africa
Address: 25 Hospital Street, Constitution Hill 2001, Johannesburg, South Africa
Phone: +27(0)11-712-6400
Fax: +27(0)11-712-6545/+27(01)11-712-6532
E-mail: Info@nioh.nhls.ac.za

The National Institute for Communicable Diseases (NICD) is one of the major global role players in infectious disease intelligence.
Web: http://www.nhls.ac.za/div_nicd.html
Postal address: P.O. Box 1038, Johannesburg, South Africa, 2000
Address: 1 Modderfontein Road, Sandringham, Johannesburg, South Africa
Phone: +27(0)11-386-6000
Fax: +27(0)11-386-6002

The Nuclear Energy Corporation of South Africa

NECSA is a public company in terms of the Nuclear Energy Act, 1999 and is wholly owned by the State. Among its other functions, it undertakes and promotes research and development in the field of nuclear energy and radiation sciences and technology. Apart from its main operations at Pelindaba, NECSA also operates the Vaalputs radioactive waste-disposal facility. It also provides a 24-hour emergency service for nuclear-related accidents throughout Africa. It is used (among other things) to produce radioisotopes that are used to fight diseases and to accurately measure critical process parameters such as levels of radioactivity, mass, density and quality and thus helps to keep the wheels of industry turning. NECSA is accredited by the International Atomic Energy Agency as a regional designated center, servicing the rest of Africa in radioactive waste management. The Corporation has been given the responsibility of developing a low-cost radioactive waste-disposal facility – known as the Borehole Nuclear Waste Disposal System – to be used for the disposal of radioactive waste from hospitals on the continent.

Web: http://www.necsa.co.za/
Postal address: P.O. Box 582, Pretoria 0001, South Africa
Address: Church Street West Extension, Pelindaba, Brits District, South Africa
Phone: +27-12-305-4911
Fax: +27-12-305-3111
Email: info@necsa.co.za

The Safety in Mines Research Advisory Committee

SIMRAC was established in terms of Section 29 (9) (a) of the Minerals Act (Act 50 of 1991) with the principal objective of advising the Mine Health and Safety Council on the determination of the safety risk on mines and the need for research into safety on mines based on the safety risk.

Web: http://www.simrac.co.za/homepage.htm
Postal address: Private Bag X63, Braamfontein 2017, Johannesburg, South Africa
Address: 2nd Floor Braamfontein Centre, 23 Jorissen Street, Braamfontein, Johannesburg, South Africa
Phone: +27-11-358-9180/9187
Fax: +27-11-403-1821
Email: bmosiuoa@mhsc.org.za

Science Councils

There are currently eight science councils in South Africa six of which are of relevance to toxicology.

Web: http://www.ird.fr/fr/science/dss/sciences_afrique/pdf/south_af/south_af6_rd_performers.pdf

The Agricultural Research Council (ARC) (http://www.arc.agric.za) is based in Pretoria and is a statutory parastatal body formed in terms of the Agricultural Research Act, 1990 (Act 89 of 1990). Its mission states that it is committed to the promotion of agriculture and related sectors through research, technology development and technology transfer, in order to optimize the role of agriculture in respect of national growth and development in the Republic of South Africa. The ARC has 15 research institutes under its control which in turn are divided into three categories: specialist institutes, plant science institutes, and animal science institutes. Of these the Onderstepoort Veterinary Institute is of importance as it houses the Department of Toxicology.

Web: http://www.arc.agric.za/home.asp?pid=614
Physical address: 1134 Park Street, Hatfield, Pretoria
Address: P O Box 8783, Pretoria, 0001, South Africa
Phone: +27(0)12-427-9700
Fax: +27(0)12-342-3948

Toxicological Diagnostics screens samples for toxic substances, verifies analytical results, advises clients, investigates unknown causes of livestock poisoning and interprets laboratory results in a meaningful manner to clients.

Animal Bio-laboratory houses cattle, sheep and small animals (mice, rats, guinea pigs) for animal experiments and toxicity testing.

Research laboratories investigate mechanisms for controlling poisoning of livestock by poisonous plants.

The Council for Mineral Technology (MINTEK) conducts research on mineralogical examination of ores, refining technologies and the manufacture of end-products.

Web: http://www.mintek.co.za/
Postal address: Private Bag X3015, Randburg 2125, South Africa
Address: 200 Hans Strijdom Drive, Randburg, Johannesburg, South Africa
Phone: +27(0)11-709-4111
Fax: +27(0)11-793-2413
Email: info@mintek.co.za

The Council for Scientific and Industrial Research (CSIR) was established in 1945 and presently is the largest community and industry-directed scientific and technological research, development and implementation organization in Africa. It conducts contract research, and provides, among other services, specialist consulting, education and training, and global science and technology links. Numerous divisions provide these services, a number of which specialize in toxicology.

Web: http://www.csir.co.za/plsql/pTl0002/PTL0002_PGE001_HOME
Postal address: P O Box 395, Pretoria 0001, South Africa
Address: Meiring Naudé Road, Brummeria, Pretoria, South Africa
Phone: +27(0)12-841-2000/2911
Fax: +27(0)12-349 1153
Within CSIR, there are four sections that conduct work relevant to toxicology.

Bio/Chemtek provides contract research to customers in the broad area of biotechnology and chemical manufacturing technology. The range of technology solutions and information also covers the chemical process industries and the manufacture of bio-chemicals.

Web: http://www.csir.co.za/plsql/pTl0002/PTL0002_PGE106_SITE_SRCH_RSLT

Environtek (Water, Environment and Forestry Technology)

Environtek provides technologies for environmental assessment and management, terrestrial resources and environmental management, forestry and forest products, water resource management and coastal development and marine resources.

Biotoxicology, a subsection of Environtek, concentrates on aquatic biotoxicology. Research conducted by this group is focused on the development, modification, evaluation and application of biological assays.

Web: http://www.csir.co.za/environmentek/biotox/biotoxweb/index.html
Links to some of the projects are given below:
Endocrine Disruption Studies
Web: http://www.csir.co.za/environmentek/biotox/biotoxweb/research_endocrine/endocrine_frame.html
Biomarker Studies

Web: http://www.csir.co.za/environmentek/biotox/biotoxweb/research_biomarker/biomarker_frame.html
Toxicity Tests
Web: http://www.csir.co.za/environmentek/biotox/biotoxweb/research/continuous.html

Centre for Integrated Waste Management provides practical, cost-effective and innovative approaches to dealing with waste.
Web: http://www.csir.co.za/ciwm/

Natural Resources and the Environment with a main focus on pollutions and waste, to reduce human activity-induced pressures on the environment. Research areas include Air Quality and Climate Change, Integrated Waste Management and Industrial Ecology, Coastal and Marine Pollution, and Water Treatment and Remediation.

Web: http://www.csir.co.za/plsql/pTl0002/PTL0002_PGE005_DIVISIONS?DIVISION_ NO=7318422

The National Research Foundation (NRF) acts as the main national funding agency and also as the administrative address for four national research facilities namely, Hartebeesthoek Radio Astronomy Observatory near Krugersdorp in Gauteng, the J.L.B. Smith Institute for Ichthyology Research (Grahamstown), the National Accelerator Centre in Faure, Western Cape and the South African Astronomical Observatory in Cape Town and Sutherland. These report to the NRF and are subsidized by the state.

Web: http://www.nrf.ac.za/
Postal Address: P O Box 2600, Pretoria 0001, South Africa
Address: Meiring Naudé Road, Brummeria, Pretoria, South Africa
Phone: +27-12-481-4000/4001
Fax: +27-12-349-1179
Email: info@nrf.ac.za

The South African Bureau of Standards (SABS) provides numerous services including compliance with National Standards, certification of products and services to assure quality and safety. The SABS is a member of the International Organisation for Standardisation and the International Electrotechnical Commission and is closely involved in the activities of the SADC and the Pacific Area Standards Congress.

Web: https://www.sabs.co.za/
Postal address: Private Bag X191, Pretoria 0001, South Africa
Address: 1 Dr Lategan Road, Groenkloof, Pretoria
Phone: +27(0)12-428-7911
Fax: +27(0)12-344-1568

The South African Medical Research Council (MRC) was established in 1969. Its mandate, among others, is to strengthen and develop institutional research capacity and also provide scientifically based information on health status in South Africa. It therefore funds university-based centers, units and groups – a number of which conduct research on topics of importance in toxicology.

Web: http://www.mrc.ac.za/
Postal address: P O Box 19070, 7505 Tygerberg, South Africa
Address: Francie van Zijl Drive, Parowvallei, Cape, South Africa.
Phone: +27(0)21-938-0911
Fax: +27(0)21-938-0200
Email: info@mrc.ac.za

The PROMEC Unit is based in Cape Town and whose main thrust is to address health issues related to food safety, nutrition and cancer.

Web: http://www.mrc.ac.za/promec/contents.htm

Its current projects can be found at http://www.mrc.ac.za/promec/projects.htm and include: The Identification and Human Exposure to Food- and Water-Borne Toxins; Cancer Registry; Epidemiology and Early Detection; Experimental Carcinogenesis; Occurrence, Incidence, Taxonomy and Toxicity of Toxigenic Fungi and the Antimutagenic and Cancer-modulating Properties of Two Unique South African Herbal Teas: Rooibos (*Aspalathus linearis*) and Honeybush (*Cyclopia genistoides*).

Web: http://www.mrc.ac.za/promec/antimutagenic.htm

The Environment and Health Research Unit is based in Johannesburg and conducts research on environmental health and nutrition.

Web: http://www.mrc.ac.za/healthdevelop/projects.htm

The South African Traditional Medicines Research Unit is based in Cape Town. Its main activities include a comprehensive traditional database for East and Southern Africa; a traditional medicines formulary; laboratory screening of traditional medicines for activity in malaria and tuberculosis and the development of systems for the scientific understanding of the action and uses of 'essential' traditional medicines in the treatment and prevention of disease.

Web: http://www.mrc.ac.za/traditionalmedicines/traditionalmedicines.htm

The South African Institute for Environmental Health

SAIEH aims to promote science and the practice of environmental health.

Web: http://www.saieh.co.za/
Postal address: Private Bag X37, Greyville 4023, South Africa
Address: 34 Wallace Rd, Morningside, Durban, 4000
Phone: +27-(0)31-303-2480
Fax: 031-312-9441
Email: sue@saieh.co.za

The South African National Accreditation System

SANAS is recognized by the South African Government as the single National Accreditation Body that gives formal recognition that Laboratories, Certification Bodies, Inspection Bodies, Proficiency Testing Scheme Providers and Good Laboratory Practice (GLP) test facilities are competent to carry out specific tasks.

Web: http://www.sanas.co.za.
Postal address: Private Bag X23, Sunnyside 0132, Pretoria, South Africa
Address: The DTI Campus, 77 Meintjies Street, Sunnyside, Pretoria 0002, South Africa
Phone: +27(0)12-394-3760
Fax: +27(0)12-394-0526

The South African National Biodiversity Institute

SANBI was established in 2004 with the intention that it will be the leading institution in biodiversity science in Africa, facilitating conservation, sustainable use of living resources and human wellbeing. It provides number of services amongst which MEDBASE, the National Medicinal Plants Database for South Africa is a system of databases holding holistic data on the 300 most important traditional medicinal plants of southern Africa.

Web: http://www.sanbi.org/homepage.htm
Postal address: Private Bag X101, Pretoria 0001, South Africa
Address: 2 Cussonia Ave, Brummeria, Pretoria
Phone: +27-12-843-5000
Fax: +27-12-804-3211
Email: info@sanbi.org

The Unilever Centre for Environmental Water Quality

UCEWQ was established in 2002 and is based at the Rhodes University, Institute for Water Research. Its main mandates include protecting water resources, research and monitoring, training and consultancy.

Web: http://www.ru.ac.za/institutes/iwr/ucewq/index.html
Postal address: P O Box 94, Grahamstown 6140, South Africa
Address: Old Geology Building, Artillery Road, Grahamstown, Eastern Cape South Africa
Phone: +27-46-622-4014/2428/4014
Fax: +27-46-622-9427
Email: ucewq@iwr.ru.ac.za

The Water Research Commission

WRC operates in terms of the Water Research Act (Act 34 of 1971). Its mandate is to support water research and development as well as the building of a sustainable water research capacity in South Africa. It funds a number of projects of which the Water and Health relevant to Toxicology.

Web: http://www.wrc.org.za/
Address: Marumati Building, c/o Frederika Street and 18th Avenue, Rietfontein, Pretoria
Postal address: Private Bag X03, GEZINA 0031, South Africa
Phone: +27-12-330-0340
Fax: +27-12-331-2565
Email: info@wrc.org.za

Universities

South African universities do not offer programs in toxicology at graduate (MSc, PhD or National Diploma) levels but many of them offer it as a subject in Environmental health. Others offer postgraduate programs that include toxicology in their curricula.

Cape Peninsula University of Technology

It is situated in Cape Town and is a result of a merger between the Cape and Peninsula Technikons.

Web: http://www.cput.ac.za/.
It is spread over five different campus sites.
For general information: +27(0)021-959-6121, info@cput.ac.za
In the Faculty of Applied Sciences situated in the Bellvile Campus, it offers courses and post graduate programs in Environmental Health (http://info.cput.ac.za/prospectus/qual.php?q=94&d=8) which include the National Diploma (http://info.cput.ac.za/prospectus/qual.php?q=94&f=3), Baccalaureus Technologiae (http://info.cput.ac.za/prospectus/qual.php?q=95&f=3), Magister Technologiae (Research-based Degree or Course-driven Degree) (http://info.cput.ac.za/prospectus/qual.php?q=102&f=3) and Doctor Technologiae Environmental

Health (Course Aim) (http://info.cput.ac.za/prospectus/qual.php?q=103&f=3).
Postal address: P.O. Box 1906, Bellville 7535, Cape Town, South Africa
Address: Symphony Way, (off Moderdam Road), Bellville
Phone: +27(0)21-460-6911
Fax: +27(0)21-460-3698
or Tel. Faculty Office: +27(0)21-959-6569
Fax: +27(0)21-959-6118
Email: jepthai@cput.ac.za

Central University of Technology

This was previously the Technikon Free State. It was opened on 1 January 1981. The first schools or academic sections were Engineering, Management, and Art and Design.

Web: http://www.cut.ac.za/web/academics

Later the Faculty of Health and Environmental Sciences was added. It consists of two Schools, namely the School of Health Technology as well as the School for Agriculture and Environmental Sciences offering National Diploma programs and B. Tech, Master's and doctorate degrees.

Web: http://www.cut.ac.za/web/academics/faculties/hea/homepage.
Postal address: Private Bag X20539, Bloemfontein 9300, Free State, South Africa
Phone: +27-(0)51-507-3911
Fax: +27-(0)51-507-3199

Durban University of Technology

This university is the result of a merger between the ML Sultan Technikon and Technikon Natal.

Web: http://www.dut.ac.za/
Phone: +27(0)31-204-2696
Fax: +27(0)31-204-2038

It is spread over seven different campus sites. It offers postgraduates a program on Environmental Health in the Department of Environmental Health located in Mansfield Road.

Web: http://www.dut.ac.za/department.aspx?id=64&fid=4#
Phone: +27(0)31-204 2111
Fax: +27(0)31-202-3405

Mangosuthu Technikon (MANTEC)

This establishment is situated on the outskirts of Durban.

Web: http://www.mantec.ac.za/
Postal address: P.O. Box 12363, Jacobs 4026, South Africa
Address: Mangosuthu Highway, Umlazi, KwaZulu-Natal, South Africa
Phone: 27(0)31-907-7111
Fax: +27(0)31-907-2892

It houses the Department of Environmental Health in the Faculty of Natural Sciences and it offers a National Diploma course in Environmental Health.

Web: http://www.mantec.ac.za/envirohealth.html
Phone: +27(0)31-907-7242
Fax: +27(0)31-907-7242

Nelson Mandela Metropolitan University (NMMU)

This university was opened on 1 January 2005, the result of a merger of the Port Elizabeth Technikon, the University of Port Elizabeth, and the Port Elizabeth campus of Vista University. In its Faculty of Health Sciences it offers National Diploma programs, undergraduate (Baccalaureus Technologiae, B Tech) and post graduate degrees (Magister Technologiae (M Tech) and Doctor Technologiae (D Tech)) in Environmental Health.

Web: http://www.nmmu.ac.za/default.asp?bhcp=1
Web: http://www.nmmu.ac.za/default.asp?id=181&bhcp=1
Postal address: P.O. Box 77000, Nelson Mandela Metropolitan University, Port Elizabeth 6031, South Africa
Phone: +27(0)41-504-2121/2111
Fax: +27(0)41-504-2854

Rhodes University

It is situated in Grahamstown. Within its Faculty of Science in the Department of Environmental Sciences, which offers post graduate degrees BSc, BEcon, BJourn and BA, it also offers an undergraduate program (BSc) in Environmental Sciences.

Web: http://www.ru.ac.za/
Web: http://www.scifac.ru.ac.za/scisub.htm
Web: http://campus.ru.ac.za/?action=category&category=45/
Web: http://campus.ru.ac.za/index.php?action=category&category=1419
Department of Environmental Science, Rhodes University, P.O. Box 94, Grahamstown 6140, South Africa
Phone: +27(0)46-603-7002
Fax: +27(0)46-622-9319

In addition, the Faculty of Science houses the Institute for Water Research and the Unilever Centre for Environmental Water Quality.

Web: http://www.ru.ac.za/institutes/iwr/
Web: http://www.ru.ac.za/institutes/iwr/ucewq/index.html
Postal address: Institute for Water Research, Rhodes University, P O Box 94, Grahamstown 6140, South Africa
Phone: +27(0)46-622-4014
Fax: +27(0)46-622-9427

Finally, in the Faculty of Pharmacy is the Biopharmaceutics Research Institute which conducts contractual research in drug testing and development.

Web: http://www.ru.ac.za/academic/departments/pharmacy/
Postal address: Biopharmaceutics Research Institute, Rhodes University, Grahamstown 6139, South Africa
Phone: +27(0)46-603-8189
Fax: +27-(0)46-636-1205

North-West University

This university was created in 2004 from the merger of the University of North-West with the Potchefstroom University for Christian Higher Education.

Web: http://www.nwu.ac.za/nwu/terms-and-conditions.html

In its Faculty of Natural Sciences there is the Centre for Environmental Management public where training courses are provided on environmental management.

Web: http://www.puk.ac.za/fakulteite/natuur/index_e.html
Web: http://www.puk.ac.za/fakulteite/natuur/soo/cem/index.html

In its School of Pharmacy it houses the Drug Research and Development unit which provides services in this field.

Web: http://www.puk.ac.za/fakulteite/gesond/nfa9.2/index_e.html
Postal address: Potchefstroom Campus, Private Bag X6001, Potchefstroom 2520, South Africa
Phone: +27 (0)18-299-1111/2222
Fax: +27-(0)18-299-2799

Tshwane University of Technology

This university is situated in Pretoria but has other campuses in other parts of the country.

Web: http://www.tut.ac.za/tut_web/

In its Faculty of Science it houses the Department of Environmental Health which offers postgraduate programs (Bachelor's Degree in Technology, Master's Degree in Technology and Doctorate in Technology) in Environmental Health.

Web: http://www.tut.ac.za/tut_web/index.php?struc=951
Postal address: Private Bag X680, Pretoria 0001, Republic of South Africa
Phone: +27 (0)12-382-5911
Fax: +27 (0)12-382-5114

University of Cape Town

The University of Cape Town is situated in Cape Town and is South Africa's oldest university.

Web: http://www.uct.ac.za/

In the Faculty of Science the Department of Environmental and Geographical Science focuses on issues relating to environmental change and human–environment interactions. It offers undergraduate and graduate (MSc and PhD) programs in Environmental and Geographical Science.

Web: http://www.egs.uct.ac.za/
Postal address: Department of Environmental and Geographical Science, University of Cape Town, Private Bag X3, Rondebosch 7701, South Africa
Address: Shell Environmental and Geographical Science Building, South Lane, Upper Campus, University of Cape Town
Phone: +27(0)21-650-2873/4
Fax: +27(0)21-650-3456
Email: admin@enviro.uct.ac.za

The Environmental Evaluation Unit (EEU) is an independent, self-funded consulting, research, and training unit. It undertakes work throughout South Africa and the SADC countries, and provides expertise to leading private and public corporations, research institutions, planning and development organizations, state departments, local authorities, and communities.

Web: http://www.egs.uct.ac.za/eeu/index.html
Physical address: University of Cape Town, Upper Campus, Rondebosch 7701, South Africa
Phone: +27(0)21-650-2866
Fax: +27(0)21-650-3791
Email: eeu@uct.ac.za

The Freshwater Research Unit is also based in the Faculty of Science where much of the research in this unit centers on the conservation and management of South African rivers, although some work is also done on wetlands and coastal lakes.

Web: http://web.uct.ac.za/depts/zoology/fru/introtofru.html
Postal address: Southern Waters Ecological Research and Consulting cc, P.O. Box 13280, Mowbray 7705, Cape Town, South Africa

Address: Freshwater Research Unit, Department of Zoology, University of Cape Town, Rondebosch 7700, South Africa
Phone: +27(0)21-650-3635/3633
Fax: +27(0)21-650-3301
Email: jday@botzoo.uct.ac.za

In the Health Sciences Faculty the Department of Occupational and Environmental Health provides postgraduate Diplomas as well MScs and PhDs in Occupational Health.

Web: http://www.uct.ac.za/faculties/health/research/oehru/study/
Postal Address: Faculty of Health Sciences, Private Bag, Observatory 7935
Address: Faculty Office, Barnard Fuller Building, Anzio Road, Observatory Cape Town
Phone: +27(0)21-406-6346
Fax: +27(0)21-447-8955
Email: medfac@curie.uct.ac.za.

University of the Free State

This is another of South Africa's old universities, based in Bloemfontein.

Web: http://www.uovs.ac.za/
Postal address: P.O. Box 339, Bloemfontein 9300, South Africa
Phone: +27(0)51-401-9111
Email: info.stg@mail.uovs.ac.za

In the Faculty of Natural and Agricultural Sciences the Centre for Environmental Management provides an MSc program.

Web: http://www.uovs.ac.za/faculties/index.php?FCode=04&DCode=106
Postal address: University of the Free State, P.O. Box 339, Bloemfontein 9300, South Africa
Phone: +27(0)51-401-2863
Fax: +27(0)51-401-2629
Email: CEM@mail.ufs.ac.za

The Department of Microbial, Biochemical and Food Biotechnology was awarded the status of a MIRCEN (Microbiological Resources Centre) by UNESCO in 1996.

Web: http://www.uovs.ac.za/faculties/index.php?FCode=04&DCode=112
Postal address: Department of Microbial-Biochemical and Food Biotechnology University of the Free State, P O Box 339, Bloemfontein 9300, South Africa
Address: Department of Microbial-Biochemical and Food Biotechnology, Microbial-Biochemical and Food Biotechnology Building, University of the Free State Mandela Avenue, Bloemfontein, South Africa
Phone: +27-(0)51-4012396
Fax: +27-(0)51-4443219
Email: dpreezjc.sci@mail.uovs.ac.za

The Institute for Groundwater Studies was founded in 1974 and provides post graduate programs and carries out contract research on a wide variety of water-related topics.

Web: http://www.uovs.ac.za/faculties/index.php?FCode=04&DCode=109
Postal address: Institute for Groundwater Studies, Faculty of Natural and Agricultural Sciences, PO Box 339, Bloemfontein 9300, South Africa
Phone: +27(0)51-401-2394
Email: hodgsonf.sci@mail.uovs.ac.za

The Department of Plant Sciences consists of the divisions of Botany, Genetics, Plant Breeding and Plant Pathology and provides undergraduate and postgraduate programs.

Web: http://www.uovs.ac.za/faculties/index.php?FCode=04&DCode=114
Postal address: Department of Plant Sciences, Faculty of Natural and Agricultural Sciences, University of the Free State, P.O. Box 339, Bloemfontein, 9300, South Africa
Phone: +27 (0)51-401-2818/2466/2514
Fax: +27(0)51-444-5945
Email: pretorza.sci@mail.uovs.ac.za

The Department of Zoology and Entomology provides an overview on poisonous and dangerous animals and also those that deal with environmental problems.

Web: http://www.uovs.ac.za/faculties/index.php?FCode=04&DCode=119
Postal address: Department of Zoology and Entomology, University of the Free State, P.O. Box 339, Bloemfontein, South Africa
Phone: +27 (0)51-401-2427
Email: vanasjg.sci@mail.uovs.ac.za

In the Faculty of Health Sciences the Department of Chemical Pathology offers training to qualified medical practitioners to become registered chemical pathologists or clinical pathologists. Candidates with a baccalareus degree in the natural sciences are offered the B Med Sc (Hon) degree leading to the M Med Sc in chemical pathology.

Web: http://www.uovs.ac.za/faculties/index.php?FCode=08&DCode=026
Postal address: Department of Chemical Pathology G3, University of the Free State, P.O. Box 339, Bloemfontein 9300, South Africa
Phone: +27(01)51-405-3023
Fax: +27 (0) 51 4442749
E-mail: KennethS.MD@mail.uovs.ac.za

In the Department of Community Health is the Provincial Occupational Health Unit of the Free State that provides an occupational health and safety support service to the facilities in the Free State Province.

Web: http://www.uovs.ac.za/faculties/index.php?FCode=08&DCode=027
Postal address: P.O. Box 339 (G52), University of the Free State, Bloemfontein, 9300, South Africa
Phone: +27(0)51-405-3136
Fax: +27(0)51-448-9278
Email: gngmtm.md@mail.uovs.ac.za

The Department of Forensic Medicine provides forensic training for undergraduate and post graduate medical, nursing and law students at the University of the Free State.

Web: http://www.uovs.ac.za/faculties/index.php?FCode=08&DCode=032
Postal address: Department of Forensic Medicine, UFS, P O Box 339, Bloemfontein, 9300, South Africa
Phone: +27(0)51-405-3132
Fax: +27(0)51-444-0464
Email: gnggmjb@med.uovs.ac.za

The National Control for Biological Products Unit functions as the Biological test laboratory of the Medicines Control Council.

Web: http://www.uovs.ac.za/faculties/index.php?FCode=08&DCode=036
Postal address: NCL (G49), UFS, Faculty of Health Sciences, P.O. Box 339, Bloemfontein, 9300, South Africa
Phone: +27(0)51-401-2450
Fax: +27(0)51-401-3404
Email: gnvrgk.md@mail.uovs.ac.za

The Department of Pharmacology promotes the rational use of drugs in humans and protects humans against poisonous substances through teaching, research and service.

Web: http://www.uovs.ac.za/faculties/index.php?FCode=08&DCode=047
Postal address: Department of Pharmacology (G6), University of the Free State, P.O. Box 339, Bloemfontein 9300, South Africa
Phone: +27(0)51-401-3134/3090
Email: waluboa.md@mail.uovs.ac.za

University of Johannesburg

This university was created by the merger between the Rand Afrikaans University and the Wits Technikon in Johannesburg. It is spread over five different campus sites.

Web: http://www.uj.ac.za/index.asp
Postal address: University of Johannesburg, P O Box 524, Auckland Park, 2006, South Africa
Phone: +27(0)11-489-2637
Fax: +27(0011-489-2191

In the Faculty of Health Sciences, the Department of Environmental Health provides a national diploma in Environmental Health.

Web: http://www.uj.ac.za/health/index.asp?page=detail&id=454.
Web: http://www.uj.ac.za/environmental/

The Department of Ecotoxicology, which studies the effects of chemicals in the natural ecosystem, provides undergraduate and post graduate programs.

Web: http://www.uj.ac.za/zoology/index.asp?page=detail&id=1401

University of KwaZulu-Natal

This unites two major educational institutions in KwaZulu-Natal – the University of Natal and the University of Durban-Westville. It is spread over five different campus sites.

Web: http://www.ukzn.ac.za/

The Centre for Environmental Management (CEM) and Centre for Environment, Agriculture and Development (CEAD) are based in the Faculty of Environmental Sciences (http://www.ukzn.ac.za/department/default.asp?dept=saesunp) and offer undergraduate and postgraduate programs on environmental assessment, hydrology, atmospheric science, air pollution, coastal geomorphology and wetland ecology.

Web: http://www.geography.ukzn.ac.za/cem/
Postal address: Centre for Environmental Management, School of Environmental Sciences, Howard College Campus, University of KwaZulu-Natal, Durban 4041, South Africa
Phone: +27(0)31-260-2653
Fax: +27(0)31-260-1391
Email: philpk@ukzn.ac.za

The Centre for Occupational and Environmental Health is based in the Department of Community Health and provides National Diploma programs to postgraduates and an MSc in Occupational and Environmental Health.

Web: http://www.ukzn.ac.za/coeh/HomePage1.aspx
Postal address: Private Bag 7, Congella 4013, South Africa

Address: Centre for Occupational and Environmental Health, School of Family and Public Health Medicine, Nelson R. Mandela School of Medicine, College of Health Sciences
Phone: +27(0)-31-260-4471
Fax: +27(0)-31-260-4663
Email: coeh@ukzn.ac.za

Forensic Medicine provides undergraduate teaching within the Faculty of Medicine as well as a Master of Medicine course for training specialist forensic pathologists.

Web: http://www.ukzn.ac.za/department/default.asp?dept=forensicund
Postal address: Private Bag 7 Congella 4013, Durban, South Africa
Address: University of Natal, Medical University Campus, Umbilo Road, Durban
Phone: +27(0)31-260-4265
Fax: +27(0)31-260-4384
Email: naidoosr@ukzn.ac.za

University of Limpopo

This university was borne of a merger between the Medical University of Southern Africa (MEDUNSA) and the University of the North. It is spread over two different campus sites.

Web: www.ul.ac.za.
Postal address: P O Box 189, Medunsa, Gauteng, 0204, South Africa
Phone: +27(0)12-521-4111

In its National School of Public Health and in the Department of Environmental and Occupational Health located in the Medunsa campus, courses are offered in occupational and environmental health.

Web: http://www.medunsa.ac.za/faculties/medicine/pharmacol.htm
Postal address: National School of Public Health at Medunsa, P.O. Box 215, Medunsa, 0204, South Africa
Phone: +27(0)12-521-4613
Fax: +27(0)12-560-0172
Email: allen.herman@nsph.medunsa.ac.za

In the Department of Pharmacology and Therapeutics, Faculty of Medicine, courses in pharmacokinetics are offered.

Web: http://www.medunsa.ac.za/faculties/nsph/nsph_depart/mainframe_depart.htm
Postal address: P O Box 225, Medunsa 0204, South Africa
Phone: +27(0)12-521-4145
Fax: +27(0)12-521-4121

University of Pretoria

Web: http://www.up.ac.za/
Postal address: University of Pretoria, Lynnwood Road, Hillcrest, Pretoria 0002, South Africa
Phone: +27(0)12-420-4111/3111
Fax: +27(0)12-420-4555

In the Department of Paraclinical Sciences, Faculty of Veterinary Sciences, the studies of medicinal plants used in ethnoveterinary medicine and the pathology, pharmacology, toxicological and veterinary public health of economically important diseases of livestock are conducted at undergraduate and postgraduate levels.

Web: http://www.up.ac.za/academic/veterinary/depts_paracl_research.htm
Postal address: University of Pretoria, Faculty of Veterinary Science, Private Bag X04, Onderstepoort, 0110, South Africa
Phone: +27(0)12-529-8000
Fax: +27(0)12-529-8300

University of Stellenbosch

This is located in Stellenbosch, the country's oldest town. It is spread over three different campus sites.

Web: http://www.sun.ac.za/index.asp.

In its Department of Botany and Zoology, situated in the Stellenbosch Campus, the Ecotoxicology Research Group offers postgraduate programs (MSc and PhD) in Ecotoxicology.

Web: http://academic.sun.ac.za/botzoo/ecotox/index.htm#ops
Physical address: Room 2033, Science ("Natuurwetenskappe") Building, Stellenbosch Campus
Postal address: Department of Botany an Zoology, Private Bag X1, Matieland, 7602 Stellenbosch, South Africa
Phone: +27(0)21-808-3236
Fax: +27(0)21-808-2405
Email: lwillems@sun.ac.za

University of Venda

University of Venda was established in 1982 and is situated in Thohoyandou, in the Vhembe district of the Limpopo Province of South Africa.

Web: http://www.univen.ac.za/
Postal address: University of Venda, Private Bag X5050, Thohoyandou 0950, Limpopo Province, South Africa
Address: University of Venda, University Road, Thohoyandou, Limpopo Province, South Africa
Phone: +27(0)15-962-8000

Fax: +27(0)15-962-4749
Email: info@univen.ac.za

In its School of Environmental Sciences, undergraduate programs on Environmental Sciences are offered.

Web: http://www.univen.ac.za/environ/environ.php
Postal address: University of Venda, School of Environmental Sciences, Private Bag X5050, Thohoyandou 0950, South Africa
Phone: +27(0)15-962-8580
Fax: +27(0)15-962-8597/4749
Email: ogolaj@univen.ac.za

University of the Witwatersrand

It is spread over three different campus sites in Johannesburg.

Web: http://web.wits.ac.za/
Phone: +27(0)11-717-1000
Fax: +27(0)11-717-1065

In its Faculty of Science, the School of Animal, Plant and Environmental Sciences (http://www.wits.ac.za/apes/research.html) in the West Campus houses a number of centers and research groups including the Centre for Water in the Environment where they offer postgraduate programs on the subject

Web: http://www.wits.ac.za/Centres/CWE/
Phone: +27(0)11-717-6419/6424
Fax: +27(0)11-717-6499
Email: kevinr@gecko.biol.wits.ac.za

Vaal University of Technology

This establishment gained the status of University in 2004.

Web: http://www.vut.ac.za/metadot/index.pl?id=2865&isa=Category&op=show
Postal address: Vaal University of Technology, International Relations Department, Private Bag X021, Vanderbijlpark 1900, South Africa
Address: Vanderbijlpark Campus (Main Campus), Andries Potgietr Blvrd, Vanderbijlpark, South Africa
Phone: +27(0)16-950-9000
Fax: +27(0)16-950-9772

Environmental Health & Pollution, in the Engineering Faculty, concentrates on research on aspects of the development of suitable absorbents for the removal of trace amounts of heavy metals from polluted waters.

Web: http://www.vut.ac.za/metadot/index.pl?iid=2771&isa=Category&op=show

Walter Sisulu University

This university is situated in the Eastern Cape and is the result of a merger between the Border Technikon, Eastern Cape Technikon, and the University of Transkei.

Web: http://www.wsu.ac.za/default.htm

The Faculty of Science and Engineering offers undergraduate programs in environmental studies.

Web: http://www.wsu.ac.za/faculties/faculties.htm
Postal address: Walter Sisulu University, P.O. Box 1421, East London, 5200
Phone: +27(0)45-838-2998
Email: info@wsu.ac.za

Professional Societies

Association of Societies for Occupational Safety and Health (ASOSH)
Web: http://www.asosh.org/ASOSH/about.htm

This is the association of 11 societies – the Chemical and Allied Industries' Association (CAIA), the Institute of Safety Management (IoSM), National Occupational Safety Association (NOSA), the Mine Ventilation Society of South Africa (MVS of SA), the Safety First Association, the South African Institute of Environmental Health (SAIEH), the South African Radiation Protection Society (SARPS), the Southern African Protective Equipment Marketing Association (SAPEMA), the South African Society of Occupational Health Nurses (SASOHN), the South African Society of Occupational Medicine (SASOM) and the Southern African Institute for Occupational Hygiene (SAIOH); four supporting company members (IRCA, 3M SA, South Africa RAI, and Transnet) and one individual member and two ex-officio members. Its main mission is to further co-operation and understanding and promotion of occupational health, safety and environmental health matters in southern Africa.

Postal address: Association of Societies for Occupational Safety and Health (ASOSH) P.O. Box 14402, Clubview 0014, South Africa
Phone/Fax: +27(0)12-654-8349
Email: raysaf@mweb.co.za

Association of Veterinary and Crop Associations of South Africa (AFCASA)
Web: http://www.avcasa.co.za/about.html

This was established in 1958 to represent companies involved in the crop protection and animal health

products industry in South Africa. From the beginning of 2003, AVCASA represents its three affiliate associations, namely SAAHA (South African Animal Health Association; www.saaha.co.za), CropLife SA (www.croplife.co.za) and Agricultural Chemical Distribution Association of South Africa (ACDASA; www.acdasa.co.za). It provides its members as well as farmers, guidelines for the classification, labeling, responsible handling and storage of products, occupational hazards and personal protection, as well as the disposal of waste and empty containers.

Postal address: P.O. Box 1995, Halfway House 1685, South Africa
Physical address: Lanzerac, Constantia Park, 526, 16th Road, Midrand, South Africa
Phone: +27(0)11-805-2000
Fax: +27(0)11-805-2222
Email: info@acdasa.co.za

Chemical and Allied Industries' Association (CAIA)

This was established in 1993 and since 1994 the CAIA launched Responsible Care in South Africa to respond to public concerns about the manufacture, storage, transport, use, and disposal of chemicals.

Web: http://www.caia.co.za/index.htm
Postal address: P.O. Box 91415, Auckland Park 2006, South Africa
Phone: +27-(0)11-482-1671

Paraffin Safety Association of Southern Africa

This was borne out of concern of high paraffin poisoning in the country. It provides educational material to paraffin users through a network of partnerships. These include NGOs, community groups, emergency and healthcare workers, herbalists and any other group or individual who can effectively disseminate safety information. It has trained a corps of master trainers who train and provide educational material in the 11 official languages to these community partners. Following the government gazetting legislation on stove standards, the Paraffin Safety Association is focusing on packaging standards to ensure paraffin is sold in clearly marked, childproof containers.

Web: http://www.pasasa.org/pasasa/
Postal address: P O Box 2321, Clareinch 7740, South Africa
Address: 125 Belvedere Road, Claremont 7740, Cape Town
Phone: +27(0)21-671-5767
Fax: +27(0)21-671-0233
Email: info@pasasa.org

Responsible Container Management Association of Southern Africa

This is the southern African organization for industrial packaging with links to various international organizations. It has the backing of industry's commitment to the public to continuously improve its health, safety, and environmental practice and performance as one of its main purposes.

Web: http://www.rcmasa.org.za/
Phone: +27(0)32-942-8256
Fax: +27(0)32-942-8328
Email: liz@rcmasa.org.za

South African Chemical Institute (SACI)

This was established in 1912 with the aim of advancing the science and practice of chemistry in South Africa and promoting and upholding the status of the profession of chemistry.

Web: http://www.saci.co.za/
Postal address: South African Chemical Institute, The Secretary, P.O. Box 407, WITS 2050, South Africa
Address: Humphrey Raikes Building room 500 Wits Campus, Johannesburg, South Africa
Phone: +27(0)11-717-6741 (from 8 a.m.–1.30 p.m.)
Fax: +27(0)11-717-6779
Email: saci@chem.wits.ac.za

South African Council for Natural Scientific Professions (SACNASP)

Its objectives are to promote the practice of natural science professions in South Africa, exercise control over the standard of professional conduct of professional natural scientists, monitor the standard of education and training of natural scientists and to recognize education and training which is a prerequisite for registration in terms of the Act.

Web: http://www.sarnap.org.za/
Postal address: Private Bag x540, Silverton, 0127, Gauteng Province, South Africa
Address: Council for Geoscience, Suite B313, 280 Pretoria Road, Silverton 0127, Gauteng Province, South Africa
Phone: +27(0)12-841-1075/50
Fax: +27(0)12-841-1057
Email: adeklerk@sarnap.org.za

South African Institute of Environmental Health

Web: http://www.saieh.co.za/

This organization was established to advance and promote the science and practice of Environmental Health as well as to promote the basic training as well as comprehensive specialized advanced education of

environmental health professionals as well as environmental research.

Postal address: Private Bag X37, Greyville 4023, South Africa
Address: 34 Wallace Rd, Morningside 4000, Durban, South Africa
Phone: +27(0)31-303-2480
Fax: +27(0)31-312-9441
Email: sue@saieh.co.za

Southern African Institute for Occupational Hygiene (SAIOH)
Web: http://www.saioh.org/
It advances the discipline of Occupational Hygiene.
Postal address: SAIOH, P.O. Box 14402, Clubview 0014, South Africa
Phone: +27(0)12-654-8349
Fax: +27(0)12-654-8358
Email: raysaf@mweb.co.za

South African Association of Physicists in Medicine and Biology (SAAPMB)

The Association encompasses a number of different fields such as Medical Physics, Nuclear Medicine, Radiation Oncology, Radiobiology, Medical Physics, and Health Informatics. Its emphasis is on the interaction of Physics with the human body. While the Association has a number of independent members it also acts as an umbrella organization for three related societies, namely: The South African Medical Physics Society (SAMPS), The South African Radiation Protection Society (SARPS) and the SARS.

Web: http://www.saapmb.org.za/overview.htm
Email: secretary@saapmb.org.za

South African Pharmacology Society

It was founded in 1966 with its first congress held in 1967. While the Society always played a central role in promoting the science of basic and clinical pharmacology in general, it enjoys support from academic, industrial, and professional practice spheres. Its objectives are to foster, promote, encourage, develop, and support interest, teaching and research in basic and clinical pharmacology.

Web: http://www.sapharmacol.co.za/home.htm
Postal address: P.O. Box 16, Pharmacology, North-West University, Potchefstroom 2520, South Africa
Phone: +27(0)18-299-4015
Email: office@sapharmacol.co.za

Southern African Society of Aquatic Scientists

SASAqS is a learned society established in 1964 as the Limnological Society of South Africa. It is concerned with the research, management, and conservation of inland waters throughout southern Africa.

Web: http://www.dwaf.gov.za/iwqs/sasaqs/
Email: rowen@pan.uzulu.ac.za

Society of Environmental Toxicology and Chemistry (SETAC) Africa
Dr Victor Wepener
Phone: +27(0)11-489-3373
Fax: +27(0)11-489-2286
Email: victorw@uj.ac.za

Toxicology Society of South Africa (TOXSA)
Web: http://www.toxsa.up.ac.za/

It was established in 2001 by a group of interested scientists. The aims of the Society are to promote and advance the study and application of toxicology in all its aspects in South Africa.

Postal address: NIOH, P O Box 4788, Johannesburg 2000, South Africa
Phonel: +27(0)11-712-6428
Fax: +27(0)11-712-6532

Poison Control Centers

Red Cross War Memorial Children's Hospital Poisons Information Service
Postal address: Department of Paediatrics and Child Health, Rondebosch 7700, South Africa
Phone: +27(0)21-689-5227
Email: pic@ich.uct.ac.za

Poisons Information Centre, Department of Pharmacology, University of the Free State
Phone: +27(0)51-401-3134/3090
Emergency phone: +27(0)51-444-2134
Fax: +27(0)51-444-1523
Email: waluboa.md@mail.uovs.ac.za

Poison Information Centre, is located at Tygerberg Hospital within the Department of Pharmacology and provides an all-hours Pharmacology/Toxicology Consultation Service to healthcare professionals (at all levels), industry, and the lay public. Although the service primarily provides in the needs of the Western Cape Province and neighboring regions, demands to meet national requirements have been increasing steadily over the past years. A similar cross-border tendency is evident, and service interaction with other countries on the African continent continues to escalate.

Web: http://academic.sun.ac.za/health/schools/basic_appl_health/pharma/dept/Information.htm
Address: Tygerberg Poison Information Centre, Department of Pharmacology, Faculty of Health Sciences, University of Stellenbosch, Cape Town, South Africa
Postal address: P.O. Box 19063, Tygerberg 7505, South Africa
Phone: +27(0)21-938-9596
Fax: +27(0)21-931-7810
Email: gmul@sun.ac.za

Poison Working Group
Web: http://www.ewt.org.za/workgroups_overview.aspx?group=poison&page=overview

The aim of the Poison Working Group of the Endangered Wildlife Trust is to protect all elements of wildlife in southern Africa against deliberate or unintentional harm by stopping irresponsible and insensitive practices involving poisons.

Postal Address: The Endangered Wildlife Trust, Private Bag X11, Parkview, 2122, South Africa
Address: The Gold Fields Environment Centre, Johannesburg Zoological Gardens, Parview, South Africa
Phone: +27(0)11-486-1102
Fax: +27(0)11-486-1506
Email: ewt@ewt.org.za

Legislation

Various Acts are promulgated by different governmental departments pertaining to toxicology. In addition, a great number of Bills, Regulations and Guidelines are also published within these Acts that can be accessed on their respective websites.

Environment Conservation Amendment Act, 2003
Substitution of section 20 of Act 73 of 1989, as substituted by section 9 of Act 79 of 1992
Web: http://www.environment.gov.za/PolLeg/Legislation/2004Mar17_2/ECA_Act50-03.pdf

Fertilizers, Farm Feeds, Agricultural Remedies and Stock Remedies Act No. 36, 1947
Web: http://www.nda.agric.za/act36/main.htm

Foodstuffs, Cosmetics and Disinfectants Act 54, 1972

Controls the sale, manufacture and importation of foodstuffs, cosmetics and disinfectants; and provides for incidental matters.

Web: http://www.doh.gov.za/docs/index.html

Genetically Modified Organisms Act, 1997

It applies to (a) the genetic modification of organisms; (b) the development, production, release, use and application of genetically modified organisms (including viruses and bacteriophages); and (c) the use of gene therapy.

Web: http://www.doh.gov.za/docs/index.html

Hazardous Substances Act, 1973

It provides for the control of substances which may cause injury, ill-health or death of human beings by reason of their toxic, corrosive, irritant, strongly sensitizing or flammable nature or the generation of pressure thereby in certain circumstances, and for the control of certain electronic products.

Web: http://www.doh.gov.za/docs/index.html

Higher Education Act 101, 1997

This Act regulates higher education. Its purpose is to provide for the establishment, composition, and functions of a Council on Higher Education; to provide for the establishment, governance, and funding of public higher education institutions; to provide for the appointment and functions of an independent assessor; to provide for the registration of private higher education institutions; to provide for quality assurance and quality promotion in higher education; to provide for transitional arrangements and the repeal of certain laws and to provide for matters connected therewith.

Web: http://www.education.gov.za/dynamic/dynamic.aspx?pageid=329&catid=12&category=Acts&legtype=1

Marine Pollution Act, 1981

It provides for the protection of the marine environment from pollution by oil and other harmful substances, and for that purpose to provide for the prevention and combating of pollution of the sea by oil and other harmful substances; to determine liability in certain respects for loss or damage caused by the discharge of oil from ships, tankers and offshore installations and to provide for matters connected therewith.

Web: http://web.uct.ac.za/depts/shiplaw/fulltext/marpollu.htm

Medicines and Related Substances Control Amendment Act, 1997

Amendment of section 1 of Act 101 of 1965, as amended by section 1 of Act 65 of 1974, section 1 of Act 17 of 1979, section 1 of Act 20 of 1981 and section 1 of Act 94 of 1991 and includes generic substitution of drugs.

Web: http://www.doh.gov.za/docs/index.html

Mine Health and Safety Act, 1996

It provides for the protection of the health and safety of employees and other persons at mines and, for that purpose, to promote a culture of health and safety; to provide for the enforcement of health and safety measures and to provide for appropriate systems of employee, employer, and state participation in health and safety matters.

Web: http://www.polity.org.za/html/govdocs/legislation/1996/act96-029.html?rebookmark=1

National Environmental Management: Air Quality Act, 2004

It is to reform the law regulating air quality in order to protect the environment by providing reasonable measures for the prevention of pollution and ecological degradation and for securing ecologically sustainable development while promoting justifiable economic and social development; to provide for national norms and standards regulating air quality monitoring, management and control by all spheres of government.

Web: http://www.environment.gov.za/PolLeg/Legislation/2005Mar15/air_quality_act_2004.htm

National Environmental Management: Biodiversity Act, 2004

The objectives of this Act are within the framework of the National Environmental Management Act, to provide for the management and conservation of biological diversity within the Republic and the use of indigenous biological resources in a sustainable manner.

Web: http://www.environment.gov.za/PolLeg/Legislation/2006Nov2/NEMBA.pdf

National Environmental Management: Protected Areas Act 57, 2003

The objectives of the Act are to provide, within the framework of national legislation, including the National Environmental Management Act, for the declaration and management of protected areas.

Web: http://www.environment.gov.za/

National Water Act, 1998

It ensures that the nation's water resources are protected, used, developed, conserved, managed, and controlled.

Web: http://www.dwaf.gov.za/Documents/Legislature/nw_act/NWA.pdf

Occupational Health and Safety Amended Act, 1993

It provides for the health and safety of persons at work and for the health and safety of persons in connection with the use of plant and machinery and for the protection of persons other than persons at work against hazards to health and safety arising out of or in connection with the activities of persons at work.

Web: http://www.labour.gov.za/download/7880/Amended%20Act%20%20Occupational%20Health%20and%20Safety.pdf

Traditional Health Practitioners Act, 2004

The purpose is to (a) establish the Interim Traditional Health Practitioners Council of South Africa; (b) provide for the registration, training and practices of traditional health practitioners in the Republic and (c) serve and protect the interests of members of the public who use the services of traditional health practitioners.

Web: http://www.doh.gov.za/docs/legislation/acts/2004/act35.pdf

Miscellaneous resources

Africa Stockpiles Programme

Highlights the need for the urgent cleanup of stockpiles of obsolete pesticides and the prevention of further accumulation in African countries; requires a co-ordinated, multistakeholder approach.

Web: http://www.africastockpiles.org/aboutasp.html
Web: http://www.africastockpiles.org/pdf/infosheets.pdf.

References

Brent AC, Rogers DE (2002) Establishing the propensity for dioxin formation using a plume temperature model for medical waste incinerator emissions in developing countries. J. Air Waste Manag. Assoc. 52: 811–821.

Coetzee AM, Smith FC, van der Merwe CA, Dreyer RJ (1986) [The influence of air pollution on health in the Sasolburg area]. S. Afr. Med. J. 70: 339–343.

Dalvie MA, Cairncross E, Solomon A, London L (2003) Contamination of rural surface and ground water by endosulfan in farming areas of the Western Cape, South Africa. Environ. Health, 2: 1.

Engelbrecht JP, Swanepoel L, Chow JC, Watson JG, Egami RT (2001) PM2.5 and PM10 concentrations from the Qalabotjha low-smoke fuels macro-scale experiment in South Africa. Environ. Monit. Assess. 69: 1–15.

Fatoki OS, Awofolu OR (2004) Levels of organochlorine pesticide residues in marine-, surface-, ground- and drinking waters from the Eastern Cape Province of South Africa. J. Environ. Sci. Health B 39: 101–114.

Grobler DG (1999) Copper poisoning in wild ruminants in the Kruger National Park: geobotanical and environmental investigation. Onderstepoort J. Vet. Res. 66: 81–93.

Naidoo G, Chirkoot D (2004) The effects of coal dust on photosynthetic performance of the mangrove, Avicennia marina in Richards Bay, South Africa. Environ. Pollut. 127: 359–366.

Oosthuizen J, Ehrlich R (2001) The impact of pollution from a mercury processing plant in KwaZulu-Natal, South Africa, on the health of fish-eating communities in the area: an environmental health risk assessment. Int. J. Environ. Health Res. 11: 41–50.

Stewart MJ, Steenkamp V, van der Merwe S, Zuckerman M, Crowther NJ (2002) The cytotoxic effects of a traditional Zulu remedy, impila (*Callilepis laureola*). Hum. Exp. Toxicol. 21: 643–647.

van Wyk E, Bouwman H, van der Bank H, Verdoorn GH, Hofmann D (2001) Persistent organochlorine pesticides detected in blood and tissue samples of vultures from different localities in South Africa. Comp. Biochem. Physiol. C Toxicol. Pharmacol. 129: 243–264.

CHAPTER

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Spain

GUILLERMO REPETTO AND MANUEL REPETTO

INTRODUCTION

The most frequently consulted toxicological textbook in the world during the Middle Ages was written by Maimonides in 1198. He was born in Córdoba (Spain) and was the most influential figure in medieval Jewish philosophy. Maimonides wrote a number of medical texts, including 'The poisons and their antidotes', explaining poisoning symptoms, antidotes, and prevention.

In 1677, Antonio de Trilla, a physician from Toledo published the book 'Treaty of the three types of poisons: mineral, plants and animals'; and Antonio Ximenez de Lorite, from Sevilla, published in 1790 the first study in Spanish that refers to health problems caused by air pollution from factories.

Mateo Orfila, the founder of modern toxicological science, was born at Mahon (Minorca), studied Medicine and immediately became a private lecturer on Chemistry in Paris. In 1819 he was appointed professor of Medical Jurisprudence, and four years later he succeeded Vauquelin as professor of chemistry in the Faculty of Medicine in the French capital. In 1830 he was nominated Dean of that Faculty, a high medical honor in France. He published several books including 'The Treaty of Poisons or General Toxicology' (1814), with experimental observations on the symptoms of poisoning, explaining the kinetics and organ tropism of poisons, their physiological action, and the means of detecting them. Few branches of science can be said to have reached such a pinnacle due to the labor of a single individual.

Other interesting historical publications in Spain were the 'Compendium of General and Special Toxicology' by Pedro Mata (1875), a book dedicated to Orfila, but criticizing his work, or the 'General Toxicology' by Perez-Argiles (1943).

Judicial toxicological analyses were first ordered by the judges to members of the National Forensic Medicine Body, or to Professors of Legal Medicine or Pharmacy. The organization, now known as the National Institute of Toxicology and Forensic Sciences, was established in 1887, to perform the requested studies. About 250 scientists are now working in the Institute's four centers.

The National Institute for Health and Safety at Work (INSHT) was created in 1970. It is composed of four territorial departments and 40 provincial offices, and is involved, with the Autonomic Communities, in the protection of worker health and the prevention and control of occupational exposures.

The first meeting of Spanish toxicologists was organized in 1971 and mainly focused on forensic toxicology. Since then, a biannual meeting was convened, leading to the foundation in 1980 of The Spanish Association of Toxicology (AETOX), just in time to organize in 1987, an International Meeting on the Bicentenary of Orfila near his birthplace (Minorca). The AETOX is now a society of approximately 400 members from academia, government, and industry. It holds, apart from the general biannual meeting, other workshops organized by a number of sections of the society (Alternative Methods, Clinical Toxicology, Environmental Toxicology, Food Safety, Forensic Toxicology, Veterinary and Toxicology).

AETOX has very good relationships with other societies interested in human and environmental health, such as the Spanish Society of Environmental

Health (SESA), founded in 1964, with more than 350 members, a part of the larger Spanish Society of Public Health and Administration (SESPAS), with 3500 members.

A very important milestone in the Spanish academic system occurred in 1996; 'Toxicology' was identified as an independent area of knowledge within the universities, representing its recognition as a scientific and professional discipline. Since then, the number of professors of toxicology teaching in various faculties has increased considerably, with more than 50 positions occupied throughout the country. However, in Spain, there are not degrees in Toxicology, nor recognition of a medical speciality in clinical toxicology.

The relevance and complexity of regulatory activities forced the administration to create the Spanish Agency of Pharmaceuticals and Medical Products (AGEMED) in 1997 for the authorization of medicines, and the Spanish Agency on Food Safety and Nutrition in 2001.

Following the example given by other European associations and the recommendation of EUROTOX, a Register of Spanish Toxicologists was established in 2000. About 50 professionals in basic and applied toxicology have been registered, demonstrating at least five years of experience and high level of professional competence and ethical conduct.

Finally, in 2004, the Spanish Committee of the International Union of Toxicology (IUTOX) was formed, under the umbrella of the International Council of Scientific Unions (ICSU). This committee is a collaboration between Spain's public administration and scientific societies and has a global impact due to the influence of IUTOX.

RESOURCES

Books

Many Spanish authors routinely submit their original research articles in toxicology to international journals and books that are referenced in the appropriate sections of the other countries in this book. In addition, there are some Spanish journals and books that describe original research in toxicology and environmental and occupational safety and health. There is a broad audience in many Spanish-spoken countries for these publications.

Agudo J (2004)
El control de contaminación. Técnicas jurídicas de protección medioambiental (Pollution control. Legal techniques of environmental protection)
Madrid: Editorial Montecorvo SA

This book describes the current legislation to control pollution.

Alastuey MC (2004)
El delito de contaminación ambiental: Artículo 325.1 del código penal (The crime of environmental contamination)
Albolote: Editorial Comares S.L.

This book deals with the legal prosecution of those responsible for pollution.

Alonso MJ, Melgar J, García MA (1997)
Hongos silvestres comestibles en la Provincia de Lugo: contaminación por plomo y cadmio y sus repercusiones toxicológicas (Lead and cadmium contamination of fungi and their toxicological consequences)
Lugo: Servicio de Publicaciones Diputación Provincial de Lugo

A research document on cadmium and lead human exposure through fungi.

Aragón P (2005)
Contaminación atmosférica: manual de laboratorio (Atmospheric pollution: laboratory handbook)
Valencia: Universidad Politécnica de Valencia

A laboratory handbook on atmospheric pollution.

Azpeitia P, Rosado A (2004)
Revisión de métodos de análisis de contaminantes prioritarios en suelos (Review of analytical methods of contaminants in soil)
Madrid: Instituto Geológico y Minero de España.

A review of analytical techniques in contaminated soil.

Ballesteros E, Jurado R, San Andres MI (2000)
Toxicología Animal Originada por Plantas, Flora Silvestre Española (Animal Toxicology from the Spanish flora)
Madrid: Editorial Complutense

Animal poisoning due to plants.

Bataller Sifre R (2004)
Toxicología Clínica (Clinical Toxicology)
Valencia: Universitat de València.

A book on different aspects of clinical toxicology.

Baucells J, Vernet J (2004)
La prevención y el control integrados de la contaminación (The integrated pollution prevention and control)
Madrid: Marcial Pons

Contains information on prevention and integrated control of contamination.

Bello J, López de Cerain A (2001)
Fundamentos de Ciencia Toxicológica (The Foundation of Toxicological Science)
Madrid: Díaz de Santos

A textbook for undergraduate students.

Cabrera R, Mencias E, Cabrera J (1993)
Toxicología de los Psicofármacos (Psychotropic Toxicology)
L. Beecham: Madrid

An epidemiological study of poisoning by psychotropics, considering pharmacokinetics and pharmacodynamics in general, and that pertains to the different groups of this type of medicine.

Cabrera R (2001)
Manual Toxicológico de Productos Fitosanitarios para uso Sanitario (Toxicological Workbook of non-agriculture pesticides)
Madrid: Consejería de Salud

A book about the toxicology of biocides.

Camí J (1995)
Farmacología y toxicidad de la MDMA (Pharmacology and Toxicity of MDMA)
Neurociencias: Barcelona

Review of the pharmacology, effects, and clinical characteristics of ecstasy use.

Capó M (2002)
Principios de Ecotoxicología (Principles of Ecotoxicology)
Madrid: McGraw-Hill Interamericana

A review on the basis of ecotoxicology.

Carreño F, Rodríguez I (2006)
Elaboración y estructuración de una base de datos cartográfica de la contaminación marina provocada por el Prestige y su integración en un sistema de información geográfico (Preparation and structure of a cartographic database of the marine contamination produced by the Prestige and integration in a geographic information system)
Madrid: Editorial Dykinson

Database constructed with data from the disaster of the contamination caused by the leakage of petrol from a ship.

Casas M, Gutiérrez M, San L (1995)
Avances en Drogodependencias (Advances in Drug Addiction)
Neurociencias: Barcelona

The current situation of the criteria regarding therapeutic methods based on the substitution of opiates by methadone, buprenorphine, etc., and the use of antagonists.

Compaño R, Rios A (2002)
Garantía de Calidad en los laboratorios analíticos (Quality assurance in analytical laboratories)
Madrid: Síntesis

A practical review on the implementation of quality control and assurance systems in analytical process.

Coordinadora de ONGs (1995)
Directorio. Organizacions no-gubernamentales que intervienen en drogodependencias (Directory. Non-Governmental Organizations Intervening in Drug Addictions)
OMGs: Madrid

File on human resources and associations of all types with activities in the fight against drug addiction.

de la Fuente L, Frutos J (1995)
Toxicología y Seguridad Química Evaluación y Gestión del Riesgo Químico (Toxicology, Chemical Safety and Chemical Risk Management)
Madrid: Colegio Oficial de Biólogos. Consejería de Salud

A review on risk assessment and management.

de la Peña E, Gómez Campoy E (2005)
Toxicología Ambiental: Seguridad Química (Environmental Toxicology: Chemical Safety)
Murcia: AETOX, SESA, Consejeria de Sanidad. Comunidad Autónoma de la Región de Murcia. CSIC (CD-ROM)

An update on the basis and procedures used in chemical safety.

de la Peña E, Guadaño A, Barrueco C, Repetto G, Gonzalez Menció F, Garcia Partida P (1995)
ICLAS/CSIC Working Group on Complementary Methods
Madrid: Comité Español del ICLAS/CICYT/CSIC, Dirección General de Investigación Científica y Técnica

Report produced in a meeting of experts in alternative and complementary methods to the use of animals in testing.

de la Peña E, Burguete I, Guadaño A (1999)
Evaluación Mutagénica y Genotóxica (Mutagenic and Genotoxic Evaluation)
Murcia: DGES,CMEyC – SEMA

This is a compendium of available techniques applicable to the study of the genotoxic and mutagenic capacity of compounds.

de la Peña E, Gomez Campoy E (2000)
Evaluación Toxicológica de los Plaguicidas y la Sanidad Ambiental (Toxicological Evaluation of Pesticides and Environmental Safety)
Murcia: Monografía SESA/AET SESA, AET, RAMCM, CSyC, CFRM.

This is a compilation of strategies used for testing the toxicity of pesticides.

de Moreno MD (2003)
Toxicologia Ambiental: Evaluacion de Riesgo para la Salud Humana (Environmental Toxicology: Human Risk Assessment)
Madrid: McGraw-Hill/Interamericana de España, S.A.

This book describes the strategies for the assessment of human risks from environmental exposure.

Dirección General de Calidad y Evaluación Ambiental (2006)
Prevención y control integrados de la contaminación (IPPC): documento de referencia de mejores técnicas disponibles en la industria de procesos de metales férreos (Prevention and integrated control of contamination: the iron industry)
Madrid: S.G.T. Ministerio de Medio Ambiente

A review on the control procedures applicable to the iron industry to reduce pollution.

Domènech X (2000)
Química atmosférica: origen y efectos de la contaminación (Atmospheric chemistry: origin and effects of contamination)
Madrid: Miraguano Ediciones

A book reviewing the sources and adverse effects of atmospheric pollutants.

Domènech X (2000)
Quimica del Suelo, el Impacto de los Contaminantes (Chemistry of Soil and Impact of contaminants)
Madrid: Miraguano Ediciones

A book reviewing the adverse effects caused by soil pollutants.

Dueñas A (1999)
Intoxicaciones agudas en medicina de urgencia y cuidados Intensivos (Acute Poisonings in Urgency Medicine and Intensive Care)
Madrid: Masson, S.A.

Clinical features, diagnosis, and management of main acute poisonings are presented from the perspective of clinical toxicology.

Felices F, Nogué S, Civeira E (1993)
Medicina Intensiva Práctica. Intoxicaciones Agudas (Practical Intensive Medicine. Acute Poisonings)
IDEPSA: Madrid

Describes the general basis for the treatment of acute poisoning, with chapters covering medicines, drugs of abuse, alcohol, and other frequent agents of poisoning.

Gelpi E (2001)
Advances in Mass Spectrometry 15
Barcelona: Wiley

This volume comprises the proceedings of the 15th International Mass Spectrometry Conference held in Barcelona.

Gestal JJ, Smyth E, Figueiras A, Montes A (2004)
Recollida e limpeza do fuel do Prestige. Avaliación da exposición e danos á saúde en voluntarios e traballadores (Cleaning of Fuel from the Prestige. Exposure Evaluation and Health Effects in Volunteers and Workers)
Saúde Pública: Santiago de Compostela, Universidade de Santiago de Compostela

A study of the human health effects due to the cleaning procedures applied in the petrol leakage from the Prestige ship.

Gisbert-Calabuig JA (2004)
Medicina Legal y Toxicologia, 6th Edition (Legal Medicine and Toxicology)
Barcelona: Masson

An extensive text and reference book for forensic science students.

Hernández I, Gil A, Delgado M, Bolúmar F (2005)
Manual de Epidemiología y Salud Pública
Madrid: Panamericana

A textbook for students of public health.

Laborda R (2001)
Evaluación de la exposición a agentes químicos en el trabajo: manual práctico (Exposure Assessment to Chemical Agents at Work: Practical Manual)
Valencia: Bèrnia

A laboratory handbook for the evaluation of the ocupational exposure to chemicals.

Ladrón de Guevara J, Moya V (1995)
Toxicología Médica: Clínica y Laboral (Medical Toxicology: Clinical and Occupational)
Madrid: McGraw-Hill

Contains a general section, several chapters on basic, clinical, and workplace toxicology, followed by a descriptive dictionary of poisonous compounds.

López de Cerain A, Bello J (2000)
Toxicología: guía de prácticas (Toxicology: A Guide of Practical Teaching)
Pamplona: Universidad de Navarra

A textbook describing practical procedures for training in toxicology.

Manzanera R, Torralba I, Solanes P (1995)
Plan municipal de acción sobre drogodependencias (Municipal Plan of Action on Drug Addiction)
Corporation: Barcelona

Municipal plans for the prevention, treatment, and rehabilitation of drug addicts.

Marruecos L, Nogué S, Nolla J (1993)
Toxicología Clínica (Clinical Toxicology)
Springer Verlag Ibérica: Barcelona

A study of epidemiology, physiopathology, laboratory and clinical diagnosis; also addressing the therapeutics of the principal types of acute poisoning, with special discussion of the most frequent groups of poisons.

Mateu J (1994)
Toxicología Médica: productos de uso doméstico, mordeduras y picaduras, Toxicología Vegetal. Tratamiento general de las Intoxicaciones (Medical Toxicology)
Doyma: Barcelona

Compilation of the symptoms and therapeutics of poisoning by household products, cosmetics, and products for personal hygiene, detergents and soaps, disinfectants, pesticides, fuels, etc. and by poisonous animals.

Mateu J (1995)
El niño intoxicado (The Poisoned Child)
McEdiciones: Barcelona

A very attractively presented book; addressed to the public rather than to health professionals, with the intention of preventing poisonings and to give first aid to the poisoned.

Mateu J (1999)
Guia Practica de Primeros Auxilios (II) (Toxicologia Vegetal y Accidentes) (Vegetal Toxicology and accidents)
Murcia: Diego Marin Librero Editor, S.L.

A guide for first aid treatment of poisonings.

Mencias E, Mayero LM (2000)
Manual de Toxicologia Basica (Manual of Basic Toxicology)
Madrid: Ediciones Diaz de Santos, S.A.

A multiauthor book with a variety of information about the toxicity and treatment of different compounds.

Nogue S, Sanz P (2001)
Atlas de Toxicologia Clínica y Laboral (Atlas of Clinical and Occupational Toxicology)
Barcelona: Universidad Politecnica de Cataluña

A book about clinical and occupational effects of toxicants.

Nogué S, Munné P, Nicolás JM (2003)
Intoxicaciones agudas. Protocolos de Tratamiento (Acute Poisonings. Protocol Treatments)
Barcelona: Morales i Torres editores S.L.

A very detailed book containing established protocols used for the treatment of acute poisonings in the Clinic Hospital of Barcelona.

Obiols J (1998)
Quinto Control biológico de los trabajadores expuestos a contaminantes químicos (5th Biological Control of Workers Exposed to Chemical Pollutants)
Madrid: Instituto Nacional de Seguridad e Higiene en el Trabajo

This is a compilation from a biological control carried out in workers of different activities.

Pérez M, Soler F (2005)
Toxicología Clínica de Pequeños Animales (Clinical Toxicology of Small Animals)
Madrid: Consulta de Difusión Veterinaria 98

Piqueras J (1996)
Intoxicaciones por plantas y hongos (Poisonings by Plants and Toadstools)
Masson: Barcelona

Summarizes the author's experience in the treatment of patients poisoned by plants and especially by toadstools, with a detailed classification and description of the botanical and toxicological aspects.

REMA (Red Española de Métodos Alternativos) (2005)
Curso-Taller de Reducción, Refinamiento y Reemplazo de animales en Investigación, Desarrollo y Docencia (Course on Reduction, Refinement and Replacement of Animals in Research, Development and Education)
Madrid: Red Española de Métodos Alternativos (REMA) (CD-ROM)

This publication is targeted for scientists using animals in research, education, and testing. There are many possibilities to reduce, refine, or replace their use.

Repetto M (1978)
Toxicologia de los Aerosoles (Toxicology of Aerosols)
Universidad: Sevilla

This book studies the physiochemical properties of colloidal dispersions and the uses and applications of

aerosols, as much to military, agricultural, or medical ends as to meteorological. It revises knowledge of absorption by inhalation, of lung clearance, and of local or systemic pathologies that aerosols can cause. This book also presents the appropriate methodology for toxicity testing.

Repetto M, et al (1985)
Toxicología de la Drogadicción (Toxicology of Drug Addiction)
Díaz de Santos: Madrid

This is a collective book, whose authors – physicians, chemists, biologists, pharmacists, a judge, and a psychologist – approach the different aspects of the problem of drug addiction from their personal points of view.

Repetto M, Sanz P (1995)
Glosario de términos usados en Toxicología (Glossary of Terms Used in Toxicology)
Doble Cero: Sevilla

This is the Spanish version of the IUPAC glossary, including most of the words used in toxicology (Duffus et al 1993), including over 1000 terms.

Web: http://buscatox.info

Repetto M, et al (1995)
Toxicología Avanzada (Advanced Toxicology)
Díaz de Santos: Madrid

This collective work is an examination of several toxicological subjects, from ancient to the modern, based on extensive research of the literature.

Repetto G, del Peso A, Salguero M, Repetto M (1999)
Inventory of the Spanish Institutions and Scientists Involved in Alternatives to the use of Laboratory Animals (Refinement, Reduction or Replacement)
Revista de Toxicología 16: 50–127

Database on groups working on the development of alternative methods in Spain.

Repetto M (2001)
Evolución, estado actual, retos y tendencias de la Toxicología comenzar el milenio (Evolution, Present Situation and Trends of the Toxicology at the Start of the Millennium)
Sevilla: Área de Toxicología, Universidad de Sevilla (CD-ROM)

Published as a textbook in a short course for postgraduate students of toxicology.

Repetto M (2002)
Toxicología de Postgrado (Postgrade Toxicology)
Sevilla: Área de Toxicología, Universidad de Sevilla (CD-ROM)

Published as a textbook in a course to obtain the title of Universitary Expert in Toxicology.

Repetto M (2003)
Toxicología de Postgrado 03, 2nd Edition (Postgraduate Toxicology)
Sevilla: Área de Toxicología, Universidad de Sevilla (CD-ROM)

Repetto M (2004)
Toxicología de Postgrado 04, 3rd Edition (Postgraduate Toxicology)
Sevilla: Área de Toxicología, Universidad de Sevilla (CD-ROM)

Repetto M (2005)
Toxicología de Postgrado 05 (Enlargement of Postgraduate Toxicology 05)
Sevilla: Área de Toxicología, Universidad de Sevilla (CD-ROM)

Published as a textbook in a course to obtain the title of Universitary Master in Toxicology.

Repetto M, Cameán AM (2006)
Toxicología Alimentaria (Food Toxicology)
Madrid: Díaz de Santos

This multiauthor book is an extensive review of the different areas related to food toxicology, including analytical procedures, distribution and kinetics, effects of chemicals, risk assessment, treatment of poisonings, etc.

Repetto M (2006)
Toxicología de Postgrado 06, 4th Edition (Postgraduate Toxicology 06)
Sevilla: Área de Toxicología, Universidad de Sevilla (CD-ROM)

Repetto M (2007)
Ampliación de Toxicología de Postgrado 07, 2nd Edition (Enlargement of Postgrade Toxicology 07)
Sevilla: Área de Toxicología, Universidad de Sevilla (CD-ROM)

Repetto M, Repetto G (2009)
Toxicología Fundamental, 4th Edition (Fundamental Toxicology)
Díaz de Santos: Madrid

This is a multidisciplinary text in which, from biological, chemical, anatomical, and physiological knowledge, physiopathological processes of toxic origin are explained. Several chapters are also dedicated to the basis of toxicological analysis and the treatment of the poisoned.

San Andrés MI (2000)
Toxicología Animal originada por Plantas (Toxicology of Animals due to Plants)
Madrid: Editorial Complutense

The effects of plant toxins on animals are reviewed.

Sogorb MA, Vilanova E (2004)
Técnicas analíticas de contaminantes químicos: aplicaciones toxicológicas, medioambientales y alimentarias (Analytical Techniques of Chemical Pollutants: Toxicological, Environmental and Food Applications)
Madrid: Díaz de Santos

This book covers many different applications for the analytical quantification of chemicals.

Soler F (2003)
Plantas Tóxicas para el Ovino I (Toxic Plants for the Ovine)
Revista OVIOS: Monografía Nov

Soler F (2004)
Plantas Tóxicas para el Ovino II (Toxic Plants for the Ovine)
Revista OVIOS: Monografía Marzo

Valledor A (1994)
Envenenamiento por animales (Poisoning Due to Animals)
Diaz de Santos: Madrid

A review of the habits and characteristics of animals (vertebrates and invertebrates) of the entire world, whose behavior produces poisoning and also of the preventive and therapeutic actions applicable in each case.

Valverde JL, Perez De-Gregorio JJ (2002)
Manual de Toxicología Medioambiental Forense (Manual of Environmental Forensic Toxicology)
Madrid: Editorial Universitaria Ramon Areces

A review of the legislation and the procedures used for the investigation of cases of environmental pollution.

Vera DJ (2005)
Actividades molestas, insalubres, nocivas y peligrosas: normativa de evaluación del impacto ambiental y prevención y control de la contaminación (Regulations for the Environmental Impact Evaluation and Prevention and Control of Contamination)
Madrid: Ed. Tecnos

Procedures for environmental impact studies and the integrated prevention of pollution.

Journals

Adicciones (Addictions)
Madrid: Socidrogaalcohol Society
Presents papers on aspects of research, symptoms, or epidemiology regarding abuse of drugs or alcohol.
Web: http://socidrogalcohol.psiquiatria.com/adicciones/

Alimentaria. Revista de tecnología e higiene de los alimentos (Foodstuffs. Journal of technology and safety of foods) (1963–)
Madrid: Servicio de Informática y Documentatión Alimenticia
Web: http://sumaris.cbuc.es/03005755.htm

Ambienta: La revista del Ministerio de Medio Ambiente (The Journal of the Ministry of Environment)
Madrid: Ministerio del Medio Ambiente
Web: http://www.mma.es/secciones/biblioteca_publicacion/publicaciones/revista_ambienta/index.htm

Archivos de prevención de riesgos laborales (Archives of Occupational Risks Prevention)
Barcelona: Societat Catalana de Seguretat i Medicina del Treball (SCSMT)
Web: http://dialnet.unirioja.es/servlet/revista?tipo_busqueda=CODIGO&clave_revista_6054

Boletín del Grupo de Trabajo Especializado en Métodos Alternativos-GTEMA (Bulletin of the Group on Alternative Methods)
Bulletin of the Spanish Group on Alternative Methods.
Web: http://www.uv.es/aetoxweb/grupos/gtema/gtema.html

Ciencia Forense: Revista Aragonesa de Medicina Legal (Forensic Science. Journal from Aragón)
Zaragoza: Fernando el Católico
Web: http://www.dpz.es

Conductas Adictivas (Addictives Behaviors)
Journal about addictive behaviors.
Web: http://www.conductasadictivas.org/

Cuadernos de Medicina Forense (Journal of Forensic Medicine)
Sevilla: Asociación Andaluza de Médicos Forenses
Web: http://scielo.isciii.es/scielo.php?pid=1135-7606&script=sci_serial

Ecosistemas: Revista científica y técnica de ecología y medio ambiente (Ecosystem: Scientific and Technical Journal of Ecology and Environment)
Madrid: Asociación Española de Ecología Terrestre
Web: http://www.revistaecosistemas.net/

El Farmaceutico (The Pharmacist) (1966–)
Madrid: Real e Ilustre Colegio Oficial de Farmaceuticos
Web: http://www.edicionesmayo.es

Food Science and Technology International (Published since 1960 as Revista de Agroquimica y Tecnologia de Alimentos)
Valencia: SAGE Publications
Web: http://fst.sagepub.com/

Grasas y aceites (Fats and Oils)
Sevilla: Instituto de la Grasa
A journal about edible fats from any origin.
Web: http://grasasyaceites.revistas.csic.es/index.php/grasasyaceites/

Ingeniería Química (Chemical Engineering)
Madrid: Alción
Chemical engineering and environment.
Web: http://www.alcion.es

Journal of Physiology and Biochemistry
Pamplona: Universidad de Navarra
Web: http://www.unav.es/fyn/jphysiolbiochem/default.html

Mapfre Seguridad (MAPFRE Safety) (1980–)
Fundación MAPFRE: Madrid
Web: http://www.editorialmapfre.com/revistas.asp

Medicina Clínica (Clinical Medicine)
Barcelona: Doyma
Web: http://www.doyma.es/medicinaclinica/

Panorama del Medicamento (Panorama of Medicines) (1976–)
Madrid: Real e Ilustre Colegio Oficial de Farmacéuticos
Web: http://www.portalfarma.com/

Quimica e Industria (Chemistry and Industry) (1954–)
Madrid: Asociación Nacional Químicos
Web: http://www.anque.es/

Red de Revistas Científicas Españolas (Spanish Network of Spanish Scientific Journals)
Web: http://www.revicien.net/

Revisiones en Cáncer (Cancer Reviews)
Madrid: Aran
Web: http://www.grupoaran.com/

Revista española de Drogodependencias (Spanish Journal of Drug Addictions)
Asociación Española de Estudio en Drogodependencias: AESED
Web: http://www.aesed.com

Revista Española de Medicina Legal (Spanish Journal of Legal Medicine)
Asociación Nacional de Médicos Forenses
Web: http://www.arrakis.es/~anmf/

Revista Española de Salud Pública (Spanish Journal of Public Health)
Madrid Dirección General de Salud Pública
Web: http://www.scielo.isciii.es/scielo.php/script_sci_serial/pid_1135-5727/lng_es/nrm_iso

Revista de Salud Ambiental (Journal of Environmental Health)
Valencia: Sociedad Española de Sanidad Ambiental
Web: http://www.sanidadambiental.com

Revista de Toxicología (Journal of Toxicology)
Valencia: Asociación Española de Toxicología
Web: http://www.uv.es/aetoxweb/revista/revtox.html

RET: Revista de Toxicomanías (Journal of Drug Addiction)
Barcelona: Cat-Barcelona
Web: http://www.cat-barcelona.com/ret/

Salud y drogas (Health and Drugs)
Elche: Instituto de Investigaciones en Drogodependencias
Web: http://inid.umh.es/?mod=revistalct=numeros2.asp

Seguridad y salud en el trabajo (Health and Safety at Work) (1977–)
Madrid: Instituto Nacional de Seguridad e Higiene del Trabajo
Web: http://insht.es/portal/site/Insht/menuitem.1f1a3bc79ab34c578c2e8884060961ca/?vgnextoid=f2d5cf0a42e36110VgnVCM1000000dc0ca8cORCRDRvgnextchannel=9f164a7f8a651110VgnVCM1000000dc0ca8cORCRD/

Tecno ambiente: Revista profesional de tecnología y equipamiento de ingeniería ambiental (Professional Journal of Technology and Equipment in Environmental Engineering)
Madrid: TIASA
Web: http://www.tiasa.net/

Trastornos Adictivos (Addictive Alterations)
Madrid: Doyma
A journal about alterations in addictive people.
Web: http://www.doyma.es/ta

Technical Reports and Other Documents

A few representative technical reports have been selected and the links to several collections are included.

Calitox
Quality indicators for the urgent patient assistance in acute poisonings.
Web: http://wzar.unizar.es/stc/actividades/CALITOX-AETOX-30-04-2006.zip

Chemical Products
Basic guide on labeling and safety data sheets.
Sevilla: Junta de Andalucía
A very complete compilation of the criteria used for labeling of chemicals and for the preparation of safety cards.
Web: http://www.juntadeandalucia.es/salud/principal/documentos.asp?pagina={pdf}institucional/sanidad%20ambiental/guias/inglesprot.pdf (English)
Web: http://www.juntadeandalucia.es/salud/principal/documentos.asp?pagina={pdf}/institucional/sanidad%20ambiental/nuevaweb_sa/guiaquimicos3ed.pdf (Spanish)

Chemical Products
Hazard and control of health risk.
Sevilla: Junta de Andalucía
A very interesting update of the criteria for hazard and risk assessment.
Web: http://www.juntadeandalucia.es/salud/principal/documentos.asp?pagina=productos_quimiscos_op1 (Spanish)

Diccionario de acrónimos para las Ciencias de la Salud (Dictionary of Acronyms for Health Sciences)
Illera M (1994)
Madrid: Fundación Welcome

Publications of the Ministry of Health and Consumer Issues
The information about many publications by the Ministry of Health and Consumer Issues can be found in the following link.
Web: http://www.msc.es/

Publications of the Ministry of the Environment
Many publications of the Spanish Ministry of the Environment are included in the following link.
Web: https://www.fomento.es/cpmf/

Publications of the National Institute of Health and Safety at Work
Web: http://www.es/portal/site/Insht/

About 400 publications are available, most of them online.

Technical Guides for the Evaluation and Prevention of Risks
National Institute of Health and Safety at Work
More than 25 illustrative Technical Guides (not binding) designed to interpret the rules which arise from the Prevention of Risks at Work Act.
Web: http://www.insht.es/portal/site/Insht (English)
Web: http://www.insht.es/portal/site/insht/ (Spanish)

Occupational Exposure Limits for Chemical Agents, which have been adopted by the National Institute for Health and Safety at Work (Instituto Nacional de Seguridad e Higiene en el Trabajo, INSHT)
Web: http://www.insht.es (Spanish only)

Databases

Acute poisoning. Protocols of treatment of the Clínic Hospital, Barcelona
Nogué S, Munné P, Nicolás JM (2003)
Web: http://wzar.unizar.es/stc/actividades/protocolos.html

A very up-dated and complete collection of detailed protocols of poisoning treatment.

CINDOC – Center of Information and Documentation
Web: http://www.cindoc.csic.es/eng/principal.html (English)
Web: http://www.cindoc.csic.es/ (Spanish)

Collects the Spanish scientific output and make it widely available by developing and distributing to the corresponding databases.

Data base of Medicines – CGCOF
Web: http://pfarmals.portalfarma.com:8080/farma/

Information about the human pharmaceutical products authorized in Spain.

DIAGNOS^{MD}
Web: http://www.diagnos98.com/

Diagnos is a very useful computerized system developed in 1998 as a tool to assist in the differential clinical diagnostics of the different types of disease. Includes a special part dedicated to poisonings from general chemicals (200), pharmaceuticals (500) and plants (3000), and adverse interactions. The recommended treatment is also included.

Dialnet
Web: http://dialnet.unirioja.es/

Supplies information and alerts about the content of journals published in Spanish, doctoral theses, etc.

Directory of Chemical Companies and Products. Spanish Chemical Industry Federation
Web: http://www.adinte.net/basefeique/indice.htm (Spanish and English)

A database with information of the products produced by Spanish chemical companies.

Directory of Spanish resources on Pharmacology
Web: http://www.imim.es/DREF/default.htm

Information about societies related to Pharmacology, journals, institutions, ethical committees and pharmaceutical laboratories.

Documentation and information centre on drugs. Ministry of Health and Consumer Issues
Web: http://www.pnsd.msc.es/en/Categoria2/centro/home.htm (English)
Web: http://www.pnsd.msc.es/Categoria2/centro/home.htm (Spanish)

EPER – España. Spanish Pollutant Emissions and Sources Register
Web: http://www.eper-es.es/

Includes the emission maps from the different areas of Spain.

Hispagua. Spanish Water Information System
Web: http://hispagua.cedex.es/en/index.php (English)
Web: http://hispagua.cedex.es/index.php (Spanish)

A database about water quality.

Informtoxic. A multimedia toxicological database
Argemi J, Mateu J (1993)
Barcelona: Infofarma España S. L.
Web: http://www.infanciasegura.com

A database containing detailed information on clinical and toxicological aspects regarding domestic products, and bites and stings of poisonous animals, together with the general treatment of poisonings.

Inventory of the Spanish Institutions and Scientists Involved in Alternatives to the use of Laboratory Animals (Refinement, Reduction or Replacement)
Web: http://www.uv.es/aetoxweb/grupos/gtema/gtema.inv.html

Database on groups working on the development of alternative methods in Spain.

Limit values: Biological limit values – VLBs
Web: http://www.insht.es/Inshtweb/Contenidos/Documentacion/TextosOnline/Valoies_Limite/GT-LEPN024-07%20VLA%202008%20negro_2.pdf

Official list of biological limit values approved in Spain for monitoring occupational exposure to chemical compounds.

Limit values: Carcinogenic and mutagenic susbtances with limit value adopted
Web: http://www.insht.es/Inshtweb/Contenidos/Documentacion/TextosOnline/Valoies_Limite/GT-LEPN024-07%20VLA%202008%20negro_2.pdf

Official list of environmental limit values approved in Spain for monitoring occupational exposure to carcinogenic and mutagenic compounds.

Limit values: Occupational exposure limits – TLVs
Web: http://www.insht.es/Inshtweb/Contenidos/Documentacion/TextosOnline/Valoies_Limite/GT-LEPN024-07%20VLA%202008%20negro_2.pdf

Official list of environmental limit values approved in Spain for monitoring occupational exposure to chemical compounds, including the Daily Exposure Values (TLV-TWA) and their Short Exposure values (TLV-Stel).

Register of non-agricultural pesticides or biocides
Ministry of Health and Consumer Issues
Web: http://www.msc.es/en/ciudadanos/saludAmbLaboral/prodQuimicos/sustPreparatorias/biocidas/frmRegistroPlaguicidas.jsp

The official database of the biocides authorized in Spain, with information about the risks, uses and producers.

Register of Plant Protection Products – Pesticides
Ministry of Agriculture, Fisheries and Food
Web: http://www.mapya.es/es/agricultura/pags/fitos/registro/menu.asp

The official database of the pesticides and other Plant Protection Products authorized in Spain, with information about the risks, uses and producers.

Registry of Toxicologists – Spain
Web: http://www.uv.es/aetoxweb/info/regtoxicol.html

The Spanish Registry of Toxicologists includes more than 50 professionals specialized in basic and applied toxicology. The list is included in the Register of EUROTOX. The registered toxicologists should possess a high level of professional competence and ethical conduct.

RISCTOX. Syndicate Institute of Work
Web: http://www.istas.net/ecoinformas/web/index.asp?idpagina=575

Toxicological data provided to workers of about 1000 products of industrial use, including exposure levels and human and environmental adverse effects.

SciELO – Spain – Scientific Electronic Library Online
Web: http://scielo.isciii.es/scielo.php (Spanish only)

The objective of the site is to implement an electronic virtual library, providing full access to a collection of serial titles, a collection of issues from individual serial titles, as well as to the full text of articles.

SINAC – Information System on Water of Human Consumption
Ministry of Health and Consumer Issues
Web: http://sinac.msc.es/sinac/homeEstatica.html

Network with information about the quality of tap water.

SIRIPQ – Information and Rapid Interchange System on Chemical Products
Ministry of Health and Consumer Issues
Web: http://www.msc.es/en/ciudadanos/saludAmbLaboral/prodQuimicos/sustPreparatorias/rednacVigi/siripq.htm (English)
Web: http://www.msc.es/ciudadanos/saludAmbLaboral/prodQuimicos/sustPreparatorias/rednacVigi/siripq.htm (Spanish)

Network for the surveillance and control of the use of chemicals and to the prevention of the risks derived from the exposure to substances.

SISAL – Information System on Occupational Health
Ministry of Health and Consumer Issues
Web: http://www.msc.es/ciudadanos/saludAmbLaboral/saludLaboral/sisal.htm

Network for the surveillance, control and prevention of the risks derived from the occupational exposure to chemicals.

Spanish legislation. Journal of the Official Gazette
Web: http://www.boe.es/g/eng/index.php (English)
Web: http://www.boe.es/g/es/bases_datos/iberlex.php (Spanish)

The complete Spanish legislation to be searched.

Spanish legislation on Hazardous Substances, Chemical and Occupational Safety and Health
Web: http://www.insht.es/portal/site/Insht/menuitem.75eb39a3ca8b485dce5f66a150c08a0c/?vgnextoid=75164a7f8a651110VgnVCM1000000dc0ca8cDRCRD (Spanish only)

The Spanish legislation classified according to the different areas.

Spanish Resources on Safety and Health – CEW
Web: http://www.civileng.com/segur.htm

A summary of resources for workers in a web of civil engineering.

Swimming pool water treatment products
Ministry of Health and Consumer Issues
Web: http://www.msc.es/ciudadanos/saludAmbLaboral/calidadAguas/piscinas/home.htm

The official database of products used in swimming pools authorized in Spain, with information about the risks, uses, and producers.

Table of concentrations of xenobiotics in human biological fluids as reference for the toxicological diagnostic
Web: http://busca-tox.com

Reference values useful for the interpretation of the concentrations present in blood or urine.

Toxicologia.net
Web: http://wzar.unizar.es/stc/toxicologianet/index.htm

An interesting database and self-learning system mainly focused in clinical toxicology.

Virtual Library on Health in Spain
Web: http://bvs.isciii.es/i/index.php (English)
Web: http://bvs.isciii.es/E/index.php (Spanish)

Represents an instrument to spread scientific knowledge that arises from national and international public organizations' concern to offer quality-assured scientific information through the Internet.

Water quality
Ministry of Health and Consumer Issues
Web: http://www.msc.es/en/ciudadanos/saludAmbLaboral/calidadAguas/home.htm (English)
Web: http://www.msc.es/ciudadanos/saludAmbLaboral/calidadAguas/home.htm (Spanish)

A database about water quality.

Organizations (government)

Spain is a constitutional and hereditary monarchy, with legislative power being held by the Parliament. Executive power is nominally exercised by the cabinet led by the President of the Government. The country is divided into 17 counties, administered by locally elected governments and parliaments, with considerable autonomy in environmental matters. The following presents a summary of legislation concerning pollution, hazardous toxic waste, pesticides, additives and product control in Spain. In this chapter are listed the various authorities with addresses. The most

relevant centers related to toxicology and environmental and occupational safety and health are included.

Administration of the State
Web: http://www.060.es/ (Spanish only)

Institute of Safety and Occupational Health of Murcia – CARM
Web: http://www.carm.es/issl/ (Spanish only)

Ministry of the Environment and Rural and Marine Affairs
Paseo de Infanta Isabel 1, 28071, Madrid
Web: http://www.marm.es/index_en.htm (English)
Web: http://www.marm.es/ (Spanish)

Ministry of Defence
P. de la Castellana 109, 28071, Madrid
Web: http://www.mde.es/ (Spanish only)

Ministry of Education, Social Affairs and Sport
C/ Alcalá 36, 28071 Madrid
Web: http://www.mepsyd.es/ (Spanish only)

Ministry of Science and Innovation
C/ Albacete 5, 28027, Madrid
Web: http://web.micinn.es

From the centers depending on this Ministry, the following are cited:

Agency against doping (AEA)
Web: http://www.csd.mecd.es/

Center of Biologic Researches CIB
Web: http://www.cib.csic.es/en/index.php? (English)
Web: http://www.cib.csic.es/ (Spanish)

Center of Environmental Sciences CCMA
Web: http://www.ccma.csic.es/ (English)
Web: http://www.ccma.csic.es/ (Spanish)

Center Mediterranean of Environmental and Marine Research CMIMA
Web: http://www.cmima.csic.es/index.php?displayLang=EN (English)
Web: http://www.cmima.csic.es/index.php?displayLang=ES (Spanish)

Center for Research on Energy, Environment and Technology CIEMAT
Web: http://www.ciemat (English)
Web: http://www.ciemat.es/ (Spanish)

Center of Soil Science and Applied Biology – CEBAS
Web: http://www.cebas.csic.es/ (Spanish only)

Center of Scientific Research Isla de la Cartuja (CIC)
Web: http://www.cartuja.csic.es/ (Spanish only)

Center for Research and Development (CID)
Web: http://www.cid.csic.es/indexC.html (Spanish only)

Doñana Biological Station
Web: http://www.ebd.csic.es (English)
Web: http://www.ebd.csic.es/ (Spanish)

Experimental Station of Zaidin EEZ
Web: http://www.eez.csic.es/ (Spanish only)

Institute of Agro chemistry and Food Technology – IATA
Web: http://www.iata.csic.es/index.htf.en (English)
Web: http://www.iata.csic.es (Spanish)

Institute of Aquaculture Torre de la Sal IATS
Web: http://www.iats.csic.es/

Institute of Chemical Research IIQ
Web: http://www.iiq.cartuja.csic.es/

Institute of Chemical and Environmental Research of Barcelona IIQAB
Web: http://www.iiqab.csic.es/

Institute of Edible Oils (Instituto de la Grasa)
Web: http://www.ig.csic.es/

Institute of Marine Sciences – ICM
Web: http://www.icm.csic.es/index.php?displayLang=EN (English)
Web: http://www.icm.csic.es/index.php?displayLang=ES (Spanish)

Institute of Marine Sciences in Andalusia
Web: http://www.icman.csic.es/ (Spanish only)

Institute of Molecular Biology of Barcelona
Web: http://www.ibmb.csic.es/index.php?pIdioma=ENG (English)
Web: http://www.ibmb.csic.es/index.php?pIdioma=CAST (Spanish)

Institute of Molecular and Cellular Biology of Cancer – IBMCC
Web: http://www.cicancer.org/

Institute of Natural Resources and Agrobiology of Salamanca – IRNASA
Web: http://www.irnasa.csic.es/

Institute of Natural Resources and Agrobiology of Seville – IRNAS
Web: http://www.irnase.csic.es/ (Spanish only)

Institute of Neurobiology Cajal – INRC
Web: http://www.cajal.csic.es/ (English)
Web: http://www.cajal.csic.es/ (Spanish)

Institute of Neurosciences
Web: http://in.umh.es/

http://www.vnci.nl/Institute of Parasitology and Biomedicine 'López Neyra'
Web: http://www.ipb.csic.es/index_ingles.html (English)

Web: http://www.ipb.csic.es/ (Spanish)

Institute of Pharmacology and Toxicology – IFT
Web: http://www.ift.csic.es/

Institute of Sustainable Agriculture – IAS
Web: http://www.ias.csic.es/

Institute of Vegetal Biochemistry and Photosynthesis – IBVF
Web: http://www.ibvf.cartuja.csic.es/

National Institute of Research and Agrarian and Food Technology – INIA
Web: http://www.inia.es/

Centre of Research on Animal Health CISA
Web: http://www.inia.es/

Centre of Forestry Research – CIFOR
Web: http://www.inia.es/gcont/redestem/centrosydep.jsp?idcentro=16

Centre of Phytogenetic Resources – CRF
Web: http://www.inia.es

Department of the Environment INIA
Web: http://www.inia.es

Institute Geological and Mining
Web: http://www.igme.es/

Ministry of Health and Consumer Issues
P° del Prado 18–20, 28071, Madrid
Web: http://www.msc.es

Agency for the Evaluation of Medical Technology – AETS
Web: http://www.isciii.es/

General Sub direction of Environmental and Occupational Health
Web: http://www.msc.es

Institute of Health Carlos III http://www.isciii.es/
C/ Sinesio Delgado 4–6, 28029 Madrid
A large institution formed by several centers.
Web: http://www.isciii.es/

Institute of Research on Rare Diseases http://www.isciii.es/htdocs/centros/enfermedadesraras/enfermedaderaras_presentacion.jsp

National Center of Environmental Health
Web: http://www.isciii.es/htdocs/centros/sanidadambiental/sanidadambiental_presentacion.jsp

National Center of Epidemiology
Web: http://www.isciii.es/htdocs/centros/epidemiologia/epidemiologia_presentacion.jsp

National School of Health
Web: http://www.isciii.es/htdocs/centros/epidemiologia/epidemiologia/presentacion.jsp

National School of Occupational Medicine
Web: http://www.isciii.es/htdocs/centros/medicinadeltrabajo/medicinatrabajo_presentacion.jsp

National Institute of Consumption
C/ Príncipe de Vergara 54, 28071 Madrid
Web: http://www.consumo-inc.es

Center for Research and Quality Control – CICC
Web: http://www.consumo-inc.es

Center for Information and Documentation on Consumption
Web: http://www.consumo-inc.es

Chemical products information
Web: http://www.msc.es/ciudadanos/saludAmbLaboral/prodQuimicos/home.htm

Health and the environment
Web: http://www.msc.es/ciudadanos/saludAmbLaboral/medioAmbiente/home.htm

National Plan on Drugs
C/ Recoletos, 22, 28001 Madrid
Web: http://www.pnsd.msc.es/en/home.htm (English)
Web: http://www.pnsd.msc.es/ (Spanish)

Spanish Agency of Pharmaceuticals and Medical Products
Parque Empresarial Las Mercedes – Edificio 8, C./ Campezo 1, 28022 Madrid
Web: http://www.agemed.es/

Created in 1997 for the authorization and control of medicines.

Spanish Agency on Food Safety and Nutrition– AESAN
C/ Alcalá 56, 28071 Madrid
Web: http://www.aesa.msc.es

Created in 2001 to promote the health by ensuring food safety.

Water Program (Programa agua)
Web: http://www.mma.es/agua/entrada.htm

Ministry of Home Affairs
C/ Rafael Calvo, n° 33, Madrid
Web: http://www.mir.es/

General Direction on Civil Protection and Emergencies
Web: http://www.proteccioncivil.org/index.html

Ministry of Industry, Tourism and Commerce
P° de la Castellana 160, 28071 Madrid
Web: http://www.mityc.es/

Ministry of Justice
San Bernardo 45, 28015 Madrid
Web: http://www.justicia.es/

National Institute of Toxicology and Forensic Sciences – INTCF
With four centers:
Department of Madrid. c/ Luis Cabrera 9, 28002 Madrid
Department of Barcelona. c/ Mercé 1, 08002 Barcelona
Department of Sevilla. Avda. Doctor Fedriani, s/n 41009 Sevilla
Delegation of La Laguna. Campus de Ciencias de la Salud. La Cuesta 38320, La Laguna
Web: http://www.mju.es/toxicologia/

Mainly focused in forensic toxicology, but also collaborates in clinical toxicology and carries out toxicity studies. It has a toxicological information service.

Ministry of Labour and Social Affairs
Agustín de Bethencourt 4, 28071 Madrid
Web: http://www.mtas.es/

National Institute for Health and Safety at Work INSHT
Torrelaguna 73, 28027 Madrid
Web: http://www.insht.es/portal/site/Insht

Created in 1982 is composed of four territorial departments and 40 provincial offices; it is involved, with the Autonomic Communities, in the protection of the health of the workers and the prevention and control of occupational exposure.

Portal on Chemical Risk
Web: http://www.insht.es/portal/site/Insht/menuitem.bc3e96c3f4ccbac 6fee0ba10060961ca/?vgnextoid=85726062b6763110VgnVCM1000000dc0ca8cORCRD&vgnextchannel=1l19bf04b6a03110VgnVCM1000000dc0ca8c0RCRD&x=2&y=8

Spanish Network of Health and Safety at Work
Web: http://es.osha.eu.int/index_en.stm (English)
Web: http://es.osha.eu.int/ (Spanish)

Ministry Responsible for Public Works
Paseo de la Castellana 67, Madrid
Web: http://www.mfom.es/

Center on Studies and Experimentation on Public Works – CEDEX
C/ Alfonso XII 3, 28014 Madrid
Web: http://www.cedex.es/ingles/home.html (English)
Web: http://www.cedex.es/ (Spanish)

Municipal Institute of Medical Research IMIM
C/ Dr Aiguader 88, 8003 Barcelona
Web: http://www.imim.es/ (Spanish only)

Organizations (non-government)

Contract laboratories

ADIRONDACK
S.L. Laboratorio de Análisis y Ensayos. Derio (Vizcaya)
Web: http://www.adirondack.es/

Applus (Barcelona)
Web: http://www.appluscorp.com/

Biolab Barcelona
Web: http://www.biolab.es/

CEINAL (Grupo Silliker) (Barcelona)
Web: http://www.ceinal.es/

CIDASAL Center for Research and Applied Development
Web: http://www.cidasal.es/sitmapes.htm

CIDEMCO (Guipuzcoa)
Web: http://www.cidemco.es/

Gaiker
Web: http://www.gaiker.es/

Grupo SGS (Barcelona, Madrid, Valencia, Vizcaya)
Web: http://www.es.sgs.com

Interlab
Web: http://www.interlab.es/

IQS Institut Quimic de Sarriá (Barcelona)
Web: http://www.iqs.es/

Laboratorio de Análisis Dr. Echevarne (Barcelona)
Web: http://www.echevarne.com/

UAB – Universidad Autónoma de Barcelona
Web: http://www.uab.es/

UB – Universidad de Barcelona
Web: http://www.ub.edu/homeub/en/welcome.html

UCM – Universidad Complutense de Madrid
Web: http://www.ucm.es/

Vivotecnia
Web: http://www.vivotecnia.com/

ZF – BioLabs
Web: http://www.zfbiolabs.com/

Industrial associations

AFAQUIM – Spanish Association of the Fine Chemical Manufactures
Web: http://www.afaquim.org/

Farmaindustria – Spanish Association of the Pharmaceutical Industry
Web: http://www.farmaindustria.es/

FEIQUE – Spanish Chemical Industry Federation
Web: http://www.feique.org/

FENIN – Spanish Federation of Companies of Health Technology
Web: http://www.fenin.org/

ISTAS – Sindicate Institute of Work, Environment and Health
Web: http://www.istas.net/

STANPA – Spanish Association of Perfumery and Cosmetic
Web: http://www.stanpa.es/

Other organizations

Centers of Environmental Education of the Caja de Ahorros del Mediterráneo CEMACAM
Web: http://www.cam.es/

Institute for Study the Addictions. Las drogas.info
Web: http://www.ieanet.com/

Príncipe Felipe Centro de Investigación
Web: http://ochoa.fib.es/

Spanish Waste Club
Web: http://www.isrcer.org

Sustainability Development – CONAMA Foundation
Web: http://www.conama.org/

Standardization and accreditation agencies

National Entity of Accreditation – ENAC
Web: http://www.enac.es

Spanish Association for Standardisation and Certification – http://www.aenor.es

Universities

In various Spanish university faculties, such as pharmacy, medicine, and veterinary colleges, and some of chemistry and biology, the discipline of toxicology is studied within the normal curriculum and also as monographic courses. In Spain there are not degrees in toxicology, nor recognition of a medical speciality in clinical toxicology.

Food toxicology is currently taught at several university departments within the new Food Science and Technology degree programs. Different university faculties and professional societies provide monographic courses and specialization programs for postgraduates. Environmental Sciences is also very much in demand.

Postgraduate studies lead to a doctorate in the discipline of the student's basic degree, e.g., medicine, chemistry, pharmacy, biology, and food chemistry. There is no 'doctor in toxicology' degree. However, there are titles of 'Expert in Toxicology' and 'Master in Toxicology'.

For additional information the reader is referred to the publication by Cameán and Sanchez Burson in 2002, 'Toxicology implementation in the Spanish University: results of a survey'.

This section pertains exclusively to institutions offering officially approved courses related to the disciplines of toxicology and those offering postgraduate specialization courses in toxicology.

Alcala de Henares University
Web: http://www.uah.es/
Department of Nutrition, Food Science and Toxicology
Web: http://www.uah.es/centros_departamentos/departamentos/dptos.asp?CodDepto=Z035

Alicante University
Web: http://www.ua.es/es/index.html
http://www.ua.es/es/index.html

Alfonso X el Sabio University
Web: http://www.uax.es/indice.htm
http://www.uax.es/indice.htm

Almería University
Web: http://www.ual.es/
http://www.ual.es/

Andalucía International University
Web: http://www.unia.es/presentacion_portal.html

Barcelona University
Web: http://www.ub.edu/en/
Experimental and Analytical Toxicology
Web: http://www.idibaps.ub.edu/cas/equipo_108_2003.htm)
Unit for Experimental Toxicology and Ecotoxicology (UTOX-PCB) Scientific Parc of Barcelona
Web: http://www.pcb.ub.es/homePCB/live/en/p884.asp

Barcelona Autonomous University
Web: http://www.uab.es/english/default.htm

Balearic Islands University
Web: http://www.uib.es/en/

Basque Country University
Web: http://www.ehu.es/ingles/paginas/prin_i.htm

Burgos University
Web: http://www.ubu.es/

Cádiz University
Web: http://www.uca.es/

Cardenal Herrera Oria University CEU
Web: http://www.uch.ceu.es/

Catalonia Polytechnic University
Web: http://www.upc.edu/eng/
Laboratory of Environmental Toxicology INTEXTER
Web: http://www.ct.upc.es/intexter/ctoxico.htm

Córdoba University
Web: http://www.uco.es/

Distance Education National University UNED
Web: http://www.uned.es/webuned/areasgen/info/english.htm

Extremadura University
Web: http://www.unex.es/
Toxicology Unit
Web: http://veterinaria.unex.es/Unidades/TOXICOLO.htm

Granada University
Web: http://www.ugr.es/university.htm
Department of Legal Medicine and Toxicology
Web: http://www.ugr.es/~dpto_mlp/

Huelva University
Web: http://www.uhu.es/

Jaen University
Web: http://www.ujaen.es/serv/gabrel/
Environmental Toxicology and Public Health
Web: http://www.ujaen.es/dep/ciesal/medicinapreventiva.htm

La laguna University
Web: http://www.ull.es/

Las Palmas de Gran Canaria University
Web: http://www.ulpgc.es/

Leon University
Web: http://www.unileon.es/
Department of Pharmacology and Toxicology
Web: http://www.unileon.es/index.php?nodoID=207

Lleida University
Web: http://www.udl.es/arees/ori/eng/visitors/lleida/
http://www.udl.es/arees/ori/spa/visitantes/lleida

Madrid Autonomous University
Web: http://www.uam.es/default_ing.html

Madrid Complutense University
Web: http://www.ucm.es/info/vicrint/indexe.htm
Department of Biomedicine and Health Legislation
Web: http://www.biolex.es/infor/infor.htm
Department of Toxicology and Health Legislation
Web: http://www.ucm.es/info/medlegal/

Miguel Hernandez University
Web: http://www.umh.es/
Division of Toxicology and Chemical Safety
Web: http://tox.umh.es/TOXICOLOGIA/index.htm

Murcia University
Web: http://www.um.es/english/
Group of Toxicology
Web: http://www.um.es/grupos/grupo-toxicologia/

Navarra University
Web: http://www.unav.es/
Department of Nutrition, Food Science and Toxicology
Web: http://www.unav.es/bromatologia/toxicologia/toxicologia2/default.html

Pablo de Olavide University
Web: http://www.upo.es/index_ingles.html

Pompeu Fabra University
Web: http://www.upf.es/english/web/

Rovira i Virgili University
Web: http://www.urv.net/

Salamanca University
Web: http://www.usal.es/web-usal/Ingles/index.html

Santiago de Compostela University
Web: http://www.usc.es/en/index.jsp
Department of Pathology and Forensic Sciences
Web: http://www.usc.es/cfyap/doc/departamento.html

Sevilla University
Web: http://www.us.es/
Area of Toxicology
Web: http://www.area.us.es/toxicologia/index.htm

Valencia University
Web: http://www.uv.es/~webuv/ingles/index.htm
Department of Preventive Medicine and Public Health, Food Science, Toxicology and Legal Medicine
Web: http://centros.uv.es/web/departamentos/D265/ingles/

Valladolid University
Web: http://www.universityofvalladolid.uva.es/

Vigo University
Web: http://www.uvigo.es/relaciones/index.gl.htm
Toxicology
Web: http://webs.uvigo.es/qanalim/es/807.html

Zaragoza University
Web: http://wzar.unizar.es/servicios/ingles/prese.htm

Professional Societies

These bodies provide a focal point for toxicology, environmental and occupational safety and health

professionals in Spain. They arrange meetings and publish journals and books to keep scientists up to date with changes in methods, techniques, and advances in the subject allowing for continuing professional development.

AEFI – Spanish Association of Industrial Pharmacists
Web: http://www.aefi.org/

AETOX – Spanish Association of Toxicology
Web: http://www.aetox.com

With professionals of different disciplines working in the diverse areas of toxicology. A national meeting is held every two years and a quarterly journal is edited. The working sections are Alternative Methods – GTEMA, Clinical Toxicology Section, Environmental Toxicology Section, Food Safety Section, Forensic Toxicology Section and Veterinary Toxicology Section.

ASEICA – Spanish Association of Research in Cancer
Web: http://www.onco.net/aseica/

Group of Clinical Toxicology (GITAB). SOCMIC – Societat Catalana De Medicina Intensiva I Crítica
Web: http://www.academia.cat/societats/intensiva/index.html

Formed by the doctors who work in the different hospitals in northeastern Spain and who have intensive care units for poisoned patients.

REMA – Spanish Network for the Development of Alternative Methods
Web: http://www.remanet.net

SEBBM – Spanish Society of Biochemistry and Molecular Biology
Web: http://sebbm.bq.ub.es/

Sociedad Española de Medicina Legal y Forense (Spanish Society of Legal and Forensic Medicine)

Web: http://www.sc.ehu.es/scrwwwsr/Medicina-Legal/SEMLYF/SEMLYF.htm

SEBC – Spanish Society of Cellular Biology
Web: http://www.cib.csic.es/sebc/

SECAL – Spanish Society of the Science of Laboratory Animals
Web: http://www.secal.es/

SECCFF – Spanish Society of Physiological Sciences
Web: http://www.seccff.org/

SEE – Spanish Society of Epidemiology
Web: http://as-seepidemiologia.es/

SEF – Spanish Society of Pharmacology
Web: http://www.socesfar.com/

SEMA – Spanish Society of Environmental Mutagenesis
Web: http://www.institucional.us.es/sema/

SEMICYUC – Sociedad Española de Medicina Intensiva y Unidades Coronarias
Web: http://www.semicyuc.org/

SEQC – Spanish Society of Cosmetic Chemists
Web: http://www.e-seqc.org/esp/default.asp

SESA – Spanish Society of Environmental Health
Web: http://www.sanidadambiental.com/
Founded in 1964.

SESPAS – Spanish Society of Public Health and Administration
Web: http://www.sespas.es/

An integration of several societies with more than 3500 members mainly from the central, regional, and local administrations.

SETOX – Spanish Society of Drug Addictions
Web: http://www.setox.org/

SICTA – Iberoamerican Society of Contamination and Environmental Toxicology
Web: http://www.ehu.es/sicta/english/2.htm#HASIERA

Poison Control and Information Centers

Poison and information centers provide advice to medical professionals and members of the public about the risk and treatment of the exposure to chemicals.

CADIME – Andalusian Centre of Documentation and Information on Pharmaceuticals
Web: http://www.easp.es/web/cadime/index.asp?idSub=303&idSec=303&idCab=303

CEVIME-MIEZ – Vasque Centre of Information on Medicines
Web: http://www.osasun.ejgv.euskadi.net/r52-478/es/contenidos/informacion/presentacion_cevime/es_1219/indice_c.html

CIMEX – Pharmaceuticals Information Center of Extremadura
Web: http://e2salud.juntaextremadura.net/dgfics/cimex/cimex.htm

Database on Medicines. Consejo General de Colegios Oficiales de Farmacéuticos
Web: http://www.portalfarma.com

National Plan on Drugs. Ministry of Health and Consumer Issues
Web: http://www.pnsd.msc.es/ (English)
Web: http://www.pnsd.msc.es/en/home.htm (Spanish)

Complete national program against addictive drugs.

Toxicological Information Service
National Institute of Toxicology and Forensic Sciences.
C/ Luis Cabrera n° 9, 28002 Madrid
Phone: 91-562-0420
Web: http://www.mju.es/toxicologia

Unit of Clinical Toxicology
Serve d' Urgències, Hospital Clinic, Barcelona
C/Villarroel 170, 08036 Barcelona
Web: http://www.hospitalclinic.org/

Unit of Clinical Toxicology
Clinic Hospital Zaragoza Lozano Blesa
Avda. San Juan Bosco 15, 50009 Zaragoza
Web: http://www.hcu-lblesa.es/

Unit of Clinical Toxicology
Hospital Rio Ortega
Avda. Santa Teresa, s/n

Unit of Clinical Toxicology
Hospital Son Dureta, Palma de Mallorca
Web: http://www.hsd.es/

Valladolid
Web: http://www.iecscyl.com/modules/news/index.php?storytopic=30

Veterinary and Forensic Toxicology Service
University of Murcia
Phone: 968-36-4317/7022
Fax: 968-36-4317
Email: toxvet@um.es
Web: http://www.um.es/grupos/grupo-toxicologia/servtoxicologia.php

Legislation

In Spain, a number of laws dealing with chemical compounds provide the legal authority for control and intervention by public institutions. It is necessary to carry out a risk assessment on the notified substances to identify possible toxicological and ecotoxicological effects and the potential for human and environmental exposure. Although handling of chemical compounds is regulated by national legislation, Spanish legislation must be harmonized with legislation in the European Union, and guidelines of the European Union have bindingly to be adopted by national regulation. Specific legislation has been developed for different categories of substances. The major categories are industrial chemicals, pesticides, food additives, feed additives, and biocides. The most relevant laws and regulations dealing with chemical compounds are described here or can be accessed in the link: http://www.msc.es/ciudadanos/saludAmbLaboral/prodQuimicos/legislacion.htm.

Dangerous substances
The Council Directive 67/548/EEC, on the approximation of the laws, regulations and administrative provisions relating to the classification, packaging, and labeling of dangerous substances, was amended several times and was adapted many times to the technical and scientific progress. It was mainly included in the Spanish Royal Decree 363/1995. However, the Spanish legislation on chemicals is adapting to the absolute new EU regulatory framework for the Registration, Evaluation and Authorization of Chemicals (REACH). The aim is to improve the protection of human health and the environment through the better and earlier identification of the properties of chemical substances. At the same time, innovative capability and competitiveness of the EU chemicals industry should be enhanced. REACH gives greater responsibility to industry to manage the risks from chemicals and to provide safety information on the substances. Manufacturers and importers are required to gather information on the properties of their substances, which will help them manage them safely, and to register the information in a central database in which consumers and professionals can find hazard information.

Restriction of substances
The Council Directive 76/769/EEC on the approximation of the laws, regulations, and administrative provisions of the Member States relating to restrictions on the marketing and use of certain dangerous substance and preparations was mainly translated into the Spanish Royal Decree 1406/1989.

Dangerous preparations
The Directive 1999/45/EC of the European Parliament and of the Council concerning the approximation of the laws, regulations and administrative provisions of the Member States relating to the classification, packaging and labeling of dangerous preparations was included in the Spanish Royal Decree 255/2003.

Accident hazards
The Council Directive 96/82/EC on the control of major-accident hazards involving dangerous substances

(Seveso) is mainly included in the Spanish Royal Decree 1254/1999 and Royal Decree 119/2005.

Product safety
The Directive 2001/95/EC of the European Parliament and of the Council on general product safety is included in the Spanish Decree 1801/2003.

Human pharmaceuticals
The Directive 65/65/EEC on the approximation of provisions laid down by law, regulation, or administrative action relating to proprietary medicinal products is presently included in the Spanish Law 25/1990.

Veterinary pharmaceuticals
The Council Directive 81/851/EEC on the approximation of the laws of the Member States relating to veterinary medicinal product is included in the Spanish Law 13/2007.

Cosmetics
The Council Directive 76/768/EEC on the approximation of the laws of the Member States relating to cosmetic products is reflected in the Spanish Royal Decree 1599/1997.

Biocides (non-agricultural pesticides)
The Directive 98/8/EC of the European Parliament and of the Council of concerning the placing of biocidal products on the market is included in the Royal Decree 1054/2002.

Pesticides
Council Directive 91/414/EEC concerning the placing of plant protection products on the market is included in Royal Decree 2163/1994.

Food additives
The Commission Directive 96/77/EC laying down specific purity criteria on food additives other than colors and sweeteners is included in the Royal Decree 142/2002.

Feed additives
The Regulation (EC) No 1831/2003 of the European Parliament and of the Council on additives for use in animal nutrition was translated to the Spanish Royal Decree 893/2005.

Toys safety
The Council Directive 88/378/EEC on the approximation of the laws of the Member States concerning the safety of toys is included in Royal Decree 880/1990.

Animal protection
The Council Directive 86/609/EEC on the approximation of laws, regulations, and administrative provisions of the Member States regarding the protection of animals used for experimental and other scientific purposes is at the present included in the Royal Decree 2001/2005.

Good laboratory practices
The Directive 2004/10/EC of the European Parliament and of the Council on the harmonization of laws, regulations, and administrative provisions relating to the application of the principles of good laboratory practice and the verification of their applications for tests on chemical substances is included in Royal Decrees 822/1993, 1369/2000 and 2043/1994.

Worker protection
The Council Directive 80/1107/EEC on the protection of workers from the risks related to exposure to chemical, physical, and biological agents at work was translated into the Royal Decree 374/2001. They include the admissible exposure levels in the working atmosphere.

Carcinogens
The Council Directive 90/394/EEC on the protection of workers from the risks related to exposure to carcinogens at work was translated into Royal Decree 665/1997.

Water
The Council Directive 98/83/EC on the quality of water intended for human consumption, was included into the Royal Decree 140/2003, and the Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for Community action in the field of water policy, into the Royal Decree 1/2001.

Pollution control
The Council Directive 2008/1/EC of concerning integrated pollution prevention and control was initiated in the Spanish Law 16/2002.

Waste
The Council Directive 75/442/EEC on waste was included in the Spanish Law 10/1998.

Emissions
For example, the Directive 97/68/EC of the European Parliament and of the Council on the approximation of the laws of the Member States relating to measures against the emission of gaseous and particulate pollutants from internal combustion engines to be installed in non-road mobile machinery is related to the Spanish Law 34/2007.

Ionizing radiation
Council Directive 97/43/Euratom on health protection of individuals against the dangers of ionizing radiation in relation to medical exposure, and repealing Directive 84/466/Euratom are related to Royal Decree 815/2001.

Electromagnetic fields
The Directive 2004/40/EC of the European Parliament and of the Council on the minimum health and safety requirements regarding the exposure of workers to the risks arising from physical agents (electromagnetic fields) is related to the Spanish Royal Decree 1066/2001.

Noise
The Directive 2002/49/EC of the European Parliament and of the Council relating to the assessment and management of environmental noise – Declaration by the Commission in the Conciliation Committee on the Directive relating to the assessment and management of environmental noise is included in the Spanish Law 37/2003.

Doping
The Resolution of the Council and of the representatives of the Governments of the Member States, meeting within the Council on a code of conduct against doping in sport in 1992 and other regulations recommended by the Mundial Agency against Doping and UNESCO are followed in Spain within the Law 10/1990 of the sport, and the Organic Law 7/2006 of the protection of health and against doping in sport.

Illicit drugs
The Regulation (EC) No 273/2004 of the European Parliament and of the Council on drug precursors is regulated through the Spanish Law 3/1996 and modifications.

Miscellaneous Resources

3Erres. List of alternatives to animals
Web: http://www.rediris.es/list/info/3erres.es.html
http://www.rediris.es/list/info/3erres.html

Forum in Spanish about the development, validation and acceptance of alternative methods to animal use.

Alternativas.info
Find alternatives to laboratory animals.
Web: http://busca.alternativas.com

Bibliotoxi
Virtual library on Toxicology.
Web: http://busca-tox.com/bibliotoxi.htm

BUSCATOX
Searching for toxicological information: a practical learning project.
Web: http://busca-tox.com

Toxicologists of the XXI century have to be able to search and use with efficiency the exponentially growing toxicological information. Most of the data are now freely available on the Internet. A specific practical project was developed for established toxicologists and for students of toxicology. The system facilitates the differentiation among the various types of sources of toxicological information, their localization, interpretation, and use in diverse toxicological areas (regulatory, occupational, clinical, experimental, environmental, etc.).

Chemical Products
Ministry of Health and Consumer Issues
Web: http://www.msc.es/en/ciudadanos/saludAmbLaboral

Main information about the legislation and resources dedicated to assure the adequate classification, labeling, and use of chemicals.

Ecosalud
The impact of the environment on the health.
Web: http://www.rediris.es/list/info/ecosalud.es.html

Emecas
List of atmospheric pollutants and health.
Web: http://www.rediris.es/list/info/emecas.es.html

Endocrine Disruptors University of Granada (Disruptores Endocrinos, Universidad de Granada)
Web: http://disruptor.ugr.es/

Farmacol
List of pharmacology
Web: http://www.rediris.es/list/info/farmacol.es.html

Farmatoxi – Network on Pharmacology and Toxicology (Farmatoxi – Red Temática de Farmacología y Toxicología)
Web: http://farmatoxi.rediris.es/

Forgen – List of Forensic Genetics (Forgen – Foro de Genética Forense)
Web: http://www.rediris.es/list/info/forgen.es.html

Integrate Prevention
Web: http://www.prevencionintegral.com/

News, legislation, and articles about occupational prevention activities.

Journal Digital Health
Web: http://www.sanidaddigital.org

A very complete website with information related to the epidemiological network of the region of Extremadura and news about food and biocides.

National Network for the Vigilance, Inspection and Control of Chemical Products. Ministry of Health and Consumer Issues
Web: http://www.msc.es/ciudadanos/saludAmbLaboral

Network for the surveillance and control of the use of chemicals and to the prevention of the risks derived from the exposure to substances. Includes a bulletin with information, the programs in collaboration with the European Union (NONS, SENSE, EUREX, EUROCAD, ECLIPS, CLEEN) and the different regions (MISACO), a toxic surveillance system with reports from poisonings and accidents, and the alert network for rapid interchange of information.

National Plan on Drugs
Web: http://www.pnsd.msc.es/

Newspaper of Food Safety – Consumaseguridad.com
Web: http://www.consumaseguridad.com/

Prevention World
Web: http://www.prevention-world.com/

Products, software, news, legislation, and articles about occupational prevention activities.

Spanish National Research Network
Web: http://www.rediris.es/index.en.html
http://www.rediris.es/

Techno science
Web: http://www.tecnociencia.es/fecyt/public/index.jsp

Information about science and technique.

The drugs.net
Web: http://www.lasdrogas.info

Directory of Internet resources on drugs addictions.

Toxicol – List of Toxicology
Web: http://www.rediris.es/list/info/toxicol.html
http://www.rediris.es/list/info/toxicol.html

Forum in Spanish about news and developments in toxicology.

Toxicosurveillance System. Ministry of Health and Consumer Issues
Web: http://www.msc.es/ciudadanos/saludAmbLaboral/prodQuimicos/sustPreparatorias/rednacVigi/toxicoVigilancia.htm

A network for toxicosurveillance purposes.

Virtual Health Library
Web: http://bvs.isciii.es/i/index.php0010300103

CHAPTER

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Sweden

LARS WIKLUND

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INTRODUCTION

In Sweden, toxicology, ecotoxicology, health and environmental risk assessment are disciplines at various universities and colleges and also at research institutions connected to central authorities and in clinics for environmental and occupational medicine. Toxicology in Sweden is concentrated in the Stockholm-Uppsala area. The main center for education and training in toxicology and health risk assessment is the Institute of Environmental Medicine (IMM), Karolinska Institutet, Stockholm, while Uppsala University offers Sweden's most extensive education within ecotoxicology.

HISTORICAL NOTES IN SWEDISH TOXICOLOGY*

1663: The earliest regulations regarding the handling of poisons were announced via the medical legislation. In 1663 the 'Kungl. Maj:t' (Swedish Government) issued a charter for *Collegium medicorum*, resulting in the public recognition of certain physicians in Stockholm.

1707: Johan Linder, MD (1678–1724), later raised to the nobility Lindestolpe, published the first Swedish monograph in toxicology: *De Venesis* ('About poisons').

Carl Wilhelm Scheele (1742–1786), a chemist and a pharmacist was the discoverer of many chemical substances, most notably said to have discovered oxygen and chlorine. Like many other chemists of his time, Scheele often worked under difficult and even dangerous conditions. Also, he had a habit of tasting chemicals that he found. It appears that this, together with frequent exposure to poisonous chemicals, was the cause of his premature death at the age of 43. At the end of his life he showed symptoms resembling mercury poisoning.

1773: Carl Peter Thunberg, a student and successor of Carl von Linné (1707–1778), sends a letter from his journey to Japan to the Swedish Academy of Sciences, describing poisoning with white lead, accidentally contaminating food.

1810: Karolinska Institutet (KI) was founded. A letter from King Karl XIII to the *Collegium Medicum* authorized the immediate establishment of a 'college for the corps of field surgeons'. The name *Medico Chirurgiska Institutet* was established in 1811 and *Carolinska* was added in 1822. In 1811 Jöns Jacob Berzelius (1779–1848) became one of KI's first professors and laid the foundation for the Institute's natural-scientific orientation. In 1895, Alfred Nobel (1833–1896) appointed Karolinska Institutet to award the annual Nobel Prize in Physiology or Medicine.

1845: NJ Berlin (1812–1891), the last student of Jöns Jacob Berzelius, published a book with the title: 'Anvisning till de allmännaste gifters upptäckande på kemisk väg – För Läkare och Apotekare' (Instructions for the chemical detection of the most general poisons – For physicians and pharmacists).

1850: On behalf of 'Kungl. Maj:t' (Swedish Government), the 'Sundhetskollegium' (something like: 'the Health teaching-staff') give a proposal for a poison regulation ('giftlagstiftning').

*Parts of the historical notes cited from: Holmstedt B, Malmfors T, Svensk Förening för Toxikologi, 1969–1994, Historiska återblickar, Stockholm, Maj 1994 and Lemne M, Bergendorff A, Toxikologi – Utbildning, forskning, testning, UHÄ-rapport 1982: 26.

1872: 'Kungl. Maj:t' (Swedish Government) decides that a position for forensic chemistry should be established, followed by changes in regulations for investigations of poisons at post-mortem examination of corpse. The first holder of this position was Nils Peter Hamberg (1815–1902). The position was later gradually developed to 'Statens rättskemiska laboratorium' (Swedish National Laboratory of Forensic Chemistry).

1876: Ordinance regarding care and the selling of arsenic and other poisonous substances and products is published in 'Svensk författningssamling' (Swedish Code of Statutes).

1889: The Riksdag (Swedish Parliament) approve a law on occupational risks. The first labor inspectors are appointed.

1900–1919: Possible arsenic poisoning from paints and wallpaper in houses. Development of new analytical methods indicating arsenic in blood, urine and spinal fluid, and the presence of organic arsenic.

1906: In the 'Giftstadga' (regulation on poisons) the poisons are divided in two classes: poisons of first degree and poisons of second degree.

1930: Erik MP Widmark (1889–1945) publishes a method for the quantification of alcohol in blood. His research on the absorption, distribution, and elimination of ethanol in the body was very influential on forensic alcohol analysis and toxicology, and paved the way for innovative traffic safety legislation that stipulated punishable limits of alcohol in the blood of a person driving a car.

1930–1939: Carl Gustav Santesson (1862–1939), professor in pharmacology at Karolinska Institutet, is studying the mechanisms of action of arrow poisons and hallucinogenic natural products.

1939–1941: 'Statens institute för folkhälsa' (Swedish Institute for Public Health) was established. Important findings regarding metal toxicity was published. The institute was closed in 1971.

1943: A new 'Giftstadga' (Poison Control Act) was launched.

1958: Karl Borg, at the National Veterinary Institute (Statens Veterinärmedicinska Anstalt, SVA) demonstrates high levels of methyl mercury from pesticide-treated seeds in seed-eating birds.

TOXICOLOGY BECOMES ORGANIZED

Toxicology in Sweden received an organized form in the 1960s. In 1963 the Poison Board (Giftnämnden) was established, and was later replaced with the Products Control Board (Produktkontrollnämnden), that became the Swedish Chemicals Agency (KemI) in 1986. In 1964 the medical research council established a research group in toxicology, which was later reorganized to the department of toxicology at Karolinska Institutet. The European Society of Toxicology (EST) had its annual conference in Stockholm in 1965: 'Experimental studies and clinical experience. The assessment of risk'.

The scientific community in Sweden has for long time provided important contributions for improved awareness of chemical risks and environmental protection. Swedish scientists, for instance, focused attention on the health hazards from organic mercury compounds used in agriculture several years before the Minimata poisonings in Japan brought those problems to the attention of the rest of the world. In 1966, PCBs were identified for the first time in wild animals in the Baltic, and later also in humans, by the scientist Sören Jensen, Stockholm University. In 1971 the first legal step to restrict PCB use in Sweden was taken (the Act on PCB), and legislation and bans were soon followed in many other countries. The Swedish Ordinance on PCB was revised in 1989 and a final time limit for the use of existing PCBs was set to January 1st 1995.

Other Swedish milestones include the establishment of the Swedish Society of Toxicology (SFT) in 1969, although not formally formed until year 1977/78. Prof. Bo Holmstedt was the first president of SFT (1978–1979) and later elected as its first honorary member. The Swedish Society of Toxicology attracts individuals from many areas of toxicology, and the number of members in SFT is currently approximately 400.

Karolinska Institutet began special education in toxicology in 1973. In 1976 this education was expanded to a Masters training program in toxicology, at that time the first cohesive toxicology educational program in Europe. Among the initiators of this unique toxicology program ('Toxikologutbildningen') were Prof Bo Holmstedt, Prof Sten Orrenius, Ass. Prof Torbjörn Malmfors and Dr Anders Bergendorff, all later elected as honorary members of SFT.

Bo Holmstedt (1918–2001) was a prominent toxicologist both nationally and internationally, well-known in the toxicology community for his outstanding research, engagement in education, contributions to toxicological organizations and with a role as a leading authority in toxicological evaluation. He became Sweden's first professor in toxicology in 1964, and in 1974 he was elected to the Swedish Royal Academy of Sciences. He held several international leading positions, most prestigious President of the International Union of Toxicology, IUTOX (1983–1986).

Sten Orrenius has been on the staff of Karolinska Institutet in various positions since 1967 (Professor of Forensic Medicine, Professor of Toxicology and

Director of the Institute of Environmental Medicine (IMM)). He was also Dean of the medical school 1980–1987, and member of the Karolinska Institutet Nobel Assembly 1971–2002. He holds honorary memberships in several international societies, and is also a member of the Royal Swedish Academy of Sciences. Sten Orrenius was president of SFT 1979–1981.

Torbjörn Malmfors, Malmfors Consulting AB, received his PhD at Karolinska Institutet in 1965. Torbjörn Malmfors has been instrumental in many international and national toxicological educational activities with a particularly focus on risk assessment. A major educational initiative he started in 1985 is the Risk Assessment Summer School (RASS), a program of the IUTOX, with Torbjörn Malmfors as the course director. Other successful educational initiatives include BTox, a toxicology education program in Estonia, Latvia, and Lithuania, and STox in Slovenia. Torbjörn Malmfors has been active in various toxicological societies, e.g. President of SFT (1983–1986), Secretary General of the Federation of European Societies of Toxicology (FEST), and Treasurer of IUTOX.

Anders Bergendorff has from the start of the masters training program in toxicology at Karolinska Institutet in 1976 up to his retirement in 2003, served as the Director of Studies, and he has been the prominent person for this united and broad education in toxicology. During all the years Anders Bergendorff has successfully managed the program, and also introduced renewals and developments in order to maintain and improve the high quality. Anders Bergendorff was the secretary of SFT 1983–1988.

The contributions and commitment to the educational activities from all these initiators of the first toxicology program at KI have been exceedingly important for promoting the competence, knowledge, and development of toxicology in Sweden.

In 1986 the Swedish Chemicals Agency was formed and in 1993 the Eurotox conference: 'Use of mechanistic information in risk assessment' was held in Uppsala.

Today the science of toxicology and ecotoxicology as well as health and environmental risk/safety assessments are natural parts of the Swedish society, e.g. at universities, governmental and non-governmental organizations, industries, etc. In 1999 and 2005 the Swedish Parliament adopted 16 national environmental quality objectives. The environmental quality objectives create a transparent and stable framework for environmental programs and initiatives, and serve to guide such efforts at various levels in society. 'A non-toxic environment', one of these objectives, aims to reduce health and environmental risks associated with the manufacture and use of chemical substances. The Swedish Chemicals Agency is the responsible agency for this objective.

Journals

Arbete och Hälsa
ISSN: 0346-7821
Web: http://www.medicine.gu.se/avdelningar/samhallsmedicin_folkhalsa/amm/aoh (Swedish)

Arbete och Hälsa is a scientific report series previously published by the National Institute for Working Life. As this Institute was closed down in 2007, *Arbete och Hälsa* was transferred to the Section of Occupational and Environmental Medicine at Göteborg University. The series publishes scientific original works, dissertations, criteria documents and literature surveys. Part of this scientific series contains the criteria documents of the Nordic Expert Group and the Criteria Group of the Swedish National Institute for Working Life.

In Sweden there are no special journals in the field of toxicology. One of the reasons for not having journals strictly in Swedish is the fact that the Nordic (Scandinavian) countries cooperate in publishing journals, e.g. *Pharmacology and Toxicology* (ISSN: 0901-9928) and *Scandinavian Journal of Work, Environment & Health* (ISSN: 0355-3140) (http://www.sjweh.fi/index.php).

Databases

Several databases are provided, produced, or administrated by different Swedish regulatory agencies. The Swedish Chemicals Agency (KemI) provides databases with information on chemical substances, toxicology and risk assessment, as well as regulatory information about chemicals (Riskline, N-Class, SPIN etc.). The library of Karolinska Institutet provides many databases related to medicine and toxicology, some with Swedish origin, e.g. SweMed+. Information of the databases is found under each of the organizations providing databases.

Organizations (government)

Ministries

Each ministry is responsible for a number of central government agencies. It is these agencies that are responsible for the day-to-day operations of public administration. The Government establishes objectives, guidelines, and the allocation of resources for the agencies' activities, but it does not decide how the agencies are to apply a law or interfere with decisions made in different matters. Only agencies with relevance on

toxicology and environmental issues are included in this overview.

Ministry of Agriculture (Jordbruksdepartementet)
Postal address: SE-103 33 Stockholm, Sweden
Address: Fredsgatan 8, Stockholm
Phone: +46-8-405-10-00
Web: http://www.sweden.gov.se/sb/d/2064; jsessionid=a5ZxPZiopFVc (English)
Web: http://www.regeringen.se/sb/d/1473 (Swedish)

Agencies for which the Ministry of Agriculture, is principal:
The Swedish Board of Agriculture (Jordbruksverket)
Swedish National Food Administration (Livsmedelsverket)
Swedish University of Agricultural Sciences (Sveriges lantbruksuniversitet, SLU)
National Veterinary Institute (Statens veterinärmedicinska anstalt, SVA)

Ministry of Culture (Kulturdepartementet)
Postal address: SE-103 33 Stockholm, Sweden
Address: Drottninggatan 16, Stockholm
Phone (switchboard): +46-8-405-10-00
Web: http://www.sweden.gov.se/sb/d/8371 (English)
Web: http://www.regeringen.se/sb/d/8339 (Swedish)

Agency for which the Ministry of Culture is principal:
The Swedish Museum of Natural History

Ministry of Defense (Försvarsdepartementet)
Postal address: SE-103 33 Stockholm, Sweden
Address: Jakobsgatan 9, Stockholm
Phone (switchboard): +46-8-405-10-00
Web: http://www.sweden.gov.se/sb/d/2060 (English)
Web: http://www.regeringen.se/sb/d/495 (Swedish)

Agencies for which the Ministry of Defense is principal:
Swedish Defense Research Agency, FOI, (Totalförsvarets forskningsinstitut)
Swedish Rescue Services Agency (Räddningsverket)

Ministry of Education and Research (Utbildningsdepartementet)
Postal address: SE-103 33 Stockholm, Sweden
Address: Drottninggatan 16, Stockholm
Phone (switchboard): +46-8-405-10-00
Web: http://www.sweden.gov.se/sb/d/2063 (English)
Web: http://www.regeringen.se/sb/d/1454 (Swedish)

Agency for which the Ministry of Education and Research is principal:
The Swedish Research Council (Vetenskapsrådet)

Ministry of Employment (Arbetsmarknadsdepartementet)
Postal address: SE-103 33 Stockholm, Sweden
Address: Jakobsgatan 26, Stockholm
Phone: +46-8-405-10-00
Web: http://www.sweden.gov.se/sb/d/8281; jsessionid=aF8NValR9UW5 (English)
Web: http://www.regeringen.se/sb/d/8270 (Swedish)

Agencies for which the Ministry of Employment is principal:
National Institute for Working Life (Arbetslivsinstitutet) (The National Institute for Working Life was closed in 2007)
Swedish Work Environment Authority (Arbetsmiljöverket)

Ministry of Enterprise, Energy and Communications (Näringsdepartementet)
Postal address: SE-103 33 Stockholm, Sweden
Address: Jakobsgatan 26, Stockholm
Phone: +46-8-405-10-00
Web: http://www.sweden.gov.se/sb/d/2067 (English)
Web: http://www.regeringen.se/sb/d/1470 (Swedish)

Agency for which the Ministry of Enterprise, Energy and Communications is principal:
VINNOVA, The Swedish Agency for Innovation Systems (Verket för innovationssystem)

Ministry of the Environment (Miljödepartementet)
Postal address: SE-103 33 Stockholm, Sweden
Address: Tegelbacken 2, Stockholm
Phone (switchboard): +46-8-405-10-00
Web: http://www.sweden.gov.se/sb/d/2066; jsessionid=a24XKpf2tE65 (English)
Web: http://www.regeringen.se/sb/d/1471 (Swedish)

Agency for which the Ministry of Environment is principal:
FORMAS, The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning
Swedish Chemicals Agency (Kemikalieinspektionen)
The Swedish Environmental Protection Agency (Naturvårdsverket)
The Swedish Radiation Safety Authority (Strålsäkerhetsmyndigheten, SSM)

Ministry for Foreign Affairs (Utrikesdepartementet)
Postal address: SE-103 39 Stockholm, Sweden
Address: Gustav Adolfs torg 1, Stockholm
Phone (switchboard): +46-8-405-10-00
Web: http://www.sweden.gov.se/sb/d/2059; jsessionid=alkgbgNxoyo_ (English)
Web: http://www.regeringen.se/sb/d/1475 (Swedish)

Agency for which the Ministry of Foreign Affairs is principal:
SWEDAC, The Swedish Board for Accreditation and Conformity Assessment

Ministry of Health and Social Affairs (Socialdepartementet)
Postal address: SE-103 33 Stockholm, Sweden
Address: Fredsgatan 8, Stockholm
Phone (switchboard): +46-8-405-10-00
Web: http://www.sweden.gov.se/sb/d/2061 (English)
Web: http://www.regeringen.se/sb/d/1474 (Swedish)

Agencies for which the Ministry of Health and Social Affairs is principal:
Medical Products Agency (MPA) (Läkemedelsverket)
National Board of Health and Welfare (NBHW) (Socialstyrelsen)
Swedish National Institute of Public Health (SNIPH) (Statens Folkälsoinstitut)
Swedish Council for Working Life and Social Research (Forskningsrådet för arbetsliv och socialvetenskap, FAS)

Ministry of Integration and Gender Equality (Integrations – och jämställdhetsdepartementet)
Postal address: SE-103 33 Stockholm, Sweden
Address: Fredsgatan 8, Stockholm
Phone (switchboard): +46-8-405-10-00
Web: http://www.sweden.gov.se/sb/d/8366 (English)
Web: http://www.regeringen.se/sb/d/8324 (Swedish)

Agency for which the Ministry of Integration and Gender Equality is principal:
The Swedish Consumer Agency (Konsumentverket)

Ministry of Justice (Justitiedepartementet)
Postal address: SE-103 33 Stockholm, Sweden
Address: Rosenbad 4, Stockholm
Phone (switchboard): +46-8-405-10-00
Web: http://www.sweden.gov.se/sb/d/584 (English)
Web: http://www.regeringen.se/sb/d/1476 (Swedish)

Agency for which the Ministry of Justice is principal:
The Swedish Gene Technology Advisory Board (Gentekniknämnden)

Governmental agencies

FORMAS, Swedish Research Council for Environment, Agricultural Sciences and Spatial planning (Forskningsrådet för miljö, areella näringar och samhällsbyggande)
Postal address: P.O. Box 1206, SE-111 82 Stockholm, Sweden
Address: Kungsbron 21, Stockholm
Phone: +46-8-775-40-00
Email: info@formas.se
Web: http://www.formas.se/default____529.asp (English)
Web: http://www.formas.se/default____182.aspx (Swedish)

FORMAS is a governmental research-funding agency related to several ministries which supports and disseminates information on research within its areas of responsibility. The Council promotes growth within the framework of an ecologically sustainable development.

Medical Products Agency, MPA (Läkemedelsverket)
Postal address: Medical Products Agency, P.O. Box 26, SE-751 03 Uppsala, Sweden
Address: Uppsala Science Park, Dag Hammarskjölds väg 42, Uppsala
Phone: +46-18-17-46-00
Web: http://www.lakemedelsverket.se/Tpl/StartPage____395.aspx (English)
Web: http://www.lakemedelsverket.se/Tpl/StartPage____3.aspx (Swedish)

The Medical Products Agency is responsible for regulation and surveillance of the development, manufacturing, and sale of drugs and other medicinal products. The control and supervision of the Agency concerns three main product areas: Medicinal Products, Cosmetic and Hygiene Products, and Medical Technical Products. Its operations are largely financed through fees.

National Board of Health and Welfare (NBHW) (Socialstyrelsen)
Postal address: Socialstyrelsen, SE-106 30 Stockholm, Sweden
Address: Rålambsvägen 3, Stockholm
Phone: +46-8-555-530-00
Email: socialstyrelsen@socialstyrelsen.se
Web: http://www.socialstyrelsen.se/en/ (English)
Web: http://www.socialstyrelsen.se/ (Swedish)

The National Board of Health and Welfare is a government agency under the Ministry of Health and Social Affairs, with a very wide range of activities and many different duties within the fields of social services, health and medical services, environmental health, communicable disease prevention and control and epidemiology.

National Food Administration (Livsmedelsverket)
Postal address: The National Food Administration, P.O. Box 622, SE-751 26 Uppsala, Sweden
Address: Hamnesplanaden 5, Uppsala
Phone: +46-18-17-55-00
Email: livsmedelsverket@slv.se
Web: http://www.slv.se/default.aspx?id=231&epslanguage=EN-GB (English)

Web: http://www.slv.se/ (Swedish)

The National Food Administration (NFA) is the central administrative authority for matters concerning food, including drinking water. The NFA has the task of protecting the interests of the consumer by working for safe food of good quality, fair practices in the food trade, and healthy eating habits. The NFA's work is to a large extent based on international co-operation, especially within the EU.

National Institute for Working Life (Arbetslivsinstitutet)

As of July 1, 2007, the National Institute for Working Life was closed down permanently.
Web: http://www.arbetslivsinstitutet.se/en/ (English)
Web: http://www.arbetslivsinstitutet.se/ (Swedish)

Library of the National Institute For Working Life:
The book collections were moved to the Stockholm University Library (www.sub.su.se).
Publication services:

Many of the Institutes publications are available by new owners, see (http://www.arbetslivsinstitutet.se/en/publications.asp).
Database developed by the National Institute for Working Life:

Arbline

Arbline is a bibliographic database in the field of occupational environment, and is available online at Karolinska Institutet University Library, and at the Stockholm University.

National Veterinary Institute (Statens Veterinärmedicinska Anstalt, SVA)

Postal address: National Veterinary Institute, SVA, SE-751 89 Uppsala, Sweden
Address: Ulls väg 2B, Uppsala
Phone: +46-18-67-40-00
Email: sva@sva.se
Web: http://www.sva.se/en/Startpage/ (English)
Web: http://www.sva.se/ (Swedish)

The National Veterinary Institute (SVA) is a Swedish national authority that strives for good animal and human health, a good environment, and sustainable food production. The most important role of SVA is to align the activities towards contagious and other serious infectious diseases of animals that imply a threat to supplies of animal foodstuffs, that lead to losses for the production of animals, that concern pets, or involve diseases that can be transferred to humans, i.e., zoonoses.

SWEDAC, The Swedish Board for Accreditation and Conformity Assessment (Styrelsen för ackreditering och teknisk kontroll)

Postal addresses: Head office: P.O. Box 878, 501 15 Borås, Sweden
Stockholm office: P.O. Box 2231, 103 15 Stockholm, Sweden
Addresses: Head office: Österlånggatan 5, Borås
Stockholm office: Slussplan 9, Stockholm
Phone: Borås: +46-33-17-77-00
Stockholm: +46-8-406-83-00
Email: registrator@swedac.se
Web: http://www.swedac.se/sdd/System.nsf/(GUIview)/index_eng.html (English)
Web: http://www.swedac.se/sdd/System.nsf/(GUIview)/index.html (Swedish)

SWEDAC is a public authority under the Ministry for Foreign Affairs. SWEDAC is the national accreditation body, assessing the competence of laboratories, certification and inspection bodies. SWEDAC is also the public authority responsible for regulations and surveillance in the field of legal metrology.

The Swedish Board of Agriculture (Jordbruksverket)

Address: Jordbruksverket, SE-551 82 Jönköping, Sweden
Phone: +46-36-15-50-00
Email: jordbruksverket@sjv.se
Web: http://www.sjv.se/home.4.7502f61001ea08a0c7fff125607.html (English)
Web: http://www.sjv.se/2.7502f61001ea08a0c7fff3.html (Swedish)

The Swedish Board of Agriculture is the Government's expert authority in the field of agricultural and food policy, and the authority responsible for the sector's agriculture, horticulture and reindeer husbandry. Its responsibility includes monitoring, analyzing, and reporting to the Government on developments in these areas, and implementing policy decisions within its designated field of activities. The Board is also responsible for the assessment of animal research, in terms of ethics, and the allocation of research assistance to alternative research methods (transferred from the former Swedish Animal Welfare Agency (Djurskyddsmyndigheten) that was in operation 2004–2007).

Swedish Chemicals Agency (Kemikalieinspektionen, KemI)

Postal address: Swedish Chemicals Agency, P.O. Box 2, SE-172 13 Sundbyberg, Sweden
Address: Esplanaden 3A, Sundbyberg

Phone (switchboard): +46-8-519-41-100
Email: kemi@kemi.se
Web: http://www.kemi.se/default____550.aspx (English)
Web: http://www.kemi.se/ (Swedish)

The Swedish Chemicals Agency (KemI) is a supervisory authority under the Ministry of the Environment. KemI works to prevent damage to people and the environment caused by chemical and biotechnological products. The vision is for future generations to be able to live healthily in a good environment in a sustainable society. KemI works in Sweden and in the EU to promote legislation and rules that contribute to achieving the environmental quality objective of 'A non-toxic environment'.

The Swedish Chemicals Agency (KemI): keeps a product register; maintains a number of databases; approves pesticides; assesses the risk of chemicals; checks companies' compliance with applicable regulations; provides support to local authorities; provides support to other countries; issues reports, publications and a journal; arranges seminars; and provides statistical information on chemicals.

Selected databases provided by KemI:
N-Class – Database on Environmental Hazard Classification Web: http://apps.kemi.se/nclass/default.asp

The N-Class Database contains information on the classifications of more than 7000 substances. The data primarily concern environmental effects constituting the basis for classifications and classification proposals. Classifications of fire and health hazards are also included.

PRIO – A web-based tool for risk reduction of chemicals
Web: http://www.kemi.se/templates/PRIOEngframes____4144.aspx

A web-based tool intended to be used to preventively reduce risks to human health and the environment from chemicals.

Riskline – A bibliographic toxicology database
Web: http://apps.kemi.se/riskline/index.htm

Riskline contains over 7000 bibliographical references to peer-reviewed information on approximately 3000 chemical substances. It is the only existing bibliographic database containing solely peer-reviewed/expert group international information in complete series. Riskline contains information on both environmental effects/ecotoxicology and health effects/toxicology.

Riskline is available online at http://www.kemi.se/default____550.aspx, and as a subfile of the US TOXLINE at the National Library of Medicine (NLM), Washington, DC, USA (http://toxnet.nlm.nih.gov/index.html).

SPIN (Substances in Preparations in Nordic Countries) database
Web: http://195.215.251.229/DotNetNuke/default.aspx

The SPIN database contains information on products on the market reported to each of the Nordic products registers. SPIN also contains data on amounts of substances and in what products and sectors the substances are used.

The Swedish Consumer Agency (Konsumentverket)
Postal address: P.O. Box 48, SE-651 02 Karlstad, Sweden
Address: Lagergrens gata 8, Karlstad
Phone: +46-54-19-41-50
Email: konsumentverket@konsumentverket.se
Web: http://www.konsumentverket.se/mallar/en/startsidan.asp?lngCategoryId = 646 (English)
Web: http://www.konsumentverket.se/ (Swedish)

The Swedish Consumer Agency is assigned by the government to protect the health and safety of consumers. Means to this end are the analysis of injury data, participation in European and international standardization, market control and information to consumers.

The Agency provides advice on consumer products and carries out tests on the functionality and safety of products, including chemical products such as shampoo, detergents and toys.

Swedish Council for Working Life and Social Research (Forskningsrådet för arbetsliv och socialvetenskap, FAS)
Postal address: P.O. Box 2220, SE-103 15 Stockholm, Sweden
Visiting address: Wallingatan 2, Stockholm
Phone: +46-8-775-40-70
Email: fas@fas.se
Web: http://www.fas.forskning.se/default____206.aspx (English)
Web: http://www.fas.forskning.se/default____3.aspx (Swedish)

The Swedish Council for Working Life and Social Research supports and initiates basic and needs-based research within the fields of the labor market, work organization, working environment, public health, health services, and social welfare. The Council was established in 2001 through a merger of the Swedish Council for Social Research and the Swedish Council for Work Life Research.

Swedish Defense Research Agency, FOI (Totalförsvarets forskningsinstitut)
Postal address: FOI, SE-164 90 Stockholm, Sweden
Address: Gullfossgatan 6, Kista
Phone: +46-8-555-030-00
Email: registrator@foi.se
Web: http://www.foi.se/FOI/templates/startpage____96.aspx (English)
Web: http://www.foi.se/FOI/templates/startpage____4.aspx (Swedish)

The Swedish Defense Research Agency works with research, methods and technological development and other studies for the national defense system. FOI was established in 2001 by the merger of the past authorities FOA (Försvarets Forskningsanstalt) and FFA (Flygtekniska Försöksanstalten). FOI provides expertise in many areas, e.g. assessment of different types of threats, and protection against and management of hazardous substances.

FOI conducts research operations in the Stockholm area, Linköping and Umeå. The FOI head office is situated in Kista, Stockholm.

Swedish Environmental Protection Agency (Naturvårdsverket)
Postal address: SE-106 48 Stockholm, Sweden
Address: Valhallavägen 195, Stockholm
Phone: +46-8-698-10-00
Email: natur@naturvardsverket.se
Web: http://www.naturvardsverket.se/en/In-English/Menu (English)
Web: http://www.naturvardsverket.se/sv/ (Swedish)

The Swedish Environmental Protection Agency (Swedish EPA), created in 1967, is the national agency for environmental protection and nature conservation as well as outdoor recreation and hunting issues. Its key tasks are to present proposals for environmental policy and legislation to the Swedish Government and ensure that environmental policy decisions are implemented. The Agency complies with the ISO 14001 environmental management standard and EMAS for both direct and indirect environmental impact.

The library catalogue ELIN is the Web Catalogue of the Swedish Environmental Protection Agency. The database contains more than 45 000 references to both Swedish and international literature on environmental protection and conservation.

The Swedish Gene Technology Advisory Board (Genteknikнämnden)
Address: Genteknikнämnden, Retzius väg 13 A, SE-171 77 Stockholm, Sweden
Phone: +46-8-508-846-30
Email: genteknik@genteknik.se
Web: http://www.genteknik.se/Bazment/30.aspx (English)
Web: http://www.genteknik.se/Bazment/1.aspx (Swedish)

The Gene Technology Advisory Board, established in 1994, has an overall responsibility in the field of gene technology. The Board is to monitor developments in the field of gene technology, oversee ethical issues, and give advice on use of gene technology. According to its instructions the Board is to promote an ethically defensible and safe use of gene technology by the provision of advice, so that the health of people and animals is safeguarded.

GMO Regulations in Sweden (Genvägen)
Website of the authorities responsible for the regulations of activities involving GMOs.
Address: The Swedish Board of Agriculture, SE-551 82 Jönköping, Sweden
Phone: +46-36-15-50-00
Email: genteknik@sjv.se
Web: http://www.gmo.nu/gmoenglish.4.778a5d1001f29869a7fff935.html (English)
Web: http://www.gmo.nu/2.778a5d1001f29869a7fff2.html (Swedish)

Swedish Museum of Natural History (Naturhistoriska Riksmuseet)
Postal address: The Swedish Museum of Natural History, P.O. Box 50007, SE-104 05 Stockholm, Sweden
Address: Frescativägen 40, Stockholm
Phone: +46-8-519-540-00
Web: http://www.nrm.se/2.5fdc727f10d795b1c6e80005635.html (English)
Web: http://www.nrm.se/2.1286b10fdbe80efba80001.html (Swedish)

The Swedish Museum of Natural History is an authority under the Ministry of Culture.

The Museum is a major research institute that combines a venerable tradition with modern working methods.

Department of Contaminant Research and The Environmental Specimen Bank
(Enheten för Miljögiftsforskning och Miljöprovbanken)
Postal address: Swedish Museum of Natural History, Department of Contaminant Research,
P.O. Box 50007, SE-104 05 Stockholm, Sweden
Address: Frescativägen 40 (the museum's main entrance), contact the Reception
Web: http://www.nrm.se/researchandcollections/contaminantresearch.4.5fdc727f10d795b1c6e80005704.html (English)

Web: http://www.nrm.se/forskningochsamlingar/miljogiftsforskning.4.1b7895310364fc40ba80001077.html (Swedish)

The Department of Contaminant Research is the division at the museum appointed by the Swedish Environmental Protection Agency to monitor contaminants in the Swedish natural environment and their deleterious effects on the fauna.

Swedish National Institute of Public Health, SNIPH (Statens Folkhälsoinstitut)
Postal address: SE-831 40 Östersund, Sweden
Address: Forskarens väg 3, Östersund
Phone: +46-63-19-96-00
Email: info@fhi.se
Web: http://www.fhi.se/default____1417.aspx (English)
Web: http://www.fhi.se/ (Swedish)

The Swedish National Institute of Public Health follows up, evaluates, and disseminates knowledge about methods in the field of public health and exercises supervision in the areas of alcohol, illicit drugs, and tobacco.

The Swedish Radiation Safety Authority (Strålsäkerhetsmyndigheten, SSM)
Postal address: SSI, SE-171 16 Stockholm, Sweden
Address: Solna strandväg 96, Solna
Phone: +46-8-799-40-00
Email: registrator@ssm.se
Web: http://www.stralsakerhetsmyndigheten.se/In-English/About-the-Swedish-Radiation-Safety-Authority1/ (English)
Web: http://www.stralsakerhetsmyndigheten.se/Allmanhet/ (Swedish)

The Swedish Radiation Safety Authority is a managing authority under the Ministry of the Environment since 1 July 2008, with national collective responsibility within the areas of radiation protection and nuclear safety.

The authority, took over the responsibility and tasks from the Swedish Radiation Protection Institute and the Swedish Nuclear Power Inspectorate when these ceased to exist on 30 June 2008, works towards protecting people and the environment from the harmful effects of radiation, now and in the future. The task of protecting covers both you as a private person and as a professional.

Swedish Rescue Services Agency – SRSA (Räddningsverket)
Postal address: Swedish Rescue Services Agency, SE-65180 Karlstad, Sweden
Address: Norra Klaragatan 18, Karlstad
Phone: +46-54-13-50-00
Email: srv@srv.se
Web: http://www.srv.se/templates/SRV_AreaPage____350.aspx (English)
Web: http://www.srv.se/ (Swedish)

The Swedish Rescue Services Agency (SRSA) is the central administrative authority for questions relating to rescue services and measures to prevent accidents and damage, both in Sweden and internationally.

SRSA will be closed on December 31, 2008 and on 1st January 2009 a new authority, the Swedish Civil Contingencies Agency (Myndigheten för samhällsskydd och beredskap, MSB) will come into force to strengthen Sweden's civil protection and emergency preparedness. The new authority will be responsible for unifying, coordinating, and supportive tasks prior to, during and after emergencies. Web: http://www.sou.gov.se/msb/ (Swedish)

The Swedish Research Council (Vetenskapsrådet)
Address: Swedish Research Council, Regeringsgatan 56, SE-103 78 Stockholm, Sweden
Phone: +46-8-546-44-000
Web: http://www.vr.se/2.69f66a93108e85f68d480000.html (English)
Web: http://www.vr.se/ (Swedish)

The Swedish Research Council is a government agency funding basic research of the highest scientific quality in all disciplines. The Council has a national responsibility to support and develop basic research and promote research innovation and research communication. The goal is for Sweden to be a leading nation in scientific research.

Swedish Work Environment Authority, SWEA (Arbetsmiljöverket)
Address: Ekelundsvägen 16, SE-171 84 Solna, Sweden
Phone: +46-8-730-90-00
Web: http://www.av.se/inenglish/index.aspx (English)
Web: http://www.av.se/ (Swedish)

The Swedish Work Environment Authority is the administrative authority for questions relating to the working environment. It was formed in 2001, through the merger of the ten districts of the Labor Inspectorate and the National Board of Occupational Safety and Health. The Authority's principal objective is to reduce the risks of ill health and accidents in the workplace and to improve the work environment from the physical, mental, social, and organizational viewpoints.

VINNOVA, Swedish Governmental Agency for Innovation Systems
Postal address: VINNOVA, SE-101 58 Stockholm, Sweden
Address: Mäster Samuelsgatan 56, Stockholm
Phone: +46-8-473-30-00

Email: vinnova@vinnova.se
Web: http://www.vinnova.se/In-English/ (English)
Web: http://www.vinnova.se/ (Swedish)

VINNOVA is a State authority that aims to promote growth and prosperity throughout Sweden. The particular area of responsibility comprises innovations linked to research and development. The tasks are to fund the needs-driven research required by a competitive business and industrial sector, and to strengthen the networks that are such a necessary part of this work.

Organizations (non-government)

Forskning.se
Address: forskning.se, Vetenskapsrådet (Swedish Research Council), 103 78 Stockholm, Sweden
Phone: +46-546-44-000
Email: red@forskning.se
Web: http://www.forskning.se/webbspecifikasidor/inenglish.4.303f5325112d733769280001889.html (English)
Web: http://www.forskning.se/ (Swedish)

Forskning.se is a nationwide website that provides information on research and research findings by: collecting and sorting data on research results; supplementing texts with comprehensible summaries; prioritizing clear, straightforward presentations; being committed to the scrutiny of current Swedish research; and giving precedence to cooperative activities.

The International Chemical Secretariat (ChemSec)
Postal address: P.O. Box 7005, SE-402 31 Göteborg, Sweden
Address: Norra Allégatan 5, Göteborg
Phone: +46-31-711-04-95
Web: http://www.chemsec.org/index.php (English)

ChemSec is a non-profit organization dedicated to work towards a toxic-free environment. In order to achieve this, the Secretariat promotes the implementation of precautionary perspectives into international chemicals policies and practices.

IVL Swedish Environmental Research Institute (IVL Svenska Miljöinstitutet AB)
Postal address: PO Box 210 60, SE-100 31 Stockholm, Sweden
Address: Valhallavägen 81, Stockholm
Phone: +46-8-598-563-00
Postal address: P.O. Box 5302, SE-400 14 Göteborg, Sweden
Address: Aschebergsgatan 44, Göteborg
Phone: +46-31-725-62-00
Web: http://www.ivl.se/en/ (English)
Web: http://www.ivl.se/ (Swedish)

IVL's services to its customers and funding agencies include applied research, technological development, environmental monitoring, and assessments. An important role is to compile, evaluate, and communicate knowledge, which may be of benefit to Sweden and Swedish industry.

IVL's activities are divided in four main areas: Sustainable production, Achievement of environmental goals, Environmental communication, and International activities.

MISTRA, The Foundation for Strategic Environmental Research (Stiftelsen för miljöstrategisk forskning)
Address: Gamla Brogatan 36-38, SE- 111 20 Stockholm, Sweden
Phone: +46-8-791-10-20
Email: mail@mistra.org
Web: http://www.mistra.org/english (English)
Web: http://www.mistra.org/ (Swedish)

MISTRA supports strategic environmental research with a long-term perspective aiming to solve major environmental problems. The main part of MISTRA's funding is focused on broad-based interdisciplinary programs.

NewS, A new strategy for the risk assessment and management of chemicals
Address (Program director): Sven Ove Hansson, Philosophy Unit, Royal Institute of Technology (KTH), Teknikringen 78, SE-100 44 Stockholm, Sweden
Phone: +46-8-790-95-64
Email: soh@infra.kth.se
Web: http://www.infra.kth.se/fil/news/index.htm (English)

NewS proposes a new strategy for coping with potential unwanted adverse effects to human health and to the environment from exposure to chemical substances. Science-based precaution is a key term in the new strategy, and so is simplified risk assessment.

NewS consists of 11 research projects that aim at making the new strategy as operative as possible.

Nordic Council and the Nordic Council of Ministers, Official co-operation in the Nordic region
The Secretariats of the Nordic Council and the Nordic Council of Ministers are both based in Copenhagen.

The Nordic Council
Address: Store Strandstræde 18, DK-1255 Copenhagen K, Denmark
Phone: +45-33-96-04-00
Email: nordisk-rad@norden.org

The Nordic Council of Ministers
Address: Store Strandstræde 18, DK-1255 Copenhagen K, Denmark

Phone: +45-33-96-02-00
Email: nmr@norden.org
Web: http://www.norden.org/start/start.asp?lang=6 (English)
Web: http://www.norden.org/start/start.asp?lang=1 (Swedish)

Official Nordic co-operation is channeled through two organizations: the Nordic Council and the Nordic Council of Ministers. The Nordic Council was formed in 1952 and is the forum for Nordic parliamentary co-operation. The Nordic Council of Ministers, formed in 1971, is the forum for Nordic governmental co-operation.

ReproSafe, Reproduction and Chemical Safety
Address (Ulf Magnusson, Program Manager, Chair): The Centre for Reproductive Biology in Uppsala (CRU), P.O. Box 7054, SE-750 07 Uppsala, Sweden
Phone: +46-18-67-23-24
Email: ulf.magnusson@og.slu.se
Web: http://www-cru.slu.se/ReproSafe.htm (English)
Web: http://www-cru.slu.se/RSsvhem.htm (Swedish)

The ReproSafe (Reproduction and Chemical Safety) program is a research program supported by the Swedish Environmental Protection Agency. The ReproSafe program addresses the issue of a growing scientific and public concern that chemicals in the environment may impair human and wildlife reproduction. The program is built on a comparative approach aiming to increase the knowledge about mechanisms of action for chemically induced reproductive impairment and to develop new and sensitive methods for recording such impairment. A postgraduate school on reproductive toxicology is attached to the program and regularly seminars and stakeholder meetings are arranged.

Stockholm Environment Institute (SEI)
Address: Stockholm Environment Institute, Kräftriket 2B, SE-106 91 Stockholm, Sweden
Phone: +46-8-674-70-70
Web: http://www.sei.se/index.php (English)

The Stockholm Environment Institute (SEI) is a non-profit, independent research institute and think-tank specializing in sustainable development and environmental issues. It works at multiple levels, global, national, regional and local, and accords particular attention to cross-scale problems and interactions.

The Swedish Plastics and Chemicals Federation (Plast- & Kemiföretagen)
Postal address: P.O. Box 55915, SE-102 16 Stockholm, Sweden
Address: Storgatan 19, Stockholm
Phone: +46-8-783-86-00
Email: info@plastkemiforetagen.se
Web: http://www.plastkemiforetagen.se/PoK_eng/index.htm (English)
Web: http://www.plastkemiforetagen.se/index.htm (Swedish)

The Swedish Plastics and Chemicals Federation is the trade organization of the manufacturers and suppliers of chemicals and plastic products in Sweden. The goal of the Federation is to create good conditions for competitiveness, growth, and productivity. One of the most essential goals is that processes and products should fulfill high demands in respect of health, safety, and environment. The Swedish Plastics and Chemicals Federation is a member of The Confederation of Swedish Enterprise.

Universities

Different education and/or training programs in toxicology, ecotoxicology and health and environmental risk/safety assessment on various levels, i.e. undergraduate, MSc and PhD are provided at several universities in Sweden. The Institute of Environmental Medicine (IMM) at Karolinska Institutet (KI), Stockholm is the main center for education and training in toxicology and health risk assessment in Sweden, while Uppsala University offers Sweden's most extensive education within ecotoxicology. Details of present courses and programs are found at each university.

Göteborg University (Göteborgs Universitet)
Postal address: P.O. Box 100, SE-405 30 Göteborg, Sweden
Address: Vasaparken, Göteborg
Phone: +46-31-773-10-00
Web: http://www.gu.se/english/?languageId=0 (English)
Web: http://www.gu.se/ (Swedish)

The Faculty of Science (Naturvetenskapliga fakulteten)
Web: http://www.science.gu.se/english/ (English)
Web: http://www.science.gu.se/ (Swedish)

The Faculty of Science includes all the major subject areas in the fields of mathematics and natural sciences. The Faculty of Science offers national degree programs and courses, as well as International Master's Programs.

Masters program in Ecotoxicology
Web: http://www.science.gu.se/english/education/master/ecotoxikology/ (English)
Web: http://www.science.gu.se/utbildning/masterprogram/program/ (Swedish)

The Sahlgrenska Academy (Sahlgrenska akademin)
Web: http://www.sahlgrenska.gu.se/english/?languageId=100001&disableRedirect=true (English)

Web: http://www.sahlgrenska.gu.se/ (Swedish)

The Sahlgrenska Academy is the faculty of health sciences at Göteborg University. Education and research are conducted within the fields of pharmacy, medicine, odontology and health care sciences.

Department of Public Health and Community Medicine
(Avdelningen för samhällsmedicin och folkhälsa)
Section of Occupational and Environmental Medicine (Arbets- och miljömedicin)
Web: http://www.medicine.gu.se/english/Dept._of_public_health/
http://www2.sahlgrenska.gu.se/invmed/yrkesmed/eng/index.jsp (English)
Web: http://www.medicine.gu.se/avdelningar/samhallsmedicin_folkhalsa/
http://www.medicine.gu.se/avdelningar/samhallsmedicin_folkhalsa/amm/ (Swedish)

Research programs at the Department of Occupational and Environmental Medicine focus on toxicology, airways and the environment, and worklife and health.

Sahlgrenska University Hospital (SU) (Sahlgrenska Universitetssjukhuset)
Department of Occupational and Environmental Medicine (Arbets- och miljömedicin)
Postal address: Occupational and Environmental Medicine, Sahlgrenska University Hospital,
P.O. Box 414, SE-405 30 Göteborg, Sweden
Address: Medicinaregatan 16, Göteborg
Phone: +46-31-786-63-00
Web: http://www.amm.se/eng/index.html
http://www.miljosamverkan.se/vgrtemplates/Start____36671.aspx (English)
Web: http://www.amm.se/
http://www.miljosamverkan.se/vgrtemplates/Page____14291.aspx (Swedish)

The Department of Occupational and Environmental Medicine is a part of Sahlgrenska University Hospital (SU). The hospital provides an infrastructure necessary for teaching and research in co-operation with the Sahlgrenska Academy at Göteborg University.

Karolinska Institutet
Postal address: Karolinska Institutet, Registry Office, SE-171 77 Stockholm, Sweden
Address: Nobels väg 5, Solna
Phone: +46-8-524-865-95
Email: registrator@ki.se
Web: http://ki.se/?l=en (English)
Web: http://ki.se/?l=sv (Swedish)

Karolinska Institutet is one of Europe's largest medical universities. It is also Sweden's largest center for medical training and research.

The Institute of Environmental Medicine (Institutet för Miljömedicin, IMM)
Postal address: P.O. Box 210, 171 77 Stockholm, Sweden
Address: Nobels väg 13, Karolinska Institutet, Solna
Web: http://ki.se/ki/jsp/polopoly.jsp?d=1666&l=en (English)
Web: http://ki.se/ki/jsp/polopoly.jsp?d=1666&l=sv (Swedish)

The Institute of Environmental Medicine (IMM) is an interdisciplinary research organization that carries out research, education, and investigations in the fields of environmental medicine, toxicology, epidemiology, and health protection. The Institute also provides assistance to public authorities and others through consulting and training personnel in the field of toxicology and environmental medicine. An important part of the work at IMM is to provide the governmental agencies with environmental health risk assessments as a basis for regulations and standard settings.

Education and training in toxicology and risk assessment at IMM
IMM offers graduate training programs for higher degrees in Toxicology, Environmental Medicine, Epidemiology, Molecular Toxicology, Cell and Molecular Biology, and Molecular Genetics.
Study program in Toxicology (Toxikologutbildningen Master program 120 hp)
Web: http://ki.se/ki/jsp/polopoly.jsp?d=9340&a=7374&l=sv (Swedish)

The 2-year toxicology program at IMM, Karolinska Institutet started in 1976, at that time the first toxicology educational program in Europe. This study program in toxicology is the only cohesive education program in Sweden with the emphasis on toxicology and health risk assessment. The program is directed to either research or a professional career, and aims to educate in basic and applied toxicological research, toxicological investigations and testing, and regulatory toxicology and health risk assessment. The program is designed to provide a scientific knowledge base in toxicology and health risk assessment to meet the needs from universities, industry, and governmental agencies for qualified toxicological expertise. On successful completion of the program students have been awarded a Master of Medical Science in Toxicology ("Magister"). The curriculum for the study program in toxicology was changed in 2008 to a 2-year Master Program in Toxicology (120 ECTS credits) with

the exam entitled Degree of Master of Medical Science with a major in Toxicology.

Department of Biosciences and Nutrition (Institutionen för biovetenskaper och näringslära)
Web: http://ki.se/ki/jsp/polopoly.jsp?d=229&l=en (English)
Web: http://ki.se/ki/jsp/polopoly.jsp?d=229&l=sv (Swedish)

The department performs research and education in areas of medical science. These include signal transduction and gene regulation, structural biology and bio-organic chemistry, human genetics and functional genomics, cellular virology and environmental toxicology.

Department of Public Health Science
Division of Occupational and Environmental Medicine (Arbets- och miljömedicin)
Web: http://ki.se/occupmed
http://www.phs.ki.se/research/research_groups_en.html
http://www.folkhalsoguiden.se/AvdEnhet.aspx?id=1228 (English)
Web: http://www.folkhalsoguiden.se/AvdEnhet.aspx?id=352 (Swedish)

The Division of Occupational Medicine is associated to the Department of Occupational and Environmental Health, Stockholm County Council.

Karolinska Institutet University Library – National Resource Library of Medicine (Karolinska Institutet Universitetsbiblioteket)
Web: http://ki.se/ki/jsp/polopoly.jsp?d=167&l=en
http://ki.se/lib (English)
Web: http://ki.se/ki/jsp/polopoly.jsp?d=167&l=sv (Swedish)

Karolinska Institutet University Library is a public library, and also a national resource library for medicine, including dental science, nursing science, and health care. The library provides an extensive collection of electronic journals, books, databases, and links. The database SveMed+ is produced and available at KI University library. SveMed+ is a bibliographic database containing references to medical journal articles and reports from the Nordic countries, and also to medical dissertations from Swedish and Norwegian universities.

Linköping University (Linköpings Universitet)
Address to all units but the Faculty of Health Sciences:
Linköpings universitet, SE-581 83 Linköping, Sweden
Phone: +46-13-28-10-00
Email: liu@liu.se

Faculty of Health Sciences, Hälsouniversitetet, Universitetssjukhuset, SE-581 85 Linköping, Sweden
Phone: +46-13-22-20-00

Norrköping
Address for all units:
Linköpings universitet, Campus Norrköping, SE-601 74 Norrköping, Sweden
Phone (switchboard): +46-11-36-30-00
Web: http://www.liu.se/en/ (English)
Web: http://www.liu.se/ (Swedish)

Linköping University is organized in four faculties:
Institute of Technology
Faculty of Arts and Sciences
Faculty of Health Sciences
Educational Sciences

Faculty of Health Sciences (Hälsouniversitetet)
Web: http://www.hu.liu.se/?l=en (English)
Web: http://www.hu.liu.se/?l=sv (Swedish)

Lund University (Lunds Universitet)
Postal address: P.O. Box 117, SE-221 00 Lund, Sweden
Phone: +46-46-222-00-00
Web: http://www.lu.se/lund-university (English)
Web: http://www.lu.se/ (Swedish)

International Office:
Address: Sandgatan 3, Lund
Phone: +46-46-222-34-59
Email: intsek@intsek.lu.se

Lund University Libraries
Postal address: P.O. Box 134, SE-221 00 Lund, Sweden
Phone: +46-46-222-00-00

Faculty of Science (Naturvetenskapliga fakulteten)
Web: http://www.naturvetenskap.lu.se/o.o.i.s/2387 (English)
Web: http://www.naturvetenskap.lu.se/o.o.i.s/1743 (Swedish)

Department of Ecology (Ekologiska institutionen)
Web: http://www.kem.ekol.lu.se/chemecol.html (English)
Web: http://www.ekol.lu.se/ (Swedish)

The section has both a basic ecology education and a PhD education program.

Faculty of Medicine (Medicinska fakulteten)
Web: http://www.med.lu.se/english/ (English)
Web: http://www.med.lu.se/ (Swedish)

Department of Occupational and Environmental Medicine (Arbets och miljömedicin)
Web: http://www.med.lu.se/labmedlund/amm (Swedish)

The Department of Occupational and Environmental Medicine includes one clinical unit at the University Hospital in Lund and a unit (Division of Occupational and Environmental Medicine within the Department of Laboratory Medicine/Lund) in the Medical Faculty at Lund University.

The Royal Institute of Technology, Stockholm (Kungliga Tekniska Högskolan)
Postal address: Kungl Tekniska Högskolan, SE-100 44 Stockholm, Sweden
Address: Valhallavägen 79, Stockholm
Phone: +46-8-790-60-00
Web: http://www.kth.se/?l=en_UK (English)
Web: http://www.kth.se/?l=sv_SE (Swedish)

Stockholm University (Stockholms Universitet)
Postal address: Stockholm University, SE-106 91 Stockholm, Sweden
Address: Universitetsvägen 10A, Stockholm
Phone: + 46-8-16-20-00
Web: http://www.su.se/english/ (English)
Web: http://www.su.se/ (Swedish)

Stockholm University is the region's center for higher education and research in the humanities, law, sciences, and social sciences.

Department of Applied Environmental Science, ITM (Institutionen för Tillämpad Miljövetenskap)
Web: http://www.itm.su.se/ (English)

The Department of Applied Environmental Science (ITM) is multidisciplinary in its research and teaching, with a focus on society's impact on natural systems and processes. ITM also provides external expert support to Swedish environmental authorities.

Department of Biochemistry and Biophysics (Institutionen för Biokemi och Biofysik)
Web: http://www.dbb.su.se/index.html (English)
Web: http://www.dbb.su.se/index_sv.html (Swedish)

Department of Environmental Chemistry (Institutionen för Miljökemi)
Web: http://www.miljokemi.su.se/?lang=eng (English)
Web: http://www.miljokemi.su.se/?lang=sv (Swedish)

The Department of Environmental Chemistry is active in research and education within the field of environmental chemistry. The work is manly directed towards organic chemicals and their fate in biological systems. The department is active in information dissemination to the society in general.

Masters Programme in environmental chemistry (Mastersprogram i miljökemi)

A new international Masters Programme in environmental chemistry, Swedish School of Environmental Chemistry (SSEC), started autumn 2006.

Department of Genetics, Microbiology and Toxicology (Institutionen för Genetik, Mikrobiologi och Toxikologi)
Web: http://www.gmt.su.se/pub/jsp/polopoly.jsp?d=2397 (English)
Web: http://www.gmt.su.se/pub/jsp/polopoly.jsp?d=2396 (Swedish)

Swedish University of Agricultural Sciences, SLU (Sveriges lantbruksuniversitet)
Address: SLU, Swedish University of Agricultural Sciences, P.O. Box 7070, SE-750 07 UPPSALA, Sweden
Phone: +46-18-67-10-00
Email: registrator@slu.se
Web: http://www.slu.se/?id=580 (English)
Web: http://www.slu.se/?id=1 (Swedish)

Swedish University of Agricultural Sciences is a university with the defined role to take responsibility for the development of learning and expertise in areas concerning biological resources and biological production. This responsibility stretches over the fields of agriculture, forestry, and food industry to environmental questions, veterinary medicine, and biotechnology. Main campuses are located at Alnarp, Skara, Ultuna (Uppsala), and Umeå. Research and teaching activities are carried out throughout the country.

Umeå University (Umeå Universitet)
Postal address: SE-901 87 Umeå, Sweden
Address: University Campus, Umeå
Phone: +46-90-786-50-00
Email: umea.universitet@umu.se
Web: http://www.umu.se/english (English)
Web: http://www.umu.se/ (Swedish)

Faculty of Medicine
Department of Public Health and Clinical Medicine
Unit of Occupational and Environmental Medicine (Yrkes och Miljömedicin)
Web: http://www.umu.se/phmed/envmed/index_eng.html (English)
Web: http://www.umu.se/phmed/envmed/index.html (Swedish)

Research in occupational medicine is driven in close collaboration with Arbets- och beteendemedicinskt centrum, the Center for Work and Behavioral Medicine at Norrlands University Hospital and the National Institute for Working Life. The unit also has close collaboration within the northern region of Sweden with, amongst others, the Occupational and

Environmental Medicine at Sundsvall Hospital and Mid Sweden University in Sundsvall.

Uppsala University (Uppsala Universitet)
Postal address: Uppsala University, P.O. Box 256, SE-751 05 Uppsala, Sweden
Phone: +46-18-471-00-00
Web: http://www.uu.se/en/ (English)
Web: http://www.uu.se/ (Swedish)

Department of Pharmaceutical Biosciences (Institutionen för farmaceutisk biovetenskap)
Web: http://www.farmbio.uu.se/research.php (English)
Web: http://www.uu.se/Adresser/FF1.html (Swedish)

Division of Toxicology
Web: http://www.farmbio.uu.se/research.php?avd=3 (English)
Web: http://www.farmbio.uu.se/avdelningar.php?avd=3 (Swedish)

The division of toxicology provides several courses in toxicology.

Evolutionary Biology Centre – EBC (Evolutionsbiologiskt centrum)
Web: http://www.ebc.uu.se/index_eng.php (English)
Web: http://www.ebc.uu.se/ (Swedish)

EBC answers for most of Uppsala University's research and education in biology.

Department of Physiology and Developmental Biology (Institutionen för fysiologi och utvecklingsbiologi)
Web: http://www.fu.uu.se/ (English)

The Department performs research and education in comparative immunology, developmental biology, environmental toxicology, epigenetics, evolutionary organism biology, and neurophysiology.

Department of Environmental Toxicology
Web: http://www.fu.uu.se/etox/ (English)

The research at Department of Environmental Toxicology is largely focused on developmental effects of contaminants in various animal classes and enzyme-catalyzed activation of compounds in target cells and tissues. A particular interest is in toxic events that target the hormone system, the reproductive system, and the early brain development in vertebrates.

Educational programs in ecotoxicology, biology (Utbildning)
Web: http://www.ibg.uu.se/en/eng_ecotoxicology/index.html (English)
Web: http://www.ibg.uu.se/se/ET1/index.html (Swedish)
Web: http://www.ibg.uu.se/en/master/biology/index.html (English)
Web: http://www.ibg.uu.se/se/program/biologi/index.html (Swedish)

Uppsala University offers Sweden's most extensive education within ecotoxicology. The course package in ecotoxicology was first given in 1980 and is the only comprehensive education program in ecotoxicology in Sweden. Ecotoxicology is included as specialization in the Master of Science Program in Biology.

Professional Societies

Swedish Society of Toxicology (Svensk Förening för Toxikologi, SFT)
Address: SFT, c/o Plast- & Kemiföretagen, P.O. Box 55915, SE-102 16 Stockholm, Sweden
Phone (SFT secretary): +46-8-783-81-47
Email (SFT secretary): lisa.ekstig@plastkemiforetagen.se
Web: http://www.imm.ki.se/sft (Swedish mainly)

The Swedish Society of Toxicology is an association for: individuals with a profession in toxicology, risk assessment or related areas; students in the field of toxicology; others with a keen interest in toxicology. The overall purpose for the Swedish Society of Toxicology is to: promote the development of new knowledge within the field of toxicology; work for the spreading of toxicology knowledge and information; work for an increased and scientifically based practical application of toxicological knowledge in society. The aim of SFT is to promote the development of toxicology in Sweden and work for toxicological education and research through the arrangement of public meetings and scientific seminars and discussions. The society works for the exchange of information between members and between members and representatives of other scientific disciplines and other parts of the society as well as aim at cooperation between other closely related organizations nationally and internationally.

The Swedish Academy of Pharmaceutical Sciences (SAPS) (Läkemedelsakademin, Apotekarsocieteten)
Postal address: P.O. Box 1136, SE-111 81 Stockholm, Sweden
Address: Wallingatan 26 A, Stockholm
Phone: +46-8-723-50-00
Email (Läkemedelsakademin): info@lakemedelsakademin.se
Email (Apotekarsocieteten): apotekarsocieteten@swepharm.se

'Läkemedelsakademin'
Web: http://www.lakemedelsakademin.se/templates/LMAstandard.aspx?id=607 (English)
Web: http://www.lakemedelsakademin.se/ (Swedish)
'Apotekarsocieteten'
Web: http://www.swepharm.se/templates/SPstandard.aspx?id=759 (English)
Web: http://www.swepharm.se/ (Swedish)

The Swedish Academy of Pharmaceutical Sciences (SAPS) is a non-profit organization for people engaged in the field of medicinal drugs. The aim of the organization is to further developments in pharmaceutical research and to promote high, professional standards. The organization is a national provider of continuing education and post-graduate courses. Regional activities, in collaboration with the various divisions, are run in more than 40 locations throughout the country. The activities encompass a broad spectrum of subjects from generally oriented topics to more specific scientific-oriented ones. The Academy co-operates on a number of courses with universities and other providers of education inside and outside of Sweden. Also, a number of international symposia and workshops are held under the sponsorship of SAPS.

Toxicological Council (Toxikologiska Rådet)
Address: The Toxicological Council, Swedish Chemicals Agency, P.O. Box 2, SE-172 13 Sundbyberg, Sweden
Phone: +46-8-519-41-100
Email: toxrad@kemi.se
Web: http://www.kemi.se/templates/Page____2988.aspx (English)
Web: http://www.kemi.se/templates/Page____2832.aspx (Swedish)

The Toxicological Council is an expert body, managed by the Swedish Chemicals Agency (KemI), providing scientific advice and consultation on toxicological issues to government agencies within the environmental sector. The Toxicological Council promotes a high scientific level in risk analyses carried out by the agencies and provides guidance on criteria and principles for scientific interpretation. The Council strives for a co-coordinated and uniform design of risk analyses between agencies. Working methods vary from in-house meetings to seminars on topical toxicological issues and discussions on assessments and interpretations of toxicological data.

Poison Control Centers

Swedish Poison Information Centre (Giftinformationscentralen)
The Swedish Poisons Information Centre is located to the Karolinska University Hospital, Solna
Phone: +46-8-33-12-31
Web: http://www.giftinformation.se/intro.asp?CategoryID=6414 (English)
Web: http://www.giftinformation.se/ (Swedish)

The Swedish Poisons Information Centre is an autonomic unit of the National Corporation of Swedish Pharmacies. The main responsibility for the Swedish Poisons Information Centre is to answer questions and give advice to the general public, physicians, and other healthcare personnel in cases of acute poisonings. The service is available on a 24-hour basis, every day of the year. If needed, enquiries can be conducted in English. The staff includes physicians, pharmacists, and administrative personnel. An internal education and training period of 3–6 months is required before the pharmacists are allowed to answer telephone calls on their own. The physicians, who are specialized in anesthesiology, intensive care, and clinical toxicology, have the ultimate medical responsibility for the information provided. They also work within the ICU on a regular basis.

Miscellaneous Resources

Stockholm Centre for Public Health (Centrum för folkhälsa), Stockholm County Council
Postal address: Stockholm Centre for Public Health (Centrum för folkhälsa), PO Box 17533, SE-118 91 Stockholm, Sweden
Address: Västgötagatan 2, Stockholm
Phone: +46-8-737-35-00
Email: centrumforfolkhalsa@sll.se
Web: http://www.folkhalsoguiden.se/AvdEnhet.aspx?id=1228 (English)
Web: http://www.folkhalsoguiden.se/StartAvd.aspx?id=611 (Swedish)

Stockholm Centre for Public Health, within Stockholm County Council, has regional responsibility for work in the arena of Public Health. The principal tasks are to monitor and report on the health of the population in Stockholm, and to develop and support health-promoting and preventive work. Stockholm Centre for Public Health is closely linked to Karolinska Institutet, and also works in close co-operation with other actors on Public Health issues.

Hospitals

Karolinska University Hospital (Karolinska Universitetssjukhuset)
Karolinska University Hospital, Solna
Postal address: SE-171 76 Stockholm, Sweden
Address: Karolinskavägen, Solna
Phone: +46-8-517-700-00

Karolinska University Hospital, Huddinge
Postal address: SE-141 86 Stockholm, Sweden
Address: Hälsovägen, Flemingsberg
Phone: +46-8-585-800-00
Web: http://www.karolinska.se/templates/DivisionStart____53585.aspx?epslanguage=EN (English)
Web: http://www.karolinska.se/default.aspx?epslanguage=SV (Swedish)

Karolinska University Hospital is besides being a hospital also part of a medical school. Karolinska University Hospital works closely with several colleges and universities, mainly Karolinska Institutet, but also with Södertörns University College, Stockholm University, and the Royal Institute of Technology in Stockholm. Karolinska Institutet certifies researcher education and grants academic degrees (MD, PhD) in medicine. The Karolinska University Laboratory is one of the world's largest and most complete clinical laboratories.

Lund University Hospital (Universitetssjukhuset i Lund)
Department of Occupational and Environmental Medicine (Arbets-och Miljömedicin)
Postal address: University Hospital, Occupational and Environmental Medicine, SE-221 85 Lund, Sweden
Phone: +46-46-17-31-85
Email: AMM.usil@skane.se
Web: http://www.skane.se/templates/Page.aspx?id=109565 (Swedish)

Occupational and Environmental Medicine includes one clinical unit (Department of Occupational and Environmental Medicine) at the University Hospital in Lund and a unit (Division of Occupational and Environmental Medicine within the Department of Laboratory Medicine/Lund) in the Medical Faculty at Lund University.

Malmö University Hospital (Universitetssjukhuset MAS)
Postal address: SE-205 02 Malmö, Sweden
Phone: +46-40-33-10-00
Email: UMAS@skane.se
Web: http://www.skane.se/upload/Webbplatser/UMAS/sprak_filer/engelska.pdf (English)
Web: Web: http://www.skane.se/default.aspx?id=21002 (Swedish)

Norrlands University Hospital (Norrlands universitetssjukhus (Nus))
Postal address: Norrlands universitetssjukhus, SE-901 85 Umeå, Sweden
Phone: +46-(0)90-785-00-00
Web: http://www.vll.se/default.aspx?id=25719&refid=1926 (English/Swedish)

Occupational Medicine North
A collaboration between the occupational and environmental clinics in Sundsvall and Umeå.

Department of Occupational and Environmental Medicine in Umeå
The University Hospital of Northern Sweden, SE-901 85 Umeå, Sweden.
Phone: +46-(0)90-785-24-50

Department of Occupational and Environmental Medicine in Sundsvall
The Hospital in Sundsvall, SE-851 86 Sundsvall, Sweden
Phone: +46-60-18-19-26

Sahlgrenska University Hospital (SU) (Sahlgrenska Universitetssjukhuset)
Department of Occupational and Environmental Medicine (Arbets- och miljömedicin)
Postal address: Occupational and Environmental Medicine, Sahlgrenska University Hospital,
P.O. Box 414, SE-405 30 Göteborg, Sweden
Address: Medicinaregatan 16A, Göteborg
Phone: +46-31-786-63-00
Email: amm@amm.gu.se
Web: http://www.amm.se/eng/
http://www.sahlgrenska.se/Sahlgrenska-universitetssjukhuset/6/Medicin/Arbets--och-miljomedicin/In-English/
http://www.sahlgrenska.se/VGRTemplates/SU_start.aspx?id=36671
http://www2.sahlgrenska.gu.se/invmed/yrkesmed/eng/index.jsp (English)
Web: http://www.amm.se/
http://www.sahlgrenska.se/vgrtemplates/Page.aspx?id=14291 (Swedish)

The Department of Occupational and Environmental Medicine is a part of Sahlgrenska University Hospital. The hospital provides an infrastructure necessary for teaching and research in co-operation with the Sahlgrenska Academy at Göteborg University.

Uppsala University Hospital (Akademiska sjukhuset, Uppsala)
Occupational and Environmental Medicine, Uppsala (Arbets och Miljömedicin, Uppsala)
Address: Ulleråkersvägen 38-40, SE-751 85 Uppsala, Sweden
Phone: +46-18-611-36-42/43
Web: http://www.ammuppsala.se/default.asp?language=2&headed=1 (English)

Web: http://www.ammuppsala.se/default.asp?language=1&headed=1 (Swedish)

The Department of Occupational and Environmental Medicine includes one clinical unit at Akademiska Sjukhuset serving Uppsala, Dalecarlia, and Gävleborg and one university unit at the Department of Medical Sciences at the Uppsala University. The activities are well integrated.

Örebro University Hospital (Universitetssjukhuset Örebro)

Department of Occupational and Environmental Medicine (Arbets- och miljömedicinska kliniken)

Postal address: Örebro University Hospital, SE-701 85 Örebro, Sweden
Address: F-house, level 2, entrance F1 via Gallerian
Phone: +46-19-602-24-69
Email: uso@orebroll.se
Web: http://www.orebroll.se/uso/page_2834.aspx (English)
Web: http://www.orebroll.se/uso/clinic1_2227.aspx (Swedish)

CHAPTER

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Taiwan

JUNG-DER WANG

INTRODUCTION

Dr. Tsungming Tu, the first medical doctor and pharmacologist in Taiwan, began his studies on opiates, morphine, Chinese herbs, and snake venoms after he graduated from Kyoto Imperial University in 1922. His team has cultivated a lot of outstanding pharmacologists and toxicologists in the Graduate Institute of Pharmacology at the National Taiwan University College of Medicine (NTUCM). Among them, Drs. Chen-Yuan Lee, Chuan-Chiung Chang, Che-Ming Teng and his colleagues have conducted series of studies on snake venoms and natural products, including the discovery of bungarotoxins, which won Dr. Lee the Redi Award in 1976. There was another team of researchers who conducted studies on toxicology at the Graduate Institute of Biochemistry of the NTUCM after World War II. Among them, Drs. Ta-Cheng Tung and Jung-Yaw Lin, Guo-Huang Lin and Jen-Kun Lin were famous for studies of various phytotoxins and fungotoxins, including mimosine, abrin and ricin, territrem and azo dyes. Most of these early studies focused more on laboratory works and help the establishment of two graduate institutes of toxicology in Taiwan: one in the National Taiwan University College of Medicine (1990), with another in Chung-Shan Medical University (1996). Later on, the Division of Environmental Health and Occupational Medicine was set up in the National Health Research Institutes in 1999, which also contribute to the education and training of young toxicologists. So far, there are ***about more than 300 professionals who have joined the Taiwan Society of Toxicology and conducted laboratory researches.***

In 1982, Dr. Jung-Der Wang began to establish an occupational and environmental clinic at the National Taiwan University Hospital, which began the recognition and documentation of diseases resulting from occupational and environmental hazards in factories. Later on, Dr. Jou-Fang Deng established the Taiwan National Poison Control Center (PCC-Taiwan) in 1985 under the auspices of Department of Health, Taiwan and the Veterans General Hospital-Taiwan, which provides 24-hour free consultation assistance for identification, diagnosis, and treatment of poisonings, interpretation of laboratory tests for 23 million inhabitants. His team has co-ordinated to establish a National Antidote Stocking System in 2001, which managed the distribution and stocking of seven antidotes of first priority: physostigmine, cyanide antidote (hydroxocobalamin), BAL (DMSA, DMPS), Ca-EDTA, methylene blue, botulism antitoxin, and the antivenom against Viper russeli formosensis. Because of the co-operation among doctors from these two and other medical centers, they established the Board of Occupational Medicine approved by the Department of Health of Taiwan in 2002 and so far there have been about more than 234 board-certified occupational and environmental physicians responsible for seeing patients suffering from poisoning of occupational and environmental hazards and about 934 board-certified emergency physicians seeing patients with acute poisoning.

RESOURCES

Books

Bureau of Food and Drug Analysis (1996)
Drug Abuse Compilation: Toxicity, Metabolism and Analysis
Taipei: Bureau of Food and Drug Analysis

This book published by the Bureau of Food and Drug Analysis serves as a formal reference for healthcare workers to understand the toxicity and analytic method of different drugs that are commonly abused by people. It is an easy-to-read and ready reference.

Chang IC (1994)
Chemical Process Safety Management
Taipei: Yang-Chih Book Co., Ltd

This book provides fundamental information for chemical process safety, such as chemical toxicity and health hazard, fire and explosives, hazard identification, risk assessment, and safety management.

Chen JM (2007)
Environmental Toxicology
Taipei: Wun-Ching Publishing Group

Chen JS (1994)
Hazardous Substances Management
Taipei: Shin-Wen-Jing Book Co., Ltd

Chen JS, Cheng (1997)
Poisonous Plants in Mainland China
Taipei: Di Jin

This book contains mainly the pictures of different poisonous plants grown in mainland China. It is a good resource for people to use and identify such plants.

Chen TC, Sheng TJ (1992)
Food Additives
Taipei: Wen-Yuan Book Co., Ltd

This book is a comprehensive treatise on food additives. It is divided into three main parts: introduction to food additives, chemical and physical properties of individual food additives, and special information on food additives, such as the food additives act, dosage, usage, manufacture, storage, transport, stability, and toxicity.

Chen ZY, Hsu PM (1993)
Toxicological Chemistry
Taipei: Da-Shing

This book illustrates several toxicological aspects of generally used chemicals, including description of chemicals, intoxication symptoms, antidotes and treatments, chemical analysis of toxicants, and overview of toxic compounds.

Cheng PK (1989)
Nuclear Radiation and Detection
Taipei: Asian-Eastern Book Co.

This book discusses several important aspects of radiation hazards, including radiation protection, interaction of ionizing radiation with the biosphere, radio-detector, scintillation detection, semi-conductance detection, and nucleonics.

Cheng YC (1991)
Poisonous Plants
Taipei: Du Chia Publishing

This book contains mainly pictures of poisonous plants in Taiwan, including Taipei. It is a good resource for people to check and identify such plants.

Chueng JY (1995)
Essentials in the Protection of Public Health
Taipei: Shu-Shing Publishing Co., Ltd

This book is a concise treatise on the protection of public health. The book covers various areas of environmental sciences: environmental protection, public hazards, environmental assessment, air pollution protection, odor control, water protection, noise control, waste management, and global environmental protection.

Foundation for Poison Control (1999)
The Principle of Treatment of Acute Poisoning (I)
The Principle of Treatment of Acute Poisoning (II)
Taipei: Foundation for Poison Control

These two books are major handbooks for healthcare workers and people to have a quick access on the management information of most common poisons.

Horng KC, Yang MT, Tseng CM (1994)
Industrial Safety and Health/Management and Practice
Taipei: Yang-Chih Book Co.

This book is a comprehensive treatise on industrial safety and health. Several areas of this discipline are covered, including the role of labor safety inspection, management system, self-safety examination, education and training, physical examination, occupational hazards, and occupational safety.

Lee YJ (1995)
Environmental Attitudes and Environmental Protection Behavior – Theory & Practice
Taipei: Architectural Information Magazine Ltd

This book gives a detailed analysis on the environmental problems arising from the general population. The emphasis of this treatise is focused on environmental behavior, environmental policy, resident attitudes, and expert opinion.

Lin JK (1994)
Food and Cancer
Taipei: Lien-Jing Publishing Co.

This book is written in Chinese and aimed at laypeople. A systematic discussion on the role of dietary factors in the etiology of human cancer is given. The importance

of some anticancer factors in the daily diet is also described. The concept that reactive oxygen species may play important roles in the development of cancer, cardiovascular diseases, and aging is illustrated. This book has received the Golden Tripod Award from the Bureau of Cultural Communication, Executive Yuan, Republic of China.

Lin JK (1995)
Biochemical Mechanisms of Carcinogenesis and Anticarcinogenesis
Taipei: Laboratory for Cancer Research, Institute of Biochemistry, College of Medicine, National Taiwan University, Taipei

This book is a collection of original papers dealing with the biochemical and molecular mechanisms of carcinogenesis and anticarcinogenesis. The collection comprises four parts; analytical methods for cancer research, naturally occurring amines and N-nitroso compounds in environmental carcinogenesis, molecular mechanisms of chemical carcinogenesis, and biochemical and molecular mechanisms of anticarcinogenesis and cancer chemoprevention.

Lin JK (1995)
Genetic Engineering and Cancer Medicine
Taipei: Lien-Jing Publishing Co.

This book is a collection of 34 comprehensive papers dealing with the new developments in genetic engineering and cancer medicine. It is written in Chinese and aimed especially at high school and college students. The research works and contributions made by several Nobel prize winners are described. The recombinant DNA technology is systematically introduced.

Lin JL (2003) (2004) (2006)
Toxin in Life (1)
Toxins in Life (2)
Toxins in Life (3): Plain talking about detoxification
Taipei: Hung-Shin Book Co.

The above three books contain typical examples of poisonings and their management, which are written for lay people to obtain useful daily knowledge for toxins.

Lin JY (2003)
Drug Crimination and Prevention
Tao-Yuan: Central Police University Press

The book is mainly used for police and safety professionals to have a more in-depth understanding on drug abuse and its prevention. It collects many cases that previously happened in Taiwan and the pictures are useful for people to read and quickly get an idea of the issue.

Lin-Shiau SY (1995)
Modern Concepts in Biochemical Pharmacology
Taipei: Lien-Jing Publishing Co.

This book is a collection of papers dealing with the toxicity and mechanisms of several drugs. All are written in Chinese and suitable for laypeople.

Lin SN (1997)
Drug Abuse and Prevention
Taipei: Medtoday

This book is written by a professor in psychiatry who has ample experience of dealing with drug abuse. It is suitable for healthcare workers and public.

Miao SL, Liu YC, Liu CY (1995)
Environmental Science Dictionary
Taipei: Fishery Product Publishing Co.

This dictionary is a comprehensive treatise written in Chinese. It provides general information on environmental sciences and includes environmental pollution and hazard, assessment and monitoring, and management.

Shiau SY (1993)
Biochemical Pharmacology
Taipei: Lien-Jing Publishing Co.

This book is written in Chinese and describes the biochemical and molecular mechanisms of drug actions. Recent developments in drug receptor biology and biochemistry are described.

Teng WC (1996)
Biotechnology
Taipei: Chiow-Chow Book Co.

This book describes recent developments in biotechnology with special emphasis on medical products, food supplements, agricultural products, energy products, gasoline derivatives, and new products used in pollution control.

Tsai FG (1993)
Poisonous Plants Found Commonly in the Garden of Taipei City
Taipei: Department of Information, Taipei City Government

This book is published by the City Government of Taipei to help all residents to identify poisonous plants. It contains many pictures of such plants.

Tsai YM (1993)
Modern Safety Management
Taipei: Yang-Chih Book Co.

This book covers the following areas: safety management, industrial hygiene, safety control, and psychology and behavior.

Yang CC (2003)
Epidemiologic Data of Acute Pesticide Poisoning in Taiwan, 1985–2001
Taipei: Quarterly Publication of the Taiwan PCC

The book summarizes different cases of pesticide poisoning that were collected by PCC (Poison Control Center), and provides real examples for control of pesticide poisoning.

Yang YN (1996)
The Story of Snake Venom Research in Taiwan
Taipei: Tian-Shia Book Co., Ltd

The book is for the public to understand the history of snake venom research.

Wang JD (1987)
Environmental Pollution and Disease (I)
Taipei: Health World Publishing Co.

Wang JD (1990)
Environmental Pollution and Disease (II)
Taipei: Health World Publishing Co.

These two books are written for public education and provide actual cases and the settings of occurrence of many occupational and environmental diseases. They are written in Chinese and also contain prevention strategy.

Wang JD (2002)
Basic Principles and Practical Applications in Epidemiological Research
Singapore: World Scientific

This book details the method of epidemiology and provides several cases of occupational and environmental diseases with different types of causal inference for the recognition of occupational and/or environmental causes.

Journals

Journal of the Chinese Medical Association
Taipei: Chinese Medical Association

Journal of Chinese Oncology Society (1984–)
Taipei: Chinese Oncology Society

This journal generally publishes papers dealing with cancer research, but sometimes it also publishes papers concerning toxicology.

Journal of Food and Drug Analysis (1992–)
Taipei: National Laboratories of Foods and Drugs, Department of Health, Executive Yuan

This journal publishes papers dealing with drug and food analysis. Papers describing the toxicities of drugs are also included.

Journal of Formosan Medical Association (1901–)
Taipei: Formosan Medical Association

This journal publishes papers dealing with clinical medical sciences, but occasionally it also publishes papers relating to toxicology.

Journal of the Chinese Chemical Society
Taipei: The Chemical Society

It is published bimonthly by The Chemical Society located in Taipei. The scope of the Journal includes both experimental and theoretical reports of original research.

Journal of Occupational Safety and Health (1992–)
Taipei: Institute of Occupational Safety and Health, Council of Labor Affairs, Executive Yuan

This journal publishes papers covering the research on occupational safety and health, sponsored by the Council of Labor Affairs.

Newsletter on Drug and Food (1970–)
Taipei: Food and Drug Bureau, Department of Health, Executive Yuan

This newsletter covers various aspects of drug and food inspection, namely, updated information on the development of drug and food analysis, side effects of drugs, toxic contaminants of foods, toxicological implication in drug metabolism, and new systems of drug and food control.

Newsletter on Occupational Safety and Health (1993–)
Taipei: Institute of Occupational Safety and Health, Council of Labor Affairs, Executive Yuan

This newsletter is a short communication for occupational health and safety. It usually covers the most updated information on toxic substances.

Newsletter on Science & Technology of Environmental Protection (1983–)
Taipei: Committee for Environmental Sciences, National Science Council, Executive Yuan

This newsletter reports the research and developments of the environmental sciences. Research papers dealing with environmental pollution and toxicant analysis are included.

Taiwan Journal of Public Health (1983–)
Taipei: Taiwan Public Health Association

This journal publishes peer-reviewed articles related to all aspects of public health, including: environment

health, epidemiology, community medicine, health policy and management, behavior sciences, industrial hygiene.

The Journal of Health Sciences
Taipei: Department of Technological and Vocational Education, Ministry of Education

It publishes peer-reviewed articles on healthcare-related sciences, including nursing, recreation and healthcare, medical technology, rehabilitation, public health and management, etc.

The NTUH Drug Bulletin (1979–)
Taipei: Department of Pharmacy, National Taiwan University Hospital

This bulletin publishes abstracts selected from all kinds of medical journals and emphasizes the pharmacological and toxicological aspects of drugs.

Reports

Annual Report on the Prevention of Industrial Pollution
Technological Instruction Group, Prevention of Industrial Pollution, Department of Economics, Executive Yuan, Taipei

The annual report publishes papers dealing with environmental protection, pollution prevention technology, control of toxic compound contaminants, new technology, and legislative information.

Annual Research and Inspection Report
Food and Drug Bureau, Department of Health, Executive Yuan, Taipei

There are two kinds of papers published in this annual report: original research papers dealing with the methods of food and drug analysis and survey reports on the sanitary condition of foods and the active ingredients in the marketing of drug preparations.

Yearbook on Environmental Protection (1983–)
Taipei: Bureau of Environmental Protection, Executive Yuan

A general report on the progress, accomplishments, and ongoing projects of the Bureau of Environmental Protection during the previous fiscal year.

Organizations (government)

Academia Sinica
The most prominent research institutions in Taiwan.
Web: http://www.sinica.edu.tw/main_e.shtml (English)
Web: http://www.sinica.edu.tw/main.shtml (Chinese)
Address:
Academia Sinica
No. 128, Sec. 2, Academia Rd, Nankang, Taipei 115 Taiwan, R.O.C.
Phone: +886(2)27899481
Email: *aspublic@gate.sinica.edu.tw*

Institute of Biomedical Sciences (IBMS)

This is a branch of Academia Sinica. Established in 1981, IBMS has worked closely with major medical centers in Taiwan (National Taiwan University Hospital, Tri-Service General Hospital, and Veterans General Hospital) to promote translational research and provide a favorable environment for training and nurturing biomedical scientists.
Web: http://www.ibms.sinica.edu.tw/index_e.shtml (English)
Web: http://www.ibms.sinica.edu.tw/index_c.shtml (Chinese)

Institute of Molecular Biology

This is a branch of Academia Sinica. Established in 1982, the Institute has majored its study on molecular biology, including toxicology. It also collaborates with other Institutes in Taiwan, Europe, and the United States.

Web: http://www.imb.sinica.edu.tw/en/ (English)
Web: http://www.imb.sinica.edu.tw/ch/ (Chinese)

Atomic Energy Council (AEC)

The Atomic Energy Council was founded in 1955 at the ministerial level under the Executive Yuan. Its original mission was to foster peaceful application of atomic energy. With six reactors in operation and two under construction, it has shifted to reactor safety regulation, radiation protection, radioactive waste management, and environmental monitoring.
Web: http://www.aec.gov.tw/english/ (English)
Web: http://www.aec.gov.tw/www/index.php (Chinese)
Address:
Atomic Energy Council, Executive Yuan
Floor 2-8, No. 80, Section 1, Chenggong Rd, Yonghe City
Phone: +886(2)8231-7919
Fax: +886(2)8231-7804
Email: public@aec.gov.tw

Institute of Nuclear Energy Research

The Institute was established in 1968 specializing in nuclear technology research and development programs, under the administration of AEC, Executive Yuan.
Web: http://www.iner.gov.tw/e-inerweb/iner_index.htm (English)
Web: http://www.iner.aec.gov.tw (Chinese)

Department of Health, Executive Yuan, Taiwan, ROC

The department is the highest public health administration unit in the Executive Yuan. It missions are to handle medical, health care, and disease prevention, as well as food, drugs, and cosmetic management and health insurance affairs.
Web: http://www.doh.gov.tw/EN/Webpage/index.aspx (English)
Web: http://www.doh.gov.tw/CHT2006/index_populace.aspx (Chinese)
Address:
Department of health, Executive Yuan
No.100, Aiguo E. Rd., Jhongjheng District
Taipei City 10092, Taiwan
Phone: +886(2)2321-0151

Bureau of Food and Drug Analysis, Department of Health, Executive Yuan, Taipei

This is a governmental organization for food and drug inspection and analysis. The main role of this laboratory is to provide instrumental analysis and laboratory detection of chemical toxicants and biological toxins. National surveys on the concentrations of food additives in marketed foods are performed frequently.
Web: http://www.nlfd.gov.tw/english/index.aspx (English)
Web: http://www.nlfd.gov.tw/index.aspx (Chinese)

National Bureau of Controlled Drugs, Department of Health, Taiwan

Established in 1999, the Bureau is responsible for licensing and reporting system; enforcing inspection to control drug flow and use; studying the toxicity evaluation indicators and the testing methods of controlled drugs; implementing official policy for the non-government testing laboratory certification system.
Web: http://www.nbcd.gov.tw/home/english_version/index.aspx (English)
Web: http://www.nbcd.gov.tw/home/home/index.aspx (Chinese)

Center for Disease Control (CDC)

Established in 1999, CDC was responsible for national policy of infectious diseases control and the implementation.
Web: http://www.cdc.gov.tw/en/index.asp (English)
Web: http://www.cdc.gov.tw/index.asp (Chinese)

Committee on Chinese Medicine and Pharmacy

The Committee was set up in 1971, and is responsible for the regulation policy of Chinese medicine and pharmacy for Taiwan.
Web: http://www.ccmp.gov.tw/en/index.asp (English)
Web: http://www.ccmp.gov.tw/ (Chinese)

Environmental Protection Administration, Executive Yuan

This is a national poison control network for air pollution, environmental control, and industrial sanitation. Similar organizations are also set up in the city and provincial governments.
Web: http://www.epa.gov.tw/english/ (English)
Web: http://www.epa.gov.tw/main/index.asp (Chinese)
Address:
Environmental Protection Administration
No. 41, Sec. 1, Chung-Hwa road
10042, Taipei, Taiwan
Phone: 886(2)2311-7722
Fax: 886(2)2311-6071

Environmental Analysis Laboratory (EAL)

The EAL's mission are to upgrade the quality of environmental analysis data and to enhance the capability of public and private environmental analytical laboratories.
Web: http://www.niea.gov.tw/english/a001.htm (English)
Web: http://www.niea.gov.tw/ (Chinese)

Industrial Technology Research Institute (ITRI)

The ITRI is a non-profit R&D organization engaging in applied research and technical services, including nanotechnology and biomedical engineering. It was founded in 1973. By 2001 it had grown to a 6000-people operation, and serves as the technical center for industry and an unofficial arm of the government's industrial policies in Taiwan.
Web: http://www.itri.org.tw/eng/index.jsp (English)
Web: http://www.itri.org.tw/chi/index.jsp (Chinese)
Address:
Industrial Technology Research Institute
195 Chung Hsing Rd., Sec. 4 Chu Tung
Hsin Chu, Taiwan 310, R.O.C.
Phone: +886(3)-582-0100
Fax: +886(3)582-0045

Center for Industrial Safety and Health Technology Development
Web: http://www.cesh.itri.org.tw/eng/about.php (English)
Web: http://www.cesh.itri.org.tw/index.php (Chinese)

Biomedical Engineering Research Laboratories

Web: http://www.bmec.itri.org.tw/English/about.asp (English)
Web: http://www.bmec.itri.org.tw/default.asp (Chinese)

Institute of Occupational Safety and Health, Council of Labor Affairs, Executive Yuan

The IOSH is a research institute under the Council of Labor Affairs (CLA), Executive Yuan. Its missions include surveys and analyses of various risk factors in the working environment, prepare regulatory preambles for CLA and development of countermeasures.
Web: http://www.iosh.gov.tw/iosheng/index.htm (English)
Web: http://www.iosh.gov.tw/frame.htm (Chinese)
Address:
Institute of Occupational Safety and Health
No. 99, Lane 407, Hengke Rd., Sijhih City
Taipei County 22143, Taiwan (R.O.C.)
Phone: 886-2-26607600
Fax: 886-2-26607731
Email: aiosh@mail.iosh.gov.tw

National Fire Agency, Ministry of the Interior, R.O.C.

This organization is established in 1995 for fire prevention, disaster rescue, and emergency medical service.
Web: http://www.nfa.gov.tw/asp/enews.aspx?pid=336 (English)
Web: http://www.nfa.gov.tw/index.aspx (Chinese)
Address:
National Fire Agency, Ministry of the Interior
8F, No. 200, Sec. 3, Beixin Rd., Xindian City
Taipei County 231-43, Taiwan (R.O.C)
Phone: +886(2)8911-4119/+886(2)8195-9119

National Health Research Institutes (NHRI)

The NHRI is a non-profit foundation and an autonomous research organization under the supervision of the Department of Health, Executive Yuan. It is dedicated to the enhancement of medical research and the improvement of health care in this country.
Web: http://www.nhri.org.tw/index/eindex.php3 (English)
Web: http://www.nhri.org.tw/index/cindex.php3 (Chinese)
Address:
National Health Research Institutes
35, Keyan Road, Zhunan Town, Miaoli County 350, Taiwan, ROC
Phone: +886(37)246-166
Fax: +886(37)586-401

National Health Research Institutes (Taipei Office)
10F, 3, Yuanqu Street, Taipei 115, Taiwan, ROC
Phone: +886(2)2653-4401
Fax: +886(2)2651-3723
Email: webmaster@nhri.org.tw

Taiwan Agricultural Chemicals and Toxic Substances Research Institute, Council of Agriculture

This organization was established in 1985 and is responsible for matters regarding actual toxicity testing, review, field tests of pesticides and toxic substances related to plants. The objectives of this institute are to provide technical assistance to government in reinforcing pesticide regulations, and to develop safe, economic, and effective ways of applying pesticides.
Web: http://www.tactri.gov.tw/e-intro.asp (English)
Web: http://www.tactri.gov.tw/index.asp (Chinese)
Address:
Taiwan Agricultural Chemicals and Toxic Substances Research Institute
No.11, Guangming Rd., Wufong Township
Taichung County 41358, Taiwan (ROC)
Phone: 886(4)2330-2101
Fax: 886(4)2332-3073

Organizations (non-government)

The John Tung Foundation (JTF) Foundation

The John Tung Foundation (JTF) was founded in 1984 with its main objective of 'Health for All' for the people of Taiwan. It has focused its efforts on the enactment of tobacco control policy and is highly respected by both people and government.
Web: http://www.jtf.org.tw/JTF01/01-04.asp (English)
Web: http://www.jtf.org.tw/JTF01/01-01.asp (Chinese)
Address:
The John Tung Foundation (JTF)
12F.-3, No. 57, Fuxing N. Rd., Songshan District
Taipei City 105, Taiwan (ROC)
Phone: +886(2)2776-6133
Fax: +886(2)2752-2455

The Red Cross Society of The Republic of China

Based on love, the organization's current focus is providing services of social concern.
Web: http://www.redcross.org.tw/RedCross/indexset/Index1.jsp?groupid=106 (Chinese)
Address:
The Red Cross Society of The Republic of China
10F., No. 276, Sec. 2, Jianguo S. Rd.
Da-an District, Taipei City 106, Taiwan (ROC)
Phone: +886(2)2362-8232
Email: redcross@redcross.org.tw

Universities

Chang Gung University
Web: http://www.cgu.edu.tw/eng_cgu/eng_index.htm (English)
Web: http://www.cgu.edu.tw/ (Chinese)
Address:
Chang Gung University
259 Wen-Hwa 1st Road, Kwei-Shan Tao-Yuan
Taiwan, 333, ROC
Phone: +886(3)211-8800
Fax: +886(3)2118-700

China Medical University
Web: http://english.cmu.edu.tw/ (English)
Web: http://www.cmu.edu.tw/ (Chinese)
Address:
China Medical University
No. 91 Hsueh-Shih Road,Taichung
Taiwan 40402, ROC
Phone: +886(4)2205-3366
Email: cc@mail.cmu.edu.tw

Department of Occupational Safety and Health
Web: http://www2.cmu.edu.tw/~cmcdosh/home.htm (Chinese)

Chung Shan Medical University
Web: http://english.csmu.edu.tw/mp.asp?mp=1029 (English)
Web: http://www.csmu.edu.tw/front/bin/home.phtml (Chinese)
Address:
Chung Shan Medical University
No. 110, Sec. 1, Chien-Kuo N. Road
Taichung, 402, Taiwan, ROC
Phone: +886(4)2473-0022

Institute of Medical and Molecular Toxicology
Web: http://english.csmu.edu.tw/sp.asp?xdURL=./school/school_2-1_departments_department.asp&SchoolID=1029&SchoolAcademyID=267&AcademyDepartmentID=2956&ctNode=6536&href_from=&eat_subcategory_str=&mp=1029 (English)
Web: http://toxicol.csmu.edu.tw/front/bin/home.phtml (Chinese)

Department of Occpational Safety and Health
Web: http://english.csmu.edu.tw/sp.asp?xdURL=./school/school_2-1_departments_department.asp&SchoolID=1029&SchoolAcademyID=563&AcademyDepartmentID=3001&ctNode=6536&href_from=&eat_subcategory_str=&mp=1029 (English)
Web: http://occupation.csmu.edu.tw/front/bin/home.phtml (Chinese)

Graduate Institute of Occupational Safety and Health, Kaohsiung Medical University
Web: http://www.kmu.edu.tw/~ochs/index12.htm (Chinese)
Address:
Graduate Institute of Occupational Safety and Health. Kaohsiung Medical University
No. 100, Shiquan 1st Rd., Sanmin District
Kaohsiung City 807, Taiwan (ROC)
Phone: +886(7)3121-101

Graduate Institute of Environmental Engineering, National Central University
Web: http://w3.ev.ncu.edu.tw/ (Chinese)
Web: http://www.ev.ncu.edu.tw/Default.aspx?alias=www.ev.ncu.edu.tw/english (English)
Address:
Graduate Institute of Environmental Engineering, National Central University
No. 300, Jhongda Rd., Jhongli City
Taoyuan County 32001, Taiwan (ROC)
Phone: +886(3)4227-151

National Cheng Kung University
Web: http://www.ncku.edu.tw/ver2006/en/ (English)
Web: http://www.ncku.edu.tw/ver2006/ch/ (Chinese)
Address:
National Cheng Kung University
No. 1 University Rd., Tainan City
701, Taiwan (ROC)
Phones: +886(6)275-7575

Department of Environmental and Occupational Health
Web: http://www.ncku.edu.tw/~deoh/english_homepage/e_link_0.htm (English)
Web: http://www.ncku.edu.tw/~deoh/ (Chinese)

Center of Environmental and Occupational Medicine, National Cheng Kung University
Web: http://www.ncku.edu.tw/~oem1/ (Chinese)

Research center of environmental trace toxic substances
Web: http://www.ncku.edu.tw/~rcetts/english.htm (English)
Web: http://www.ncku.edu.tw/~rcetts/index.htm (Chinese)

Institute of Environmental Engineering, National Chiao Tung University
Web: http://www.cc.nctu.edu.tw/~iev/emain.htm (English)
Web: http://www.cc.nctu.edu.tw/~iev/main.htm (Chinese)

Address:
National Chiao Tung University
Institute of Environmental Engineering
No.75, Bo-ai St., Hsinchu City 300, Taiwan (ROC)
Phone: +886(3)5712-121, ext 55501/55502
Fax: +886(3)5725-958

National Taiwan University
Web: http://www.ntu.edu.tw/eng2007/ (English)
Web: http://www.ntu.edu.tw/chinese2007/ (Chinese)
Address:
National Taiwan University
No. 1, Sec. 4, Roosevelt Road
Taipei, 10617 Taiwan
Phone: +886(2)3366-3366
Fax: +886(2)2362-7651

College of Public Health, National Taiwan University
Web: http://homepage.ntu.edu.tw/~phc/english/index.htm (English)
Web: http://homepage.ntu.edu.tw/~phc/index.html (Chinese)
Address:
College of Public Health, National Taiwan University
No. 17 Xu-Zhou Road, Taipei, 10020 Taiwan (ROC)
Phone: +886(2)3322-8006
Fax: +886(2) 23911308
Email: (Chen, Shu-Yi) ntuphc@ha.mc.ntu.edu.tw

Institute of Environmental Health
Web: http://ieh.mc.ntu.edu.tw/english/pic/index.html (English)
Web: http://ieh.mc.ntu.edu.tw/chinese/pic/index.html (Chinese)

Institute of Epidemiology
Web: http://homepage.ntu.edu.tw/~epidem/english/index.htm (English)
Web: http://homepage.ntu.edu.tw/~epidem/index.htm (Chinese)

Institute of Occupational Medicine and Industrial Hygiene
Web: http://omih.ntu.edu.tw/ENG/index.html (English)
Web: http://omih.ntu.edu.tw/CHT/index.html (Chinese)

College of Medicine, National Taiwan University
Web: http://www.mc.ntu.edu.tw/main.php?Page=N1 (English)
Web: http://www.mc.ntu.edu.tw/main.php?Page=N1 (Chinese)
Address:
National Taiwan University
College of Medicine
No. 1, Jen Ai Rd., Section 1
Taipei 100, Taiwan (ROC)
Phone: +886(2)2312-3456
Fax: +886-2-23224793
Email: tcc@med.mc.ntu.edu.tw

Department/Institute of Pharmacology
Web: http://www.mc.ntu.edu.tw/main.php?Page=N4O3P7 (English)
Web: http://www.mc.ntu.edu.tw/main.php?Page=A4B3C3 (Chinese)

Graduate Institute of Biochemistry and Molecular Biology
Web: http://www.mc.ntu.edu.tw/main.php?Page=N4O3P6 (English)
Web: http://www.mc.ntu.edu.tw/main.php?Page=A4B3C6 (Chinese)

Graduate Institute of Toxicology
The faculty of the institute consists of five professors and associate professors.
Web: http://www.mc.ntu.edu.tw/main.php?Page=N4O3PC (English)
Web: http://www.mc.ntu.edu.tw/TOXICO/main.php?Page=A1 (Chinese)

Department of Forensic Medicine
Web: http://www.mc.ntu.edu.tw/department/forensic/index-e.html (English)
Web: http://www.mc.ntu.edu.tw/department/forensic/index.html (Chinese)

Graduate Institute of Environmental Engineering, College of Engineering
Web: http://homepage.ntu.edu.tw/~giee/e_Index.htm (English)
Web: http://www.ev.ntu.edu.tw/ (Chinese)
Address:
Graduate Institute of Environmental Engineering, College of Engineering
No. 71, Chou-Shan Rd.
Taipei 106, Taiwan
Phone: +886(2)2362-8034
Fax: +886(2)23928830
Email: giee@ntu.edu.tw

National Yang-Ming University
Web: http://www.ym.edu.tw/english/ (English)
Web: http://www.ym.edu.tw/ (Chinese)
Address:
National Yang-Ming University
No. 155, Sec. 22, Linong St., Beitou District
Taipei City 112, Taiwan (ROC)
Phone: +886(2)2826-7000

Institute of Environmental Health Science
Web: http://www.ym.edu.tw/ieh/Eng-total.htm (English)
Web: http://www.ym.edu.tw/ieh/page1.htm (Chinese)

Taipei Medical University
Web: http://english.moe.gov.tw/mp.asp?mp=1028 (English)
Web: http://www.tmu.edu.yw/ (Chinese)
Address:
Taipei Medical University
250 Wu-Xin Street, Taipei City110, Taiwan
Phone: +886(2)2736-1661

Tzu Chi University
Web: http://www.tcu.edu.tw/TcuEn/About%20TCU.asp (English)
Web: http://www.tcu.edu.tw/tcuweb/index.htm (Chinese)
Address:
Tzu Chi University
No. 701, Chung Yang Rd., Sec. 3 Hualien
Taiwan 970 (ROC)
Phone: +886(3)8565-301

Professional Societies

Chinese Institute of Chemical Engineers
Web: http://www.twiche.org.tw/ (Chinese)
Address:
R904, 9F., No. 7, Chong-Ching South Rd. Sec. 1
Taipei City 100, Taiwan (ROC)
Phone: +886(2)23754456
Fax: +886(2)23702221
Email: twiche@twiche.org.tw

Formosan Medical Association

This is the major medical association of Taiwan, which was founded in 1902.
Web: http://fma.mc.ntu.edu.tw/ (Chinese)
Address:
3F, No. 1, Changde St., Jhongjheng District
Taipei City 100, Taiwan (ROC)
Phone: +886(2)2331-0558
Fax: +886(2)2389-6716

Radiological Society Republic of China
Web: http://www.rsroc.org.tw/ (Chinese)
Address:
No. 201, Shi-Pai Rd. Sec. 2, Beitou District
Taipei City 112, Taiwan (ROC)
Phone: +886(2)2876-9035
Fax: +886(2)2876-9036

Society of Preventive Medicine in Taiwan
Web: http://www.ym.edu.tw/iph/cspm/index.htm (Chinese)
Address:
Society of Preventive Medicine in Taiwan
No. 155, Sec. 22, Linong St., Beitou District
Taipei City 112, Taiwan (ROC)
Phone: +886(2)2826-7193
Fax: +886(2) 2827-0576

Taiwan Association for Medical Informatics
Web: http://www.medinfo.org.tw/ (Chinese)
Address:
Taiwan Association for Medical Informatics
No. 5, Fuxing St., Guishan Shiang
Taoyuan County 333, Taiwan (ROC)
Phone: +886(3)3972-424
Fax: +886(3)3972-424

Taiwan Environmental and Occupational Medicine Association
Address:
No. 138, Sheng Li Road, Tainan
Taiwan 704, ROC
Department of Occupational and Environmental Medicine
College of Medicine
National Cheng Kung University
Phone: +886(6)2365228; +886(6)2347207
Fax: +886(6)2752484
Web: http://www.eoma.org.tw/

Taiwan Public Health Association

This is most important association of public health in Taiwan that has about 180 organization members and more than 1200 individual members.
Web: http://www.publichealth.org.tw/ (Chinese)
Address:
Taiwan Public Health Association
No. 17 Xu-Zhou Road, Taipei
10020 Taiwan (ROC)
Phone: +886(2)2391-9529

Toxicology Society of Taiwan (TSTA)

Laboratory of Toxicology Research, Veterans General Hospital-Taipei
Address:
No. 201, Sec. 2, Shih-Pai Road, Shih-Pai
Taipei, Taiwan 11217 (ROC)
Phone: 886(2)2871-2121, ext 3378

The Chinese Institute of Environmental Engineering

The most important association of environmental engineers in Taiwan.
Web: http://www.cienve.org.tw/ (Chinese)
Address:
The Chinese Institute of Environmental Engineering
9F., No. 283, Sec. 1, Fuxing S. Rd., Da-an District
Taipei City 106, Taiwan (ROC)
Phone: +886(2)2754-0326
Fax: +886(2)2754-4920

Poison Information Centers

The Taiwan National Poison Control Center, Veterans General Hospital, Taipei

The ongoing toxicology programs in the unit are clinical consultations and patient care, clinical toxicology laboratory service, and poison and drug consultation center.
Web: http://www.pcc.vghtpe.gov.tw/index.asp (Chinese)
Address:
The Taiwan National Poison Control Center
No. 201, Sec. 2, Shih-Pai Road, Shih-Pai
Taipei, Taiwan 11217 (ROC)
Phone: +886(2)2874-7525
Fax: +886(2)2873-9193

Poison and Toxicology Laboratory, Department of Emergency Medicine, Tai Chung Veterans General Hospital
Web: http://www3.vghtc.gov.tw/toxi/news/newsmain.html (Chinese)
Address:
No. 160, Sec. 3, Chung-Kang Rd.
Taichung, 40705 Taiwan (ROC)
Phone: 886(4)2359-9783, ext 9
Fax: 886(4)23595046

Taiwan Agricultural Chemicals and Toxic Substances Research Institute, Council of Agriculture
Web: http://www.tactri.gov.tw/e-intro.asp (English)
Web: http://www.tactri.gov.tw/index.asp (Chinese)
Address:
Taiwan Agricultural Chemicals and Toxic Substances Research Institute
No. 11, Guangming Rd., Wufong Township
Taichung County, 41358 Taiwan (ROC)
Phone: +886(4)2330-2101
Fax: +886(2)2332-3073

Laboratory of Clinical Toxicology, Department of Emergency Medicine, National Taiwan University Hospital
Web: http://erlab.mc.ntu.edu.tw/ (Chinese)
Address:
National Taiwan University Hospital
No. 7, Chung San South Road
100 Taipei, Taiwan (ROC)
Phone: +886(2)23562831
Fax: +886(2) 23223150

CHAPTER

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United Kingdom

L. ASHDOWN, P.T.C. HARRISON, P. HOLMES, AND M. TAKAMIYA

INTRODUCTION

Humanity's growing understanding that external agents may cause harm has an extremely long history, dating no doubt to the recognition by early humans that some plants and animals were poisonous and extending to the understanding that non-living materials could also cause harm. Indeed, the first known deity connected with poisons, Gula, dates back to 4500 BC, and treatises on herbal medical experiments with poisons date back to 2000 BC. A number of philosophers – including Homer, Aristotle, Theophrastus, and Socrates – from early Greek civilization were clearly well aware of the effects of some poisons, while there are stories dating from the pre-AD period of experiments, usually on criminals, of the effects of poisons and the use of antidotes.

While Europe has its own long history of famous poisoners, such as Cesare Borgia and Catherine de Medici, and knowledge of the effects of poison even found its way into the plays of Shakespeare (Romeo and Juliet Act 5 'Thy drugs are quick. Thus with a kiss I die'), the formal study of poisons as a 'science', in a way recognizable to modern toxicology is generally held to have started with Paracelsus – born Phillip von Hohenheim in Einsiedeln, Switzerland in 1493 – who famously wrote 'Alle Ding sind Gift und nichts ohn Gift; allein die Dosis macht, dass ein Ding kein Gift ist' [All things are poison and nothing is without poison, only the dose permits something not to be poisonous]. However, it was not until the 1700s that toxicological treatises can really be identified within the UK by the publication of such work as 'The Mysteries of Opium Revealed' by Dr John Jones in 1701, that discussed not only the medical uses of opium but also potential adverse effects, and a hypothesis by Dr George Baker in the 1760s that lead in apple juice was to blame for a condition, Devon Colic, that had been known since 1655. The work of Sir Percival Pott is also of note in this century, with the recognition of an association between exposure to soot and the high incidence of scrotal cancer in young chimneysweeps in 1775, thus establishing the first demonstration that a malignancy could be caused by an environmental carcinogen. In turn, the 1800s saw early applications of forensic toxicology, for example, the use of a test developed by James Marsh as evidence of arsenic poisoning in a murder case in 1840, and also the introduction of the first measures to control the sale of a poisonous substance, such as the Arsenic Act of 1851. Indeed, a bill had been proposed as early as 1819 to regulate the distribution and sale of arsenic, but was heavily opposed by the Committee of Associated Apothecaries on the grounds that it would 'embarrass the dispensing of medicines, and [was] not calculated to effect the object intended'.

With the coming of the twentieth century, there were major developments across the globe in our ability to manufacture novel toxic agents and to detect them through chemical analysis, as well as a growing understanding of the mechanisms by which the toxic agents work and the types of effect that can occur; World War I contributed in no small measure to this through the use of various poison gases in 1914 and the subsequent efforts by both sides to develop more powerful weapons and counter measures. Since that time, with its well-established university system, the establishment of dedicated research units (e.g. the

MRC's Toxicology Unit, originally established at Porton Down in 1947, to study the mechanism of action of chemicals at all levels from the animal to the individual molecules) and our large chemical, agrochemical, and pharmaceutical industrial sectors, the UK has been heavily involved in applied toxicological research, as well as contributing to basic chemical and biological (e.g. the identification of the structure of DNA by Crick and Watson at the Cavendish Laboratory, Cambridge University in 1953) understanding.

Thus, today the UK remains active in basic academic research and the application of such knowledge to practical issues across the wide field of toxicology, from the discovery and development of new drugs, regulation of the use of chemicals in relation to novel foods and food-related materials, biocides and industrial and consumer products, through to environmental- and eco-toxicology and forensic toxicology. The UK government has also played a leading role in improving the welfare of experimental animals (e.g. through the Animals (Scientific Procedures) Act 1986) and in promoting adoption of alternative test approaches wherever possible (e.g. through promotion of replacement, reduction and refinement for the use of animals, the so called '3Rs' principle) and its establishment of a National Centre for the Replacement, Refinement and Reduction of Animals in Research (NC3Rs). The current time is, however, a particularly challenging one in the history of toxicology in the United Kingdom (UK). As well as the need to address the challenges and opportunities posed to toxicological risk assessment by the rapid developments in new technologies (such as '-omics') and the increasing understanding of the mechanistic basis of genotoxic and non-genotoxic carcinogenesis and mixture toxicology, there are the forthcoming challenges presented by a major step change in the approach to chemical regulation across the European Union (EU) with the impending implementation of the Registration, Evaluation (Restriction) and Authorisation of Chemicals (REACH) regulations in 2007. Supporting this wide range of activities is a growing base of academically and/or professionally trained toxicological specialists. For example, there are at present approximately 1000 members of the British Toxicological Society (BTS) and 297 UK Registered Toxicologists (the designation of which also confers membership of the EUROTOX Register of Toxicologists). The BTS, along with sister organizations such as the Royal College of Pathologists and the Institute of Biology and the Society of Apothecaries of London, oversees the professional standing of toxicologists in this country. The Society of Environmental Chemistry and Toxicology (SETAC) has a role in representing the particular interests of environmental toxicologists and ecotoxicologists.

RESOURCES

The following books and journals were identified through the use of structured searches of online databases. The term 'toxicology' was applied as the main keyword to identify relevant documents with, for books, only those with authors identified as British or who are based in the UK being selected. Where there was any degree of uncertainty, a book was included if it was also published in the UK. Relevant journals were defined as those with one or more editors based in the UK.

Books

Aldridge WN (1996)
Mechanisms and Concepts in Toxicology
CRC Press, 254 pp

This book focuses on research procedures in toxicology, aiming to illustrate toxicological concepts and types of toxicity from a mechanistic point of view.

Ashford N, Miller C (1998)
Chemical Exposures: Low Levels and High Stakes
Chapman and Hall: London, 464 pp

This work clarifies the nature of chemical sensitivity, shows how it differs from traditional allergies and toxicity, and suggests how federal and state governments can help those who are affected.

Bal R, Halffman W (Eds.) (1998)
The Politics of Chemical Risk – Scenarios for a Regulatory Future
Kluwer Academic Publishers: London, 392 pp

This book forms a discussion of the politics of chemical risk.

Barrett S, Gots RE (1998)
Chemical Sensitivity: The Truth about Environmental
Prometheus Books: Loughton, 212 pp

The authors explore the speculations about environmental exposure in the light of scientific knowledge of human physiology, allergy and immunology, pathology, toxicology, and clinical medicine.

Donaldson K, Borm P (2006)
Particle Toxicology
CRC Press, 456 pp

The book brings together the state of the science in particle physico-chemistry, cell biology, and toxicology in a single volume. It also covers mathematical modeling and human studies as avenues for future research.

Gibson G (1993)
Peroxisomes: Biology and Importance in Toxicology and Medicine
CRC Press, 734 pp

This book describes the basic structure and functions of peroxisomes which are responsible for many cellular functions including an active auxiliary fatty acid B-oxidation system.

Harvey PW (1996)
Adrenal in Toxicology: Target Organ and Modulator of Toxicity
CRC Press, 330 pp

This book focuses on adrenal toxicity, examining how drugs and chemicals can directly and indirectly affect the adrenal gland.

Hendry JH, Lord BI (1995)
Radiation Toxicology
CRC Press, 360 pp

This book covers every injury to the bone marrow which can occur from low and high doses of ionizing radiation – for example, X-rays, gamma-rays and especially damaging types of radiation such as alpha-rays.

Hester RE, Harrison RM (Eds) (1998)
Risk Assessment and Risk Management
The Royal Society of Chemistry: Cambridge, 180 pp

This work addresses risk assessment and management within the context of environmental science and technology. Chapters cover areas including: the assessment of risks to health from the land-filling of household wastes; and aquatic risk assessment and management for pesticides.

Jones A, Dargan P (Eds.) (2001)
Churchill's Pocket Book of Toxicology
Elsevier, 176 pp

This practical manual covers the basic principle of care for poisoned patients including elimination methods, supportive care, talking to relatives, and use of the toxicology laboratory.

Kimber I, Dearman RJ (1997)
Osweiler G (1996)
Toxicology
Blackwell Publishing

This book is a concise review of clinically relevant toxicants in veterinary medicine. It covers basic toxicology, including the action of poisons, therapy, and antidotes; clinical toxicology of body systems; and classes of toxicants.

Kimber I, Maurer T (1996)
Toxicology of Contact Hypersensitivity
CRC Press, 208 pp

This book considers the condition from the perspective of the toxicologist rather than the dermatologist.

Morgan BJT (Ed.) (1996)
Statistics in Toxicology: A Volume in Memory of David A. Williams
Oxford University Press, 248 pp

Rhodes CJ (2000)
Toxicology of the Human Environment
CRC Press, 512 pp

This book covers all aspects of toxic agents in the environment from their detection to their effects.

Roberts RJ (1999)
Apoptosis in Toxicology
CRC Press, 248 pp

This book focuses on the molecular regulation of apoptosis with particular emphasis on toxicant action.

Robinson L, Thorn I (Eds.) (2001)
Handbook of Toxicology and Ecotoxicology for the Pulp and Paper Industry
Blackwell Publishing, Oxford

This book provides a guide to the use and meaning of toxicological and ecological information in the paper industry.

Robinson L, Thorn I (2005)
Toxicology and Ecotoxicology in Chemical Safety Assessment
CRC Press, 256 pp

The information contained in this book will help those personnel understand, interpret, and apply the range of information supplied on a material safety data sheet when planning the safe handling and use of chemicals.

Rose J (1998)
Environmental Toxicology: Current Developments
CRC Press, 414 pp

A collection of essays which highlights current developments in the field of environmental toxicology. It also examines the effects of toxins on other organisms, as well as the techniques, policies, and management strategies employed in studying and controlling environmental pollutants.

Shaw I, Chadwick J (1998)
Principles of Environmental Toxicology
CRC Press, 216 pp

This textbook provides a general introduction to all the major areas of environmental toxicology, including the fate of chemicals in the environment, environmental toxicity testing, risk assessment, radioactivity in the environment, legislation, environmental monitoring, and the future impact of industrial development on the environment.

Swanson TM, Vighi M (Eds.) (1998)
Regulating Chemical Accumulation in the Environment: The Integration of Toxicology and Economics in Environmental Policy-making
Cambridge University Press, 240 pp

This book forms a general study of the value of interdisciplinary approaches in environmental policy making.

Timbrell J (1997)
Study Toxicology Through Questions
CRC Press, 160 pp

This is a compilation of questions with answers for students of toxicology. The book should also be useful for qualified toxicologists and scientists working in related areas who are preparing for internal examinations.

Timbrell JA (1999)
Principles of Biochemical Toxicology
Taylor & Francis, 404 pp

This textbook provides an explanation of dose–response relationships, disposition and metabolism, toxic responses to foreign compounds and detailed examples to illustrate mechanisms of toxicity.

Timbrell J (2001)
Introduction to Toxicology
CRC Press, 232 pp

This third edition features relevant toxicological examples that reinforce principles.

Wooley A (2003)
A Guide to Practical Toxicology: Evaluation, Prediction and Risk
CRC Press, 336 pp

This book looks at the importance of toxicological normality, reviews toxicity testing methods, and explores new and 'alternative' methods of safety evaluation.

Wright DA, Welbourn P (2002)
Environmental Toxicology
Cambridge University Press, 656 pp

This is an introductory textbook dealing with most aspects of the subject, from the molecular to the ecosystem level.

Zakrzewski SF (Ed.) (2002)
Environmental Toxicology
Oxford University Press, 352 pp

This book consists of two parts. In the first part basic metabolic, physiological, and pharmacological concepts are used to explain the fate of toxic chemicals in the body, with emphasis on carcinogenesis and mutagenesis. The second part deals with specific environmental problems.

Toxicology of Chemical Respiratory Hypersensitivity
CRC Press, 172 pp

This book examines aspects of chemical respiratory allergy and occupational asthma caused by exposure to chemicals. It covers occupational safety measures, and methods for identifying and characterizing chemical allergens.

Journals

Bioorganic & Medicinal Chemistry Letters
Elsevier Science Ltd

Presents preliminary experimental or theoretical research results of outstanding significance and timeliness on all aspects of science at the interface of chemistry and biology, and on major advances in drug design and development.

Chemosphere
Elsevier Science Ltd

Offers maximum dissemination of investigations related to all aspects of environmental science.

Comparative Biochemistry and Physiology. C, Comparative Pharmacology and Toxicology
Pergamon

Concerned with chemical and drug action at different levels of organization, biotransformation of xenobiotics, mechanisms of toxicity, including: reactive oxygen species and carcinogenesis, endocrine disruptors, natural products chemistry, and signal transduction with a molecular approach to these fields.

Crop Protection
Butterworth

Emphasizes the practical aspects of control in the field, and includes work which may lead in the near future to more effective control.

Environmental Pollution
Elsevier Science Ltd

Addresses issues relevant to the nature, distribution and ecological effects of all types, and forms of chemical pollutants in air, soil, and water.

Environmental Science & Policy
Elsevier Science Ltd

Promotes communication among government, business and industry, academia, and non-governmental

organizations that are instrumental in the solution of environmental problems.

Environmental Technology
Publications Division, Selper Ltd.

Publication of technological manuscripts in the field of applied environmental studies, including environmental biotechnology, environmental and sanitary engineering, industrial waste management and hazardous waste disposal, air and water pollution control, solid waste management, industrial hygiene, and associated technologies.

Expert Opinion on Drug Metabolism & Toxicology
Ashley Publications Ltd

Provides a forum for the commentary and analysis of current and emerging research approaches in the ADME-Tox arena, as well as metabolic, pharmacokinetic, and toxicological issues relating to specific drugs or drug classes.

Food and Chemical Toxicology
Pergamon Press

Publishes original research reports and occasional interpretative reviews on toxic effects, in animals or humans, of natural or synthetic chemicals occurring in the human environment.

Food Chemistry
Elsevier Science Ltd

Publishes original peer-reviewed research papers dealing with a wide range of subjects which are essential to the food scientist and technologist.

Health Technology Assessment
National Co-ordinating Centre for Health Technology Assessment

Publication from program which ensures that high-quality research information on the costs, effectiveness, and broader impact of health technologies is produced in the most effective way for those who use, manage, and provide care in the NHS.

Health, Risk & Society
Carfax

Devotes to a theoretical and empirical understanding of the social processes which influence the ways in which health risks are taken, communicated, assessed, and managed.

Human & Experimental Toxicology
SAGE Publications

Covers all aspects of experimental and clinical studies of functional, biochemical, and structural disorder.

Journal of Applied Toxicology
John Wiley and Sons

Devoted to publishing original research, theoretical and literature reviews relating to the toxicity of drugs and chemicals to living systems at the molecular, cellular, tissue, and target organ level.

Journal of Cardiovascular Risk
Lippincott Williams & Wilkins

Embraces all the scientific, clinical, and public health disciplines that address the causes and prevention of cardiovascular disease, as well as cardiovascular rehabilitation and exercise physiology.

Journal of Occupational Medicine and Toxicology
BioMed Central

Open access, peer-reviewed, online journal that considers original research related to the field of occupational medicine and toxicology.

Journal of Toxicology and Environmental Health. Part A
Taylor & Francis

Features strictly refereed original research in the field of environmental toxicology in general as well as in special interest fields such as target organ toxicities, immunotoxicology, risk assessment, carcinogenesis, mutagenesis, ecotoxicology, environmental factors affecting health, and aquatic toxicology.

Marine Environmental Research
Elsevier Science Ltd

Serves as a forum for new information on biology, chemistry, and toxicology and syntheses that advance understanding of marine environmental processes.

Marine Pollution Bulletin
Pergamon

Concerned with the rational use of maritime and marine resources in estuaries, the seas, and oceans, as well as with documenting marine pollution and introducing new forms of measurement and analysis.

Particle and Fibre Toxicology
BioMed Central

Open-access, peer-reviewed, online journal for new scientific data, hypotheses, and reviews on the toxicological effects of particles and fibers.

Pest Management Science
John Wiley & Sons

Covers all aspects of research and development, application, use, and impact on the environment of products designed for pest control and crop protection.

The Annals of Occupational Hygiene
Oxford University Press

Interests in recognition, quantification, management, and control of risk.

Toxicology and Industrial Health
SAGE Publications

Contains original research papers presenting scientific data dealing with basic and applied research in the field of toxicology and industrial health.

Toxicology in vitro
Pergamon Press

Publishes original research papers and reviews on the application and use of in vitro systems for assessing or predicting the toxic effects of chemicals and elucidating their mechanisms of action.

Toxicology Mechanisms and Methods
Taylor & Francis

Contains original research on subjects dealing with the mechanisms by which foreign chemicals cause toxic tissue injury. Addresses aspects of the development, validation, and application of new and existing laboratory methods, techniques, and equipment.

Toxicon
Pergamon Press

Provides a medium for the publication of papers on the chemical, pharmacological, zoo-toxicological, and immunological properties of natural poisons.

Trends in Food Science & Technology
Elsevier Science Ltd

The international peer-reviewed mini-review journal in its field.

Waste Management & Research
IWM Business Services Ltd

Satisfies the growing demand for essential information that can be practically applied by those who are responsible for the management of both municipal and industrial waste.

Water Research
Pergamon Press

Publishes refereed, original research papers on all aspects of the science and technology of water quality and its management worldwide.

Water Science and Technology
Pergamon Press

Covers all aspects of the science and practice of water pollution control and water quality management worldwide.

Xenobiotica; the fate of foreign compounds in biological systems
Taylor & Francis

Covers general xenobiochemistry, molecular toxicology, and clinical pharmacokinetics and metabolism.

Organizations (Government)

Government Departments

Department for Environment, Food, and Rural Affairs (DEFRA)

Responsibilities include EU risk assessment, emission controls, risk assessment on non-native species, etc.
Nobel House, 17 Smith Square, London SW1P 3JR, UK
Phone:+44-(0)20-7238-6000
Web: http://www.defra.gov.uk/

Specific areas of activity include:
Chemicals

Responsibilities include protecting the environment and human health from the risks posed by exposure to hazardous chemicals. Aims to maximize the important socio-economic benefits that we rely on chemicals for.
Email: chemicals.strategy@defra.gsi.gov.uk
Web: http://www.defra.gov.uk/environment/chemicals/

Drinking Water Inspectorate (DWI)

Responsible for assessing the quality of drinking water in England and Wales, taking enforcement action if standards are not being met, and appropriate action when water is unfit for human consumption.
Room M03, 55 Whitehall, London SW1A 2EY, UK
Phone:+44-(0)20-7082-8024
Fax:+44 (0)20 7082 8028
Email: dwi.enquiries@defra.gsi.gov.uk
Web: http://www.dwi.gov.uk/

Water

Responsible for all aspects of water policy in England, including water supply and resources, and the regulatory systems for the water environment and the water industry.
Email: wq.enquiries@defra.gsi.gov.uk (general enquiries)
Web: http://www.defra.gov.uk/environment/water/

Department of Health (DH)

Areas of activity relevant to toxicology include risk assessment of carcinogenicity, mutagenicity of chemicals in food, consumer products, and the environment.

Richmond House, 79 Whitehall, London SW1A 2NS, UK
Phone:+44-(0)20-7210-4850
Fax:+44-(0)20-7210-5025
Web: http://www.dh.gov.uk/Home/fs/en

Specific activities include:
Animals in Medical Research

Areas of activity relevant to toxicology include animal experimentation.
Web: http://www.dh.gov.uk/en/Policyandguidance/Researchanddevelopment/A-Z/DH_4001729

International Health

Areas of activity relevant to toxicology include guidance on the move to treat certain NHS patients overseas.
Web: http://www.dh.gov.uk/en/Policyandguidance/International/index.htm

Department of Trade and Industry (DTI)

The Department responsible for trade, business, employees, consumers, science and energy.
Specific divisions include:
DTI Chemicals Unit

The DTI Chemicals Unit works with industry to help promote improvements in productivity and competitiveness, and to represent interests of the UK chemicals industry (excluding pharmaceuticals but including plastics and rubber processing), including issues relating to chemical regulation.
Contact: Unit Director
Phone:+44-(0)207-215-2911/+44-(0)207-215-2968
Web: http://www.dti.gov.uk/sectors/chemicals/index.html

Office of Science and Innovation

The Office of Science and Innovation, located within the DTI, is responsible for UK Science Policy and for funding basic research allocated via the Research Councils. It aims to maximize the contribution made by our science, engineering, and technology skills and resources to the UK's economic development, and to the quality of our lives.
Web: http://www.dti.gov.uk/science/index.html

Home Office

Activities relevant to toxicology include the establishment of toxicological information to allow the safe use of chemicals; safety assessments of chemicals to meet regulatory requirements, toxicological assessment of potential drug compounds.

Direct Communications Unit
2 Marsham Street, London SW1P 4DF, UK
Phone: +44-(0)20-7035-4848
Fax:+44-(0)20-7035-4745
Email: public.enquiries@homeoffice.gsi.gov.uk
Web: http://www.homeoffice.gov.uk/

Animals in Scientific Procedures Inspectorate

This is the part of the Home Office responsible for provision of scientific advice to the Home Secretary and to officials who operate the system that approves licences for laboratories that use animals in research.
Web: http://www.homeoffice.gov.uk/science-research/animal-testing/

National Assembly for Wales

This is the devolved administration for Wales, and is responsible for developing a sustainable environment for the Welsh population. Areas of activity include sustainable development, environmental strategy, planning and the sustainable management of landscapes.
Cathays Park, Cardiff CF10 3NQ, UK
Phone: +44-(0)845-010-3300
Web: http://new.wales.gov.uk/?lang=en

Scottish Parliament
This is the devolved administration for Scotland.
Edinburgh EH99 1SP, Scotland, UK
Phone: +44-(0)131-348-5000/+44-(0)845-278-1999
Fax: +44-(0)131-348-5601
Email: sp.info@scottish.parliament.uk
Web: http://www.scottish.parliament.uk/home.htm

Of particular relevance to toxicology is the work of the Environment and Rural Development division.
Environment and Rural Development

Considers and reports on matters relating to rural development, environment and natural heritage, agriculture and fisheries and such other matters as fall within the responsibility of the Minister for Environment and Rural Development.
Contact Jenny Goldsmith
Phone: +44-(0)131-348-5242
Email: ERDC@scottish.parliament.uk
Web: http://www.scottish.parliament.uk/business/committees/environment/index.htm

Government agencies and services

Central Science Laboratory (CSL)

An executive agency of the UK Government Department for Environment Food and Rural Affairs (Defra), undertaking research and analytical, diagnostic and consultancy services designed to support land-based and food industries.

Sand Hutton, York YO41 1LZ, UK
Phone: +44-(0)1904-462000

Fax: +44-(0)1904-462111
Email: info@csl.gov.uk
Web: http://www.csl.gov.uk/

Centre for Environment, Fisheries & Aquaculture Science (CEFAS)
Web: http://www.cefas.co.uk/default.aspx

Government-supported aquatic scientific research and consultancy service operating out of a number of laboratories:
Cefas Lowestoft Laboratory
Pakefield Road, Lowestoft, Suffolk NR33 0HT
Phone: +44-(0)1502-562244
Fax: +44-(0)1502-513865

Cefas Burnham Laboratory
Remembrance Avenue, Burnham-on-Crouch, Essex CM0 8HA
Tel: +44-(0)1621-787200
Fax: +44-(0)1621-784

Cefas Weymouth Laboratory
The Nothe, Barrack Road, Weymouth, Dorset DT4 8UB
Tel: +44-(0)1305-206600
Fax: +44-(0)1305-206601

English Nature

A Government Agency funded by Defra, promoting conservation of England's wildlife and natural features.
Natural England, Northminster House, Peterborough PE1 1UA, UK
Tel: +44-(0)845-600-3078
Fax: +44-(0)1733-455103
Email: enquiries@naturalengland.org.uk
Web: http://www.english-nature.org.uk/

Environment Agency (EA)

The lead public body for protecting and improving the environment in England and Wales. Operates at both a national and regional level.
Environment Agency, Head Office, Rio House, Waterside Drive, Aztec West, Almondsbury, Bristol BS32 4UD, UK
Phone: +44-(0)8708-506506
Web: http://www.environment-agency.gov.uk/

Area of particular relevance to toxicology:
Science and Research

Responsible for conduct of government science program for risk assessment of banned chemicals and environmental monitoring
Web: http://www.environment-agency.gov.uk/science/

Food Standards Agency (FSA)

The Food Standards Agency is an independent Government department set up by an Act of Parliament in 2000 to protect the public's health and consumer interests in relation to food.
UK Headquarters
Food Standards Agency, Aviation House, 125 Kingsway, London WC2B 6NH
Switchboard: 020-7276-8000
Emergencies only: 020-7270-8960
Web: http://www.food.gov.uk/

Northern Ireland
Food Standards Agency Northern Ireland, 10c Clarendon Road, Belfast BT1 3BG
Phone: 02890-417700

Scotland
Food Standards Agency Scotland, St Magnus House, 6th Floor, 25 Guild Street, Aberdeen AB11 6NJ
Phone: 01224-285100

Wales
Food Standards Agency Wales, 11th Floor, Southgate House, Wood Street, Cardiff CF10 1EW
Phone: 02920-678999

Area of particular relevance to toxicology:
Science and Research

Conducts and commissions extensive scientific research and survey work to ensure that advice to the public is based on the best and most up-to-date food science.
Web: http://www.food.gov.uk/science/

Health and Safety Executive (HSE)

Responsible for the regulation of almost all risks to health and safety arising from work activities in Britain, including nuclear installations, mines, factories, farms, hospitals and schools, offshore gas and oil installations, the safety of the gas grid, and movement of dangerous goods and substances and railway safety.
Phone: +44-(0)845-345-0055
Web: http://www.hse.gov.uk/

Groups of particular relevance to toxicology:
Chemical

Group responsible for chemical production, oil refining and associated onshore oil-related industry, coatings production, pharmaceuticals production, fertilizers production, production of compressed gases, production of hygiene/cleaning materials, large-scale storage of chemicals and their transport by road.
HSE Bootle Headquarters, Redgrave Court, Merton Road, Bootle, Merseyside, L20 7HS
Web: http://www.hse.gov.uk/chemicals/index.htm

Health and Safety Laboratory (HSL)

Agency of the HSE undertaking research and development; advice and consultancy; forensic investigation into causes of accidents; environmental and biological monitoring; risk assessment and control; establishing standards; and validation, certification and training.
Web: http://www.hsl.gov.uk/

Health Protection Agency (HPA)

The Health Protection Agency is the independent public body responsible for protecting UK public health through the provision of support and advice to the NHS, local authorities, emergency services, other Arms Length Bodies, the Department of Health, and the Devolved Administrations. The Agency was established as a special health authority (SpHA) in 2003. On 1 April 2005, the Agency was established as a non-departmental public body, replacing the HPA SpHA and the National Radiological Protection Board (NRPB) and with radiation protection as part of health protection incorporated in its remit. The HPA has a large network of approximately 3000 staff based at three major centers (Colindale, Porton, and Chilton) and regionally and locally throughout England. There is a small central office based in London. The Agency works closely with locally based colleagues employed within the Devolved Administrations. The Centre for Infections at Colindale is the base for communicable disease surveillance and specialist microbiology. The Centre for Radiation, Chemical and Environmental Hazards is based at Chilton and the Centre for Emergency Preparedness and Response, focusing on applied microbiological research and emergency response, is based at Porton.
HPA Central Office, 7th Floor, Holborn Gate, 330 High Holborn, London WC1V 7PP, UK
Phone: +44(0)20-7759-2700/2701
Fax: +44(0)20-7759-2733
Email: webteam@hpa.org.uk
Web: http://www.hpa.org.uk/

Divisions of particular relevance to toxicology include:
Centre for Radiation, Chemical and Environmental Hazards
Chemical Hazards and Poisons Division

The HPA Centre for Radiation, Chemical and Environmental Hazards comprises the Radiation Protection Division (formerly the National Radiological Protection Board) and the Chemical Hazards and Poisons Division.
HPA Centre for Radiation, Chemical and Environmental Hazards, Chilton, Didcot, Oxon, OX11 0RQ
Phone: 01235-822895
Email: chemicals@hpa.org.uk

Chemical Hazards and Poisons Division

The part of the Centre for Radiation, Chemical and Environmental Hazards, providing comprehensive expert advice and support for chemical incidents across England and Wales. The Division provides advice to UK Government Departments and Agencies on human health effects from chemicals in water, soil, and waste as well as information and support to the NHS and health professionals on toxicology.
Chemical Hazards and Poisons Division, Chilton, Didcot, Oxon, OX11 0RQ
Phone: 01235-822895
Email: chemicals@hpa.org.uk

Radiation Protection Division

Part of the Centre for Radiation, Chemical and Environmental Hazards, the Division carries out the Health Protection Agency's work on ionizing and non-ionizing radiations. It undertakes research to advance knowledge about protection from the risks of these radiations; provides laboratory and technical services; runs training courses; provides expert information and has a significant advisory role in the UK.
Centre for Radiation, Chemical and Environmental Hazards Radiation Protection Division, Chilton, Didcot, Oxon, OX11 0RQ
Phone: 01235-831600
Fax: 01235-833891
Email: rpd@hpa-rp.org.uk

Centre for Emergency Preparedness and Response

Centre for Emergency Preparedness and Response plays an important role in preparing for and co-ordinating responses to potential healthcare emergencies, including possible acts of deliberate release.
Phone: 01980-612100
Fax: 01980-612839
Email: erd@hpa.org.uk

National Poisons Information Service (NPIS)

A clinical toxicology service for NHS healthcare professionals, consisting of a network of units across the UK, providing information and advice on the diagnosis, treatment, and management of patients who may have been accidentally or deliberately poisoned (information available on TOXBASE).
Web: http://www.hpa.org.uk/Chemicals/npis.htm

Medicines and Healthcare Products Regulatory Agency (MHRA)
The Agency responsible for the regulation and safety assessment of medicines and medical devices in the UK.

Medicines and Healthcare Products Regulatory Agency (Information center), 10-2 Market Towers, 1 Nine Elms Lane, London, SW8 5NQ, UK
Phone: +44-(0)20-7084-2000/+44-(0)20-7210-3000
Fax: +44-(0)20-7084-2353
Email: info@mhra.gsi.gov.uk
Web: http://www.mhra.gov.uk/home/idcplg?IdcService=SS_GET_PAGE&nodeId=5

National Health Service (NHS)

The NHS for England was established in 1948 and is now the largest organization in Europe. There are separate organizations for Northern Ireland, Scotland and Wales, and the Isle of Man and the Channel Islands have separate independent health service structures.
National Health Service – England, Customer Service Centre, The Department of Health, Richmond House, 79 Whitehall, London SW1A 2NL UK
Phone: +44(0)207-210-4850
Minicom: +44(0)207-210-5025
Email: dhmail@dh.gsi.gov.uk
Web: http://www.nhs.uk/

Pesticides Safety Directorate (PSD)

The Pesticides Safety Directorate (PSD) is the Executive Agency of the Department for Environment, Food and Rural Affairs (Defra), responsible for: providing controls on pesticides used in agriculture, horticulture and in the garden; monitoring the use of pesticides and taking enforcement action against illegal use; providing policy advice to Ministers and taking the lead on pesticide issues for Defra; supporting the UK and EU reviews of the safety of pesticides on the market, working to standardize pesticide regulation within Europe; and co-ordinating a program of research and development to complement the approvals system and support our policy objectives.
PSD, Mallard House, Kings Pool, 3 Peasholme Green, York, YO1 7PX, UK
Phone: +44(0)-1904-455775
Fax: +44(0)-1904-455733
Email: information@psd.defra.gsi.gov.uk
Web: http://www.pesticides.gov.uk/corporate.asp?id=211

Scottish Agricultural Science Agency (SASA)

SASA is a government executive agency providing scientific information and advice on agricultural crops.
SASA, 1 Roddinglaw Road, Edinburgh, EH12 9FJ Scotland, UK
Phone: +44(0)-131-244-8890
Fax: +44(0)-131-244-8940
Email: info@sasa.gsi.gov.uk
Web: http://www.sasa.gov.uk/

Scottish Environmental Protection Agency (SEPA)

SEAPA is responsible for regulating and advising the Scottish Parliament through Ministers, on environmental protection. In broad terms, SEPA regulates: activities that may pollute water or air; the storage, transport and disposal of waste; the keeping and disposal of radioactive materials. Some of SEPA's other principal responsibilities include: maintaining a flood warning system; implementing the National Waste Strategy; controlling, with the Health and Safety Executive, the risk of major accidents at industrial sites; and operating the Scottish part of the Radioactive Incident Monitoring Network.
SEPA Corporate Office, Erskine Court, Castle Business Park, Stirling FK9 4TR, Scotland, UK
Phone: +44(0)-1786-457700
Fax: +44(0)-1786-446885
Web: http://www.sepa.org.uk/about/index.htm

Scottish National Heritage (SNH)

The SNH is controlled by a Board appointed by Scottish Ministers, and determines the objectives, strategies, and policies of SNH, in the light of SNH's statutory obligations and guidance from the Scottish Executive. It is supported in this work by three advisory Area Boards covering North, East and West Scotland, a Scientific Advisory Committee and an Audit and Risk Management Committee.
SNH (Headquarters), Great Glen House, Leachkin Road, Inverness IV3 8NW, Scotland, UK
Phone: +44-(0)1463-725000
Web: http://www.snh.org.uk/

Veterinary Medicines Directorate (VMD)

The VMD is an Executive Agency responsible for issues concerning the use and manufacture of veterinary medicines in the UK, with the objective of protecting public and animal health, the environment and promoting animal welfare by assuring the safety, quality, and efficacy of veterinary medicines.
VMD, Woodham Lane, New Haw, Addlestone, Surrey KT15 3LS, UK
Phone:+44-(0)1932-336911
Fax:+44-(0)1932-336618
Web: http://www.vmd.gov.uk/

Government Advisory Committees

Advisory Committee on Hazardous Substances (ACHS)

Provides expert advice on the science behind hazardous chemicals. The principal role is advising the UK Chemicals Stakeholder Forum. In particular, the

Committee has advised the Forum on its criteria for concern, in light of physical and chemical properties of substances.
Zone 4/E1, Ashdown House, 123 Victoria Street, London SW1E 6DE, UK
Phone: +44-(0)20-7082-8109
Email: ACHS@defra.gsi.gov.uk
Web: http://www.defra.gov.uk/environment/chemicals/achs/

Advisory Committee on Pesticides (ACP)

Under Section 16(7) of the Food and Environment Protection Act 1985, Ministers established the Advisory Committee on Pesticides to provide advice on any matters relating to the control of pests in furthering the general purposes of Part III of the Act.
Department for Environment, ACP, Food & Rural Affairs, Mallard House, Kings Pool, 3 Peasholme Green, York YO1 7PX, UK
Phone: +44-(0)-1904-455702/+44-(0)-1904-640500 (switchboard)
Fax:+44-(0)1904-455722
Email: acp@psd.defra.gsi.gov.uk
Web: http://www.pesticides.gov.uk/acp_home.asp

Advisory Committee on Toxic Substances (ACTS)

Advises the Health and Safety Commission on matters relating to the prevention, control, and management of hazards and risks to the health and safety of persons arising from the supply or use of toxic substances at work, with due regard to any related risks to consumers, the public, and the environment.
Health & Safety Executive, ACTS, Floor 9SW, Rose Court, 2 Southwark Bridge, London SE1 9HS, UK
Email: acts@hse.gsi.gov.uk
Web: http://www.hse.gov.uk/aboutus/hsc/iacs/ acts/

Air Quality Expert Group (AQEG)

This is an independent group that provides scientific advice on air quality, in particular the air pollutants contained in the Air Quality Strategy (AQS) for England, Scotland, Wales and Northern Ireland and those covered by the EU Directive on ambient air quality assessment and management.
AQEG Secretariat, Defra 7/F15, Ashdown House, 123 Victoria Street, London SW1E 6DE, UK
Phone: +44-(0)20-7082-8421
Fax: +44-(0)20-7082-8385
Email: air.quality@defra.gsi.gov.uk
Web: http://www.defra.gov.uk/environment/air-quality/panels/aqeg/index.htm

Animal Procedures Committee (APC)

Advises the Home Secretary on matters concerned with the Act and their functions under it, relating to any experimental or other scientific procedures applied to a protected animal which may have the effect of causing that animal pain, suffering, distress, or lasting harm. In addition, examines other related subjects considered worthy of further study.
ACP, 3rd floor, Seacole SW Quarter, 2 Marsham Street, London SW1P 2AW, UK
Phone: +44-(0)20-7035-4578/+44-(0)20-7035-4776/+44-(0)20-7035-5513
Fax: +44-(0)20-7035-1135
Web: http://www.apc.gov.uk/

Chemicals Stakeholder Forum (CSF)

The UK Chemicals Stakeholder Forum (CSF) was set up in September 2000 following the development of the UK Chemicals Strategy in December 1999. The principal function of the Forum is to advise the Government on how industry should reduce the risks from hazardous chemicals to the environment and to human health through the environment. The Forum has 23 members drawn from industry, environmental, and animal protection and conservation organizations, trade unions, consumer groups, and the scientific community.
Defra UK CSF Secretariat, Zone 4/E1 Ashdown House, 123 Victoria Street, London SW1E 6DE, UK
Phone: +44-(0)20-7082-8109
Email: chemicals.strategy@defra.gsi.gov.uk
Web: http://www.defra.gov.uk/environment/chemicals/csf/

Committee on Carcinogenicity of Chemicals in Food, Consumer Products and the Environment (COC)

COC is an independent advisory committee that provides advice to Government Departments and Agencies on matters concerning the potential carcinogenicity of chemicals ranging from natural products to new synthetic chemicals used in pesticides or pharmaceuticals. It consists of a panel of independent doctors and scientists recruited for their individual expertise from universities, research institutes and, in some cases, industry. The independent members of COC are supported in their work by a joint secretariat provided by the Health Protection Agency and the Food Standards Agency.
Mrs Janice Cleverly (Administrative Secretary), Health Protection Agency, Centre for Radiation and Chemical Hazards, Chemical Hazards and Poisons Division (Head Office), Chilton, Didcot, Oxon OX11 0RQ, UK
Phone: +44-(0)1235-841475
Email: janice.cleverly@hpa.org.uk
Web: http://www.advisorybodies.doh.gov.uk/coc/index.htm

Committee on Medical Effects of Air Pollutants (COMEAP)

COMEAP is an Advisory Committee of independent experts that provides advice to Government Departments and Agencies on all matters concerning the potential toxicity and effects upon health of air pollutants.

Miss Julia Cumberlidge (COMEAP Secretariat), Area No. 518 Wellington House, 133–155 Waterloo Road, London SE1 8UG, UK
Phone: +44-(0)20-7972-4108
Email: jcumberl@doh.gsi.gov.uk
Web: http://www.advisorybodies.doh.gov.uk/comeap/

Committee on Mutagenicity of Chemicals in Food, Consumer Products and the Environment (COM)

COM is an Independent Advisory Committee that provides advice to Government Departments and Agencies on matters concerning the potential mutagenicity of chemicals ranging from natural products to new synthetic chemicals used in pesticides or pharmaceuticals. It consists of a panel of independent doctors and scientists recruited for their individual expertise from universities and research institutes and, in some cases, industry.

Mrs Janice Cleverly (Administrative Secretary), Health Protection Agency, Centre for Radiation and Chemical Hazards, Chemical Hazards and Poisons Division (Head Office), Chilton, Didcot, Oxon OX11 0RQ, UK
Phone: +44-(0)1235-841475
Email: janice.cleverly@hpa.org.uk
Web: http://www.advisorybodies.doh.gov.uk/com/index.htm

Committee on Products and Processes (CPP)

Provides expert advice to government authorities in England and Wales on approval issues.

CPP Secretariat, Room G01, 55 Whitehall, London SW1A 2EY, UK
Phone: +44-(0)20-7082-8013/8015
Fax: +44-(0)20-7082-8012
Email: CPP@defra.gsi.gov.uk
Web: http://www.dwi.gov.uk/cpp/

Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment (COT)

A DH expert committee that provides expert advice to government authorities in England and Wales on a wide range of issues relating to the toxicity of chemicals. The Committee's terms of reference are to assess and advise on the toxic risk to man of substances which are: (a) used or proposed to be used as food additives, or used in such a way that they might contaminate food through their use or natural occurrence in agriculture, including horticulture and veterinary practice or in the distribution, storage, preparation, processing or packaging of food; (b) used or proposed to be used or manufactured or produced in industry, agriculture, food storage or any other workplace; (c) used or proposed to be used as household goods or toilet goods and preparations; (d) used or proposed to be used as drugs, when advice is requested by the Medicines and Healthcare Products Regulatory Agency; (e) used or proposed to be used or disposed of in such a way as to result in pollution of the environment.

Mr Khandu Mistry, Room 523, Department of Health, Wellington House, 133–155 Waterloo Road, London SE1 8UG, UK
Phone: +44-(0)20-7972-4946
Fax: +44-(0)20-7972-1001
Email: Khandu.Mistry@dh.gsi.gov.uk
Web: http://www.advisorybodies.doh.gov.uk/cotnonfood/index.htm

Expert Panel on Air Quality Standards (EPAQS)

The Expert Panel on Air Quality Standards (EPAQS) was set up in 1991 to provide independent advice on air quality issues, in particular the levels of pollution at which no or minimal health effects are likely to occur. Members of the Panel are primarily drawn from those eminent in the fields of health research, practice, and teaching. The Panel's recommendations were adopted as the benchmark standards in the National Air Quality Strategy. EPAQS gives advice on non-occupational ambient air quality standards, with particular reference to the levels of airborne pollutants at which no or minimal effects on human health are likely to occur, taking account of the best available evidence.

EPAQS Secretariat, Defra 7/F15, Ashdown House, 123 Victoria Street, London SW1E 6DE, UK
Phone: +44-(0)20-7082-8421
Fax: +44-(0)20-7082-8385
Email: air.quality@defra.gsi.gov.uk
Web: http://www.defra.gov.uk/environment/airquality/panels/aqs/index.htm

Parliamentary Select Committee on Science and Technology

One of the departmental select committees of the House of Commons (Parliament). This committee focuses on the expenditure, administration, and policy of the Office of Science and Innovation and its associated public bodies.

Phone: +44-(0)20-7219-2793/+44-(0)20-7219-2794
Fax: +44-(0)20-7219-0896

Email: scitechcom@parliament.uk
Web: http://www.parliament.uk/parliamentary_committees/science_and_technology_committee.cfm

Royal Commission on Environmental Pollution (RCEP)

A standing body independent of government. Reviews and anticipates trends and developments in environmental policies, identifies fields where insufficient attention is being given to problems, and recommends action that should be taken.
Third Floor, The Sanctuary, Westminster, London SW1P 3JS, UK
Phone: +44-(0)20-7799-8970
Fax: +44-(0)20-7799-8971
Email: enquiries@rcep.org.uk
Web: http://www.rcep.org.uk/

Sustainable Development Committee

The government's independent watchdog on sustainable development, reporting to the Prime Minister and the First Ministers of Scotland and Wales. Its policies are composed of ten areas; climate change, consumption, economics, education, energy, engagement, health, housing, regional and local government, and transport.
Sustainable Development Committee (Main Office), Ground Floor, Ergon House, Horseferry Road, London SW1P 2AL, UK
Phone: +44-(0)20-7238-4995
Fax: +44-(0)20-7238-4981
Email: enquiries@sd-commission.org.uk
Web: http://www.sd-commission.org.uk/pages/aboutus.html

Veterinary Products Committee (VPC)

The Veterinary Products Committee (VPC) was established in 1970 under section 4 of the Medicines Act 1968 (the Act). The VPC took over from the Advisory Committee on Pesticides and other Toxic Chemicals which had, up until then, been responsible for advising the Health and Agriculture Ministers on the administration of the voluntary Veterinary Products Safety Precautions Scheme (VPSPS), which had been established in 1964 for the scrutiny of veterinary medicines. In October 2005, the Medicines Act 1968 was disapplied to veterinary medicines by the Veterinary Medicines Regulations S.I. 2005 No 2745 (the Regulations) which made provision for the continuance of the VPC.
Veterinary Medicines Directorate, Woodham Lane, New Haw, Addlestone, Surrey KT15 3LS, UK
Phone: +44-(0)1932-338490
Fax: +44-(0)1932-336618
Email: vpc@vmd.defra.gsi.gov.uk
Web: http://www.vpc.gov.uk/

Working Group on Action to Control Chemicals (WATCH)

WATCH is the scientific and technical subcommittee of HSC's Advisory Committee on Toxic Substances. It advises on matters relating to the prevention, control, and management of hazards and risks to the health and safety of persons arising from the supply or use of toxic substances at work, with due regard to any related risks to consumers, the public, and the environment.
Health & Safety Executive, Floor 9SW, Rose Court, 2 Southwark Bridge, London SE1 9HS, UK
Email: acts@hse.gsi.gov.uk
Web: http://www.hse.gov.uk/aboutus/hsc/iacs/acts/watch/index.htm

Government-funded Independent Research Councils

Biotechnology and Biological Sciences Research Council (BBSRC)

The funding agency for academic research and training in the non-clinical life sciences. Supports research and research training in universities and research centers throughout the UK, and promotes knowledge transfer from research to applications in business, industry and policy, and public engagement in the biosciences.
BBSRC, Polaris House, North Star Avenue, Swindon SN2 1UH, UK
Phone: +44-(0)1793-413200 (switchboard)
Fax: +44-(0)1793-413201
Web: http://www.bbsrc.ac.uk/

BBSRC is responsible for:
Institute of Grassland and Environmental Research (IGER)

Institute of Grassland and Environmental Research (IGER) is one of eight research institutes funded by the Biotechnology and Biological Sciences Research Council. Its mission is to determine viable options for grassland-dominated landscapes and land use systems that lead to a sustainable rural economy, a multifunctional healthy environment, and a safe and high-quality food chain. This will be achieved by undertaking integrated research aimed at better understanding the interactions between plants, soil, microbes, livestock, food, the environment, and humans.
Plas Gogerddan, Aberystwyth, Ceredigion SY23 3EB, UK
Phone: +44-(0)1970-823000
Fax: +44-(0)1970-828357
Web: http://www.iger.bbsrc.ac.uk/default.asp

Medical Research Council (MRC)

The MRC is a publicly funded research council focused on improving human health through medical and other scientific research activities. It supports research across

the biomedical spectrum, from fundamental lab-based science to clinical trials, and in all major disease areas. It is governed by the MRC Council, which directs the scientific strategy and corporate policy. Five MRC Research Boards decide which scientific proposals the MRC funds, and a Training and Development Board distributes funding scientific training. A MRC Executive Board, based at our head office in London, is responsible for the day-to-day management of the organization. It also supports a number of MRC research units, institutes, and an affiliated company, MRC Technology, which works with industry to translate scientific discoveries into new treatments and technologies.

MRC Head Office, 20 Park Crescent, London W1B 1AL, UK
Phone: +44-(0)20-7636-5422
Fax: +44-(0)20-7436-6179
Email: corporate@headoffice.mrc.ac.uk (general enquiries)
Web: http://www.mrc.ac.uk/index.htm

Research groups of particular relevance to toxicology include:

MRC Environmental Epidemiology Unit

The MRC Epidemiology Resource Centre, located at the University of Southampton, has a remit to investigate occupational and environmental causes of disease within the UK.

MRC Epidemiology Resource Centre, Southampton General Hospital, Southampton SO16 6YD, UK
Phone: +44-(0)23-8077-7524
Fax: +44-(0)23-8070-4021
Web: http://www.mrc.soton.ac.uk/index.asp

MRC Toxicology Unit

The Toxicology Unit studies fundamental mechanisms of cellular and tissue response to injury caused by drugs, chemicals, and endogenous molecules.

MRC Toxicology Unit, Hodgkin Building, PO Box 138 University of Leicester, Lancaster Road, Leicester LE1 9HN, UK
Phone: +44-(0)116-252-5544
Fax: +44-(0)116-252-5616
Web: http://www.le.ac.uk/mrctox/

MRC Dunn Human Nutrition Unit

The unit studies the fundamental processes of human nutrition, especially in energy metabolism, the involvement of these processes in human disease and ageing, and the impact of diet on human health and longevity.

The Wellcome Trust/MRC Building, Addenbrooke's Site, Cambridge, CB2 0XY, UK
Phone: 01223-252700
Fax: 01223-252715
Web: http://www.mrc-dunn.cam.ac.uk

MRC Centre for Nutritional Epidemiology in Cancer Prevention and Survival (CNC)

The MRC Centre for Nutritional Epidemiology in Cancer Prevention and Survival (CNC) was launched in July 2006 with a £2.3 m MRC award to the University of Cambridge to fund research into the impact of diet on cancer. The center is hosted by the Clinical School's Department of Public Health and Primary Care and is directed by Dr Shelia Bingham to provide international leadership in research in the epidemiology and molecular origins of the dietary causes of cancer.

MRC Centre for Nutritional Epidemiology in Cancer Prevention and Survival (CNC), Department of Public Health and Primary Care, University of Cambridge, Cambridge CB1 8RN, UK
Phone: 01223-740151
Web: http://www.srl.cam.ac.uk

MRC Human Reproductive Sciences Unit

The Unit undertakes studies at a molecular, cellular, and endocrine level on the regulation of the human reproductive system, with particular attention to mechanisms that might be exploited for purposes of contraception or account for infertility, menstrual cycle abnormalities, and disorders of pregnancy and fetal development. Immunological, hormonal, and pharmacological approaches for the reversible regulation of human fertility are under investigation, and clinical development through links with industry and international agencies.

Centre for Reproductive Biology, Queen's Medical Research Institute, 47 Little France Crescent, Edinburgh, EH16 4TJ, UK
Phone: 0131-242-9100
Fax: 0131-242-6231
Web: http://www.hrsu.mrc.ac.uk

MRC Centre for Neurodegenerative Research

The MRC Centre for Neurodegeneration Research (CNR) works mainly on two neurodegenerative diseases, Alzheimer's disease and motor neurone disease. The research is urgently needed because there are no effective therapies for these progressive diseases.

MRC Centre for Neurodegenerative Research, King's College London; Institute of Psychiatry, Box PO37, De Crespigny Park, London SE5 8AF, UK
Phone: 020-7848-0259
Web: http://cnr.iop.kcl.ac.uk/

Natural Environment Research Council (NERC)

NERC is a publicly funded research council focused on delivery of independent research, survey, training,

and knowledge transfer in the environmental sciences. NERC funds scientific research projects and also supports a number of research centers.
NERC, Head Office, Polaris House, North Star Avenue, Swindon SN2 1EU, UK
Phone: +44-(0)179-3411500
Fax: +44-(0)179-3411501
Web: http://www.nerc.ac.uk/

NERC-supported research groups of particular relevance to toxicology include:
British Geological Survey

Studies the potential risk to human health posed by the geologically diverse and naturally mineralized rural and urban environments of the UK, including the impact of a long industrial heritage.
Central Enquiries Desk, British Geological Survey, Kingsley Dunham Centre, Keyworth, Nottingham NG12 5GG, UK
Phone: +44-(0)115-936-3143
Fax: +44-(0)115-936-3276
Email: Enquiries@bgs.ac.uk
Web: http://www.bgs.ac.uk/

Centre for Ecology and Hydrology (CEH)

Undertakes research in the land and freshwater environmental sciences.
Polaris House, North Star Avenue, Swindon, Wiltshire, SN2 1EU, UK
Phone: +44-(0)1793-442516
Fax: +44-(0)1793-442528
Email: director@ceh.ac.uk
Web: http://www.ceh.ac.uk/index.html

Natural History Museum

The Natural History Museum is an international leader in the scientific study of the natural world. More than 300 scientists work at the Museum to tackle a diverse range of global problems, such as threats to the Earth's biodiversity, the maintenance of delicate ecosystems, environmental pollution and disease.
Natural History Museum, Cromwell Road, London, SW7 5BD, UK
Phone: + 44-(0)20-7942-5000
Web: http://www.nhm.ac.uk/research-curation/

Organizations (Non-Government)

Non-government Organizations/Trade Associations

Biosciences Federations

The federation address a wide range of scientific areas, from physiology and neuroscience, biochemistry and microbiology, to ecology, taxonomy and environmental science. Currently, the society has 42 member societies and organizations.
Biosciences Federations, P.O. Box 502, Cambridge CB1 0AL, UK
Email: info@bsf.ac.uk (general enquiries)
Web: http://www.bsf.ac.uk/default.htm

British Plastics Federation (BPF)

This is a trade association of the UK plastics industry.
BPF, 6 Bath Place, Rivington Street, London EC2A 3JE, UK
Phone: +44-(0)20-7457-5000
Fax: +44-(0)20-7457-5045
Email: bpf@bpf.co.uk
Web: http://www.bpf.co.uk/

British Union for the Abolition of Vivisection (BUAV)

Anti-vivisection campaigning organization. Raises awareness and exposes the reality of animal experimentation and creates meaningful changes in policy while defending the rights of animals and the well-being of people through public campaigning, hard-hitting undercover investigations, media activities, political lobbying, promotion of cruelty-free products, legal and scientific expertise, and quality educational and information materials.
BUAV, 16a Crane Grove, London N7 8NN, UK
Phone: +44-(0)20-7700-4888
Fax: +44-(0)20-7700-0252
Email: info@buav.org
Web: http://www.buav.org/

Chemical & Industrial Consultants Association

This is a trade body established by independent consultants specialising in applications of chemistry in industry.
CICA Honorary Secretary, 8 Chestnut Close, Baltonsborough, Somerset BA6 8PH, UK
Phone/Fax: +44-(0)1458-851568
Email: secretary@chemical-consultants.co.uk
Web: http://www.chemical-consultants.co.uk/

Chemical Hazards Communication Society (CHCS)

Chemical Hazards Communication Society was launched at an inaugural meeting at the Health and Safety Executive, London in April 1994, as an unincorporated, non-profit-making society. It provides information and training guidance for associations or for government, involved with the ever-increasing complexity of chemical hazards regulations and international codes.
Chemical Hazards Communication Society, P.O. Box 222, Lymington SO42 7GY, UK
Phone: +44-(0)7000-790337
Fax: +44-(0)7000-790338

Mobile and messaging: +44-(0)7880-723330
Email chcs@chcs.org.uk
Web: http://www.chcs.org.uk/

Chemical Industries Association (CIA)

This is the largest trade association of chemical manufactures in the UK.
CIA, Kings Buildings, Smith Square, London SW1P 3JJ, UK
Phone: +44-(0)20-7834-3399
Fax: +44-(0)20-7834-4469
Email: enquiries@cia.org.uk
Web: http://www.cia.org.uk/newsite/

Friends of the Earth

This is an environmental pressure and campaign group that seeks to influence policy and practice by; working local to global, solutions based research, and enabling campaigning. It is organized as two distinct organizations, a charity (Friends of the Earth Trust) and a limited company (Friends of the Earth Limited). Both focus on conservation and the protection and improvement of the environment.
Friends of the Earth, 26–28 Underwood Street, London N1 7JQ, UK
Phone: +44-(0)20-7490-1555
Fax: +44-(0)20-7490-0881
Web: http://www.foe.co.uk/

Fund for the Replacement of Animals in Medical Experiments (FRAME)

FRAME is a registered charity promoting the total elimination of laboratory animal use. It supports efforts to reduce the numbers of animals used through better science and better experimental design, and refines procedures so that the suffering of any animals necessarily used is minimized in line with the 3R's principle.
FRAME, Russell & Burch House, 96–98 North Sherwood St, Nottingham NG1 4EE, UK
Phone: +44-(0)115-9584740
Fax: +44-(0)115-9503570
Email: frame@frame.org.uk
Web: http://www.frame.org.uk/

Green Alliance

This is an independent charity working to promote sustainable development by ensuring that the environment is at the heart of decision-making.
Green Alliance, 36 Buckingham Palace Road, London SW1W 0RE, UK
Phone: +44-(0)20-7233-7433
Fax: +44-(0)20-7233-9033
Email: ga@green-alliance.org.uk
Web: http://www.green-alliance.org.uk/

Greenpeace

Greenpeace is an independent non-profit campaigning organization active in the UK. It focuses on government's and industry's role in environmental issues around the world.
Greenpeace, Canonbury Villas, London N1 2PN, UK
Phone: +44-(0)20-7865-8100
Fax: +44-(0)20-7865-8200
Email: info@uk.greenpeace.org
Web: http://www.greenpeace.org.uk/

Institute of Occupational Medicine (IOM)

The IOM is an independent center of scientific research in the fields of occupational and environmental health, hygiene, and safety. It was founded as a charity in 1969 by the UK coal industry in conjunction with the University of Edinburgh and became fully independent in 1990.
IOM, Riccarton, Edinburgh EH14 4AP, UK
Phone: +44-(0)870-850-5131
Fax: +44-(0)870-850-5132
Email: Info@iom-world.org
Web: http://www.iom-world.org/

Institute of Occupational Safety and Health (IOSH)

IOSH is an independent, non-profit organization that sets professional standards, supports and develops members, and provides authoritative advice and guidance on health and safety issues.
IOSH, The Grange, Highfield Drive, Wigston, Leicestershire, LE18 1NN, UK
Phone: +44-(0)116-257-3100
Fax: +44-(0)116-257-3101
Email: enquiries@iosh.co.uk
Web: http://www.iosh.co.uk/

Institution of Chemical Engineers

This is the UK's professional institution for chemical engineers.
Institution of Chemical Engineers (Headquarters), Davis Building, 165–189 Railway Terrace, Rugby CV21 3HQ, UK
Phone: +44-(0)1788-578214
Fax: +44-(0)1788-560833
Web: http://cms.icheme.org/MainWebSite/Homepage3bf36337.aspx?Map=1B65ED76D4B00E9E78817E89DC003264

Pesticide Action Network (PAN) UK

PAN is an independent, non-profit organization working to promote healthy food, agriculture, and environment, and focuses on the use of chemicals in food production and agriculture. In particular, the focus is

on the elimination of the hazards of pesticides, reduction of dependence on pesticides, and prevention of unnecessary expansion of use; and increasing the sustainable and ecological alternatives to chemical pest control.
PAN, Development House, 56–64 Leonard Street, London EC2A 4JX, UK
Phone: +44-(0)20-7065-0905
Fax: +44-(0)20-7064-0907
Email: admin@pan-uk.org
Web: http://www.pan-uk.org/About/index.htm

Royal Society for the Prevention of Cruelty to Animals (RSPCA)

This is a UK charity working to prevent cruelty, promote kindness to, and alleviate suffering of animals. It is active in relation to the use of animals in scientific experiments.
RSPCA, Wilberforce Way, Southwater, Horsham, West Sussex, RH13 9RS, UK
Phone: +44-(0)870-3335-999
Fax: +44-(0)870-7530-284
Web: http://www.rspca.org.uk/servlet/Satellite?pagename= RSPCA/News/NewsFeature

Sense about Science

This is an independent charitable trust promoting good science and evidence in public debates.
Sense about Science, 60 Cambridge Street, London SW1V 4QQ, UK
Tel: +44-(0)20-7478-4380
Email: enquiries@senseaboutscience.org
Web: http://www.senseaboutscience.org.uk/index.php

Wellcome Trust

The Wellcome Trust is an independent charity funding research to improve human and animal health.
Wellcome Trust, Gibbs Building, 215 Euston Road, London NW1 2BE, UK
Phone: +44-(0)20-7611-8888
Fax: +44-(0)20-7611-8545
Email: contact@wellcome.ac.uk
Web: http://www.wellcome.ac.uk/

Women's Environmental Network (WEN)

WEN is an independent campaigning organization, which represents women and campaigns on issues that link women, environment, and health. Formed in 1988, it is a registered charity.
WEN, P.O. Box 30626, London E1 1TZ, UK
Phone: +44-(0)20-7481-9004
Fax: +44-(0)20-7481-9144
Email: nappies@wen.org.uk
Web: http://www.wen.org.uk/rnw/

Women's Institute (WI)

The (NFWI) is the largest organization for women in the UK with 215 000 members in England, Wales, and the Islands. It works to educate women, to expand their horizons, and to develop and pass on important skills. It is active in the field of the potential effects of chemicals present in the environment.
National Federation of Women's Institutes, 104 New Kings Road, London SW6 4LY, UK
Phone: +44-(0)20-7371-9300
Web: http://www.womens-institute.co.uk/index.shtml

WWF-UK

WWF-UK is part of an international organization, the WWF. It is an independent conservation charity that carries out conservation work in Africa, Latin America, the Asia-Pacific region, and Europe. It also undertakes environmentally focused campaigns in the UK.
WWF-UK, Panda House, Weyside Park, Godalming, Surrey, GU7 1XR, UK
Phone: +44-(0)1483-426444
Fax: +44-(0)1483-426409
Web: http://www.wwf-uk.org/core/about/about-wwf.asp

Consultancies and Laboratories

AEA Technology plc

Formerly part of the United Kingdom Atomic Energy Authority, now provides independent consultancy, technical services and products to the rail, environment, and portable power market.
329 Harwell International Business Centre, Didcot, Oxon OX11 0QJ, UK
Phone: +44-(0)870-190-1900
Fax: +44-(0)870-190-8261
Email: enquiry@aeat.co.uk
Web: http://www.aeat.com/

ALCAT

Conducts food and chemical sensitivity test.
Wellington House, 96–98 Wellington Street, Newmarket, Suffolk CB8 8SX, UK
Phone: +44-(0)1638-665-350
Fax: +44-(0)1638-664-913
Email: info@nptech.co.uk
Web: http://www.alcat.info/Default.htm

Biolab Medical Unit (UK)

A medical referral laboratory specializing in nutritional and environmental medicine.
Biolab Medical Unit, The Stone House, 9 Weymouth Street, London W1W 6DB, UK

Phone: +44-(0)20-7636-5959/5905
Fax: +44-(0)20-7580-3910
Email: info@biolab.co.uk
Web: http://www.biolab.co.uk/

Bodycote Testing Ltd

Offers a wide range of chemical analysis techniques reflecting its interests in metallic, pharmaceutical, and environmental analysis.
Phone: +44-(0)161-868-6675
Email: mtweb@bodycote.com
Web: http://mt.bodycote.com/?OB=84

Building Research Establishment Ltd (BRE)

A former government research laboratory with expertise in buildings, construction, energy, environment, fire, and risk; undertakes research-based consultancy, testing and certification services.
BRE, Bucknalls Lane, Watford WD25 9XX, UK
Phone: +44-(0)1923-664000
Email: enquiries@bre.co.uk
Web: http://www.bre.co.uk/

Covance Laboratories Ltd

Global drug development services company, providing a portfolio of preclinical and clinical development and commercial services.
Covance Laboratories Ltd, Otley Road, Harrogate HG3 1PY, North Yorkshire, UK
Phone: 01423-500011
Fax: 01423-501999
Web: http://www.covance.com/

Crowther Clayton Associates

Environmental, water, wastewater, health and safety executive, and chemical engineering consultants.
31 Tennyson Road, London NW7 4AB, UK
Phone: +44-(0)20-8959-7376/ +44-(0)20-8959-7000 CLAYTON
Fax: +44-(0)20-8959-6880
Freephone: 0800-074-7166
Email: rccweb@crowther-clayton.com
Web: http://www.crowther-clayton.com/

David Horrocks Environmental Health Services
An environmental protection consultancy.
17 Starlight Ways, St Albans, Hertfordshire
Phone: 01727-863112

EEF Sheffield
An environmental protection consultancy.
Broomgrove, 59 Clarkehouse Road, Sheffield S10 2LE, UK
Phone: +44-(0)114-268-0671
Fax: +44-(0)114-266-4227
Email: info@eefshe.co.uk
Web: http://www.eefshe.co.uk/

Food Chemical Risk Analysis (FCRA)

Company providing scientific and regulatory support to food and chemical industries operating in European markets.
Food Chemical Risk Analysis, 14 St Mary's Square, Brighton BN2 1FZ, UK
Phone: +44-(0)1273-241-753
Web: http://www.fcra.co.uk/

Huntingdon Life Sciences (HLS)

An international development company providing a range of services to the pharmaceutical, biopharmaceutical, chemical, crop protection, veterinary, and food industries.
Huntingdon Research Centre, Woolley Road, Alconbury, Huntingdon, Cambridgeshire, PE28 4HS, UK
Phone: +44-(0)1480-892-000
Fax: +44-(0)1480-890-693
Email: sales@ukorg.huntingdon.com
Web: http://www.huntingdon.com/

Instant Analysis

Offers chemical analysis and consultancy in relation to chemical product development.
Quality House, 73 Windsor Road, Prestwich, Manchester M25 0DB, UK
Phone: +44-(0)161-721-4418
Fax: +44-(0)161-740-4186
Email: info@instantanalysis.co.uk
Web: http://www.instantanalysis.co.uk/

IPPC Consultants Limited

An environmental protection consultancy.
Mobile: +44-(0)7712-583517
Email: martin.glossop@ippc-consultants.co.uk
Web: http://www.ippc-consultants.co.uk/

Len Hall Chemical Consultant

Online health and safety advice to chemical and distribution industries.
14 Knowsley Meadows, Darwen, Lancashire, BB33 2UP, UK
Phone: +44-(0)1254-701972
Mobile: +44 (0)7747 692193
Email: lhdgsa@aol.com
Web: http://www.lenhallsafetyadvisor.co.uk/

LGC

Formerly the Laboratory of the Government Chemist, LGC is now an independent, science-based service

company providing chemical, biochemical, and DNA-based analysis. LGC's services include analytical testing, research, consultancy, validation, training, and knowledge transfer for the public and private sectors. It is active in: food and agriculture, oil and chemicals, pharmaceuticals, environment, health care, life sciences, and law enforcement. It also provides chemical, biochemical, and DNA-based analytical services. It operates through several sites.
LGC Limited, Queens Road, Teddington, Middlesex, TW11 0lY, UK
Web: http://www.lgc.co.uk/

M R Associates

An environmental protection consultancy.
1st Floor, Westgate House, 100 Wellington Street, Leeds, West Yorkshire, LS1 4LT, UK
Phone: +44-(0)800-019-9725
Fax: +44-(0)845-130-3178
Email: enquiries@mraukltd.com
Web: http://www.mrassociates.co.uk/

MESH Consultants

Consults on health and safety of employees.
East Malling Enterprise Centre, New Road, East Malling, Kent, ME19 6BJ, UK
Phone: +44-(0)1732-897455
Email: martin.moy@consultmesh.co.uk
Web: http://www.consultmesh.co.uk/

Osborne Richardson

An environmental protection consultancy.
4th floor, Circus House, 26 Little Portland Street, London, W1W 8BX, UK
Phone: +44-(0)207-5801500
Email: mail@or-environmentalhealth.com
Web: http://www.or-environmentalhealth.com/

Peter Fisk Associates

Provides specialist services in environmental science, human health, and chemistry in relation to data collation and analysis (including the OECD HPV Programme, REACH submissions, hazard and risk assessment, voluntary initiatives and general regulatory compliance)
39 Bennell's Avenue, Tankerton, Whitstable, Kent CT5 2HP, UK
Phone/Fax/voice mail: +44-(0)1227-752442
Mobile: +44-(0)7795-517615
Email: peter.fisk@ecotoxchem.co.uk
Web: http://www.ecotoxchem.co.uk/index.html

Quintiles UK Ltd

Quintiles is a full-service contract research organization for the pharmaceutical and biotechnology industry. Facilities in Scotland provide preclinical development, pharmaceutical sciences, clinical trial manufacturing, packaging and distribution, clinical trial management, central laboratory services, regulatory affairs, data management, and clinical trial services.
Quintiles UK, Research Avenue South, Heriot Watt University Research Park, Riccarton, Edinburgh EH14 4AP, UK
Email: qedi.busdev@quintiles.com
Web: http://www.quintiles.com/

RPS

An international consultancy providing advice upon the development of natural resources, land and property, the management of the environment, and the health and safety of people.
Business Information Unit, RPS Group Plc, Centurion Court, 85 Milton Park, Abington, OX14 4RY, UK
Phone: +44-(0)1235-863252
Fax: +44-(0)1235-438151
Web: http://www.rpsplc.co.uk/

SafePharm Laboratories

Contract research company involved in the safety evaluation of speciality and performance chemicals, pharmaceuticals, agrochemicals, intermediates, and medical devices.
SafePharm Laboratories, Shardlow Business Park, London Road, Shardlow, Derbyshire, DE72 2GD, UK
Phone: +44-(0)1332-792896
Fax: +44-(0)1332-799018
Email: marketing@SafePharm.co.uk
Web: http://www.safepharmlabs.com/

SATRA

A not-for-profit organization offering a wide range of testing, research, training, and consultancy services relating to the physical, chemical, environmental, and flammability properties of materials and consumer products.
SATRA House, Rockingham Road, Kettering, Northamptonshire, NN16 9JH, UK
Phone: +44-(0)1536-410000
Fax: +44-(0)1536-410626
Email: info@satra.co.uk
Web: http://www.satra.co.uk/

Sequani

Sequani is a contract research organization conducting both preclinical and clinical research on pharmaceutical, biotechnology, and medical device products.
Sequani, Bromyard Road, Ledbury HR8 1LH, UK
Phone: +44-(0)1531-634121
Fax: +44-(0)1531-634753
Web: http://www.sequani.com/

STL

STL is an environmental testing organization, working in the fields of water cycle, contaminated land, emissions, effluent and microbiological analysis, and endocrine-disrupting chemicals.
STL Business Centre, Torrington Avenue, Coventry CV4 9GU, UK
Phone: +44-(0)24-7642-1213
Fax: +44-(0)24-7685-6575
Email: info@stl-ltd.com
Web: http://www.stl-ltd.com/

Surgical Materials Testing Laboratory (SMTL)

SMTL undertakes contract laboratory testing of medical devices and dressings to British, European, and International standards, clinical trials, and research and development into disposable medical devices and dressings.
SMTL, Princess of Wales Hospital, Coity Road, Bridgend CF31 1RQ, UK
Phone: +44-(0)1656-752820
Fax: +44-(0)1656-752830
Web: http://www.smtl.co.uk/

The Risk Assessment Company
Undertakes occupational health and safety consultancy.
Phone: +44-(0)870-870-9102
Fax: +44-(0)870-870-9103
Mobile: +44-(0)7973-560173
Email: info@riskassessmentcompany.co.uk
Web: http://www.riskassessmentcompany.co.uk/

Watts & Crane Associates

Independent company providing scientific advice on environmental sources and pathways of chemicals, and their effects on human and ecological receptors, for the water, chemicals, retail, and regulatory sectors.
Watts & Crane Associates, 23 London Street, Faringdon, Oxfordshire, SN7 7AG, UK
Phone: +44-(0)1367-244311
Mobile: +44-(0)7845-929978
Web: http://www.wfcenvironment.co.uk/index.html

WRc plc

WRc plc (formerly Water Research Centre) is an independent company, founded in 1989, that provides consultancy to industries in the water, waste, and environment sectors, and to government and regulatory bodies.
WRc, Frankland Road, Blagrove, Swindon, Wiltshire, SN5 8YF, UK
Phone: +44-(0)1793-865000
Fax: +44-(0)1793-865001
Email: solutions@wrcplc.co.uk
Web: http://www.wrcplc.co.uk/

Universities

Brunel University
Uxbridge, Middlesex, UB8 3PH, UK
Phone: 01895-274000
Fax: 01895-232806
Web: http://www.brunel.ac.uk/

Centre for Environmental Research in Centre for the Analysis of Risk and Optimisation Modelling Application

The mission of CARISMA is to be a center of excellence recognized for its research and scholarship in: analysis of risk, optimization modeling and the combined paradigm of risk and return quantification. As such the center is involved in research, postgraduate and masters degree training and consultancy.
Uxbridge UB8 3PH, UK
Phone: +44-(0)1895-265187
Fax: +44-(0)1895-269732
Email: carisma@brunel.ac.uk
Web: http://www.carisma.brunel.ac.uk/http://carisma.brunel.ac.uk/

Centre for Epidemiology and Health Service Research

This is composed of an interdisciplinary team of academics, undertaking research and providing consultation support in the fields of epidemiology and health-service-related research, with a particular emphasis on maintaining and promoting the highest methodological standards.
Web: http://www.brunel.ac.uk/about/acad/health/healthres/researchareas/ehsrg

Cardiff University
Wales CF10 3XQ, UK
Phone: +44-(0)29-2087-4000 (main switchboard)
Web: http://www.cardiff.ac.uk/index.html

Department of Epidemiology, Statistics and Public

Identifying factors in the social and physical environment which cause ill health and consequently reduce the quality of life.
Department of Epidemiology, Statistics & Public Health, Centre for Health Sciences Research, Cardiff University, 4th Floor, Neuadd Meirionnydd, Heath Park, Cardiff CF14 4YS, UK
Phone: +44-(0)29-2068-7228
Email: coomberr@cf.ac.uk
Web: http://www.cardiff.ac.uk/medicine/epidemiology_statistics/

Department of Pharmacology, Therapeutics and Toxicology, Wales College of Medicine, Cardiff University, Heath Hospital Campus, Cardiff, CF14 4XN, UK
Phone: +44-(0)29-2074-2060/2051
Fax: +44-(0)29-2074-8316
Web: http://www.cardiff.ac.uk/medicine/departments/pharmacology/index.htm

Cranfield University
Cranfield University (Main campus), Cranfield, Bedfordshire MK43 0AL, UK
Phone: +44-(0)1234-750111
Fax: +44-(0)1234-750875

Cranfield Health

Focuses on health research, education and consultancy and combines science technology, human factors and management to provide new solutions for the health sector.
Cranfield University, Cranfield Health, Silsoe, Bedfordshire MK45 4DT, UK
Phone: +44-(0)1234-750111
Email: health@cranfield.ac.uk
Web: http://www.cranfield.ac.uk/health/

Institute of Environment and Health

A part of Cranfield Health that promotes a healthier environment through activities such as: facilitating information exchange, identifying and evaluating environment and health issues, and managing research programs on the adverse effects of chemicals.
Institute of Environment and Health, Cranfield University, Silsoe, Bedfordshire MK45 4DT, UK
Phone: +44-(0)1525-863002
Web: http://www.silsoe.cranfield.ac.uk/ieh/

Lancaster University
Bailrigg, Lancaster LA1 4YW, UK
Phone: +44-(0)1524-65201
Web: http://www.lancs.ac.uk/

Department of Environmental Science

Conducts research into the aquatic, atmospheric, and terrestrial environments.
Department of Environmental Science, Lancaster University, Lancaster LA1 4YQ, UK
Phone: +44-(0)1524-65201 (ext. 94308)
Fax: +44-(0)1524-593985
Email: EnvSci@lancaster.ac.uk
Web: http://www.es.lancs.ac.uk/

The Lancaster Environment Centre

Conducts biostatistical analysis. Has particular strengths in environmental epidemiology.
Lancaster Environment Centre, Lancaster University, Lancaster, LA1 4YQ, UK
Phone: +44-(0)1524-510223
Email: lec@lancs.ac.uk
Web: http://www.lec.lancs.ac.uk/lu_theme4.htm

Liverpool John Moores University
Roscoe Court, 4 Rodney Street, Liverpool L1 2TZ, UK
Phone: +44-(0)151-231-2121 (main switchboard)
Web: http://www.ljmu.ac.uk/

Centre for Public Health

Conducts projects in the area of environmental health, integrated pollution, prevention and control, food and health, and reaching responsibilities.
Centre for Public Health, North Street, Liverpool L3 2AY, UK
Phone: +44-(0151)-231-4510
Fax: +44-(0151)-231-4515
Email: info@cph.org.uk
Web: http://www.cph.org.uk/

Loughborough University
Leicestershire LE11 3TU, UK
Phone: +44-(0)1509-263171
Web: http://www.lboro.ac.uk/

Department of Chemical Engineering

Conducts research of safety, environment, and loss prevention.
Web: http://www.lboro.ac.uk/departments/cg/

Napier University
Napier University, Craiglockhart Campus, Edinburgh EH14 1DJ, UK
Phone: 08452-606040
Web: http://www.napier.ac.uk/

School of Life Sciences, Centre for Health and Environment

Investigates the toxicology of different types to nanoparticles.
Web: http://www.lifesciences.napier.ac.uk/Research/CHEfiles/CHEhealth.htm

Newcastle University
Newcastle University, NE1 7RU, UK
Phone: +44-(0)191-222-6000
Web: http://www.ncl.ac.uk/

Institute of Health and Society

Conducts the environment and health research programs.
NE2 4AA, UK
Phone: +44-(0)191-222-7045
Web: http://www.ncl.ac.uk/ihs/research/environment/

Institute for Research on Environment & Sustainability and School of Clinical and Laboratory Sciences

Interdisciplinary research institute based within the University of Newcastle upon Tyne.
Devonshire Building, University of Newcastle, Newcastle upon Tyne NE1 7RU, UK
Phone: +44-(0)191-246-4960
Fax: +44-(0)191-246-4998
Email: ires@ncl.ac.uk
Web: http://www.ncl.ac.uk/environment/

Oxford Brookes University

Undertakes postgraduate courses on environmental assessment.
Headington Campus, Gipsy Lane, Oxford OX3 0BP, UK
Phone: +44-(0)1865-741111
Web: http://www.brookes.ac.uk/

University of Aberdeen
Aberdeen AB24 3FX, UK
Phone: +44-(0)1224-272000
Web: http://www.abdn.ac.uk/

Environment and Occupational Medicine

Conducts research projects covering both environmental and occupational health issues.
Department of Environmental & Occupational Medicine, Liberty Safe Work Research Centre, Foresterhill Road, Aberdeen AB25 2ZP, UK
Phone: +44-(0)1224-558188
Fax: +44-(0)1224-551826
Email: deom@abdn.ac.uk
Web: http://www.abdn.ac.uk/deom/

Institute of Medical Sciences

Provides a wide area of medical research programs.
Institute of Medical Sciences, University of Aberdeen, Foresterhill, Aberdeen AB25 2ZD, UK
Phone: +44-(0)1224-555700
Fax: +44-(0)1224-555844
Email: ims@abdn.ac.uk
Web: http://www.abdn.ac.uk/ims/about.shtml

School of Biological Sciences

Provides wide area of biological taught and research course.
Zoology Building, Tillydrone Avenue, University of Aberdeen, Aberdeen AB24 2TZ, UK
Phone: +44-(0)1224-272861
Fax: +44-(0)1224-272396
Email: bioscience@abdn.ac.uk
Web: http://www.abdn.ac.uk/biologicalsci/

University of Birmingham
Edgbaston, Birmingham, B15 2TT, UK
Phone: +44-(0)121-414-3344
Web: http://www.bham.ac.uk/default.asp

Institute of Occupational and Environmental Medicine (IOEM)

Develops and conducts research and teaching programs in occupational and environmental medicine, epidemiology, ergonomics, toxicology, hygiene, and other related disciplines.
Email: MED-DeansOffice@bham.ac.uk (general enquiries)
Web: http://www.pcpoh.bham.ac.uk/ioem/

School of Biosciences

Delivers teaching and research across the broad span of modern biology.
School of Biosciences, the University of Birmingham, Birmingham B15 2TT, UK
Phone: +44-(0)121-414-5400
Fax: +44-(0)121-414-5925
Web: http://www.biosciences.bham.ac.uk/

University of Dundee
Nethergate, Dundee DD1 4HN, Scotland, UK
Phone: +44-(0)1382-383000 (main switchboard)
Fax: +44-(0)1382-201604
Email: university@dundee.ac.uk
Web: http://www.dundee.ac.uk/

Division of Community Health Sciences

Undertakes research relevant to public health and the delivery of health care in the broadest sense.
Division of Community Health Sciences, the MacKenzie Building, Kirsty Semple Way, Dundee DD2 4BF, UK
Phone: +44-(0)1382-420100
Fax: +44-(0)1382-420101
Web: http://www.dundee.ac.uk/epidemiology/

University of East Anglia
Norwich NR4 7TJ, UK
Phone: +44-(0)1603-456161
Fax: +44-(0)1603-458553
Web: http://www1.uea.ac.uk/cm/Home

School of Environmental Sciences

Conducts teaching and research, integrating physical, chemical, biological, social and geotechnical sciences into the study of natural and human environment.
School of Environmental Sciences, University of East Anglia, Norwich NR4 7TJ, UK
Phone: +44-(0)1603-592542
Fax: +44-(0)1603-591327
Email: env.enquiries@uea.ac.uk
Web: http://www1.uea.ac.uk/cm/home/schools/sci/env

University of Leicester
University Road, Leicester LE1 7RH, UK
Phone: +44-(0)116-252-2522
Fax: +44-(0)116-252-2200
Web: http://www.le.ac.uk/external/

Department of Cancer Studies and Molecular Development

Conducts cancer research focusing on aspects such as etiology, biology, prevention, and treatment, and research into stem cell and cell biology relating to the reproductive and gastrointestinal systems.
Head, Cancer Studies and Molecular Medicine, University of Leicester, 2nd Floor, Osborne Building, Leicester Royal Infirmary, Leicester LE1 5WW, UK
Phone: +44-(0)116-258-7597
Fax: +44-(0)116-258-7599
Web: http://www.le.ac.uk/cm/

University of Liverpool
Liverpool L69 3BX, UK
Phone: +44-(0)151-794-2000/ +44-(0)151-708-6502
Web: http://www.liv.ac.uk/

School of Biomedical Sciences, Department of Pharmacology

Conducts research and teaches courses to promote and develop safe and effective use of drugs.
Web: http://www.liv.ac.uk/Pharmacology/root/department%20of%20pharmacology/index.htm

University of London
Senate House, Malet Street, London WC1E 7HU, UK
Phone: +44-(0)20-7862-8000
Web: http://www.lon.ac.uk/

London School of Hygiene & Tropical Medicine

Undertakes research, postgraduate teaching, and advanced training in national and international public health and tropical medicine, and research to inform policy and practice in these areas.
London School of Hygiene & Tropical Medicine, Keppel Street, London WC1E 7HT, UK
Phone: +44-(0)20-7636-8636
Web: http://www.lshtm.ac.uk/

Contaminated Land Assessment & Remediation Research Centre (CLARRC)

Centre for academic research, contract research, laboratory analysis, consulting services.
Phone: +44-(0)131-650-7327
Fax: +44-(0)131-650-6554
Web: http://www.clarrc.ed.ac.uk/

University of Manchester
Oxford Road, Manchester M13 9PL, UK
Phone: +44-(0)161-306-6000
Web: http://www.coeh.man.ac.uk/cgi-bin/frameset/launch.pl?link_id=24

Centre for Occupational and Environmental Health (COEH)

Undertakes research on the effect of occupation and environment on health.

Centre for Occupational and Environmental Health, Faculty of Medical and Human Sciences, University of Manchester, 4th Floor, Block C, Humanities Building (Devas Street), Oxford Road, Manchester M13 9PL, UK
Phone: +44-(0)161-275-5522
Email: lesley.jordan@manchester.ac.uk
Web: http://www.medicine.manchester.ac.uk/coeh/

Environmental Impact Assessment

An independent university-based research organization, specializing in environmental impact assessment, research, training, and information.
EIA Centre, Planning and Landscape, University of Manchester, Oxford Road, Manchester M13 9PL, UK
Phone: +44-(0)161-275-6881
Fax: +44-(0)161-275-6893
Email: eia.centre@manchester.ac.uk
Web: http://www.art.man.ac.uk/EIA/

University of Strathclyde
John Anderson Campus, 16 Richmond Street, Glasgow G1 1XQ, Scotland, UK
Phone: +44-(0)141-552-4400 (main switchboard)
Fax: +44-(0)141-552-0775

Jordanhill Campus, 76 Southbrae Drive, Glasgow G13 1PP, Scotland, UK
Phone: +44-(0)141-950-3000
Fax: +44-(0)141-950-3166
Web: http://www.strath.ac.uk/

University of Surrey
Guildford, Surrey GU2 7XH, UK
Phone: +44-(0)1483-300800
Fax: +44-(0)1483-300803
Web: http://www.surrey.ac.uk/

Centre of Toxicology

Active in all areas of toxicological research.
Web: http://www.centrefortoxicology.com/

School of Biomedical and Molecular Sciences

Active in biomedical and molecular science.
School of Biomedical and Molecular Sciences, University of Surrey, Guildford, Surrey GU2 7XH, UK
Phone: +44-(0)1483-686400

Fax: +44-(0)1483-686401
Email: sbms@surrey.ac.uk (general enquiries)
Web: http://www.surrey.ac.uk/SBMS/

University of Wales, Aberystwyth
Old College, King Street, Aberystwyth, Ceredigion SY23 2AX, UK
Phone: +44-(0)1970-623-111
Web: http://www.aber.ac.uk/en/visitor/

Centre for Research in Environment and Health

A non-profit-making organization, dedicated to furthering the improvement of the environment and health by research and education.
Web: http://www.creh.org.uk/

University of the West of England (UWE)
Coldharbour Lane, Bristol BS16 1QY, UK
Phone: +44-(0)117-965-6261
Minicom: +44-(0)117-976-3806
Web: http://www.uwe.ac.uk/

Faculty of Applied Sciences, Centre for Research in Environmental Sciences (CRES)

Promotes integrated research into the environment, the damaging effects of pollution and how to remedy this damage.
Faculty of Applied Sciences, Head of Department of Environmental Sciences, University of the West of England, Frenchay Campus, Coldharbour Lane, Bristol BS16 1QY, UK
Phone: +44-(0)117-32-83692
Fax: +44-(0)117-32-82132
Email: James.Longhurst@uwe.ac.uk
Web: http://science.uwe.ac.uk/research/homePage.aspx?pageId=cresHome

Professional Societies

British Pharmacological Society (BPS)

Concerns with research into drugs and the way they work; covering the whole spectrum of pharmacology, including the laboratory, clinical, and toxicological aspects.
16 Angel Gate, City Road, London EC1V 2PT, UK
Phone: +44-(0)20-7239-0171
Fax: +44-(0)20-7417-0114
Email: yn@bps.ac.uk
Web: http://www.bps.ac.uk/

British Society of Toxicological Pathologists (BSTP)

Non-profit organization involved in the education of pathologists working in the field of human safety assessment.
Email: bstpoffice@aol.com
Web: http://www.bstp.org.uk/

British Toxicology Society (BTS)

Currently the BTS is the largest professional toxicology society in the UK, with approximately 1000 members and 297 registered toxicologists. BTS is active to promote the advancement, communication, and understanding of those scientific disciplines necessary to foster public health and environmental safety. It is affiliated to regional (EUROTOX) and international (IUTOX) toxicology societies, and BTS members automatically have access to national society member benefits within these umbrella organizations. The UK Register of Toxicologists is jointly sponsored by the Institute of Biology and the British Toxicology Society, and was established in 1993. Members of the UK Register of Toxicologists gain automatic membership of the EUROTOX Register of Toxicologists.
BTS Administration Office, P.O. Box 249, Macclesfield SK11 6FT, UK
Phone: +44-(0)1625-267881
Fax: +44-(0)1625-267879
Email: secretariat@thebts.org
Web: http://www.thebts.org/

Chartered Institute for Environmental Health (CIEH)

CIEH is a professional and campaigning body that sets standards and is responsible for the accreditation of courses. It also provides information, evidence and policy advice, and qualifications, events, and trainer and candidate support materials on topics relevant to health, wellbeing, and safety. CIEH works to push environmental health further up the public agenda and to promote improvements in environmental and public health policy for environmental and public health.
CIEH, Chadwick Court, 15 Hatfields, London SE1 8DJ, UK
Phone: +44-(0)20-7928-6006
Fax: +44-(0)20-7827-5862
Email: info@cieh.org
Web: http://www.cieh.org/

Forensic Science Society

The Forensic Science Society is an international professional body with members in over 60 countries. It publishes a peer-reviewed journal, a newsletter, awards qualifications and prizes, arranges scientific conferences in the UK and abroad, and is engaged in setting standards and accreditation in forensic sciences. Most of its members are UK scientists but there is a significant minority of other forensic professionals involved such as police officers and crime scene investigators. The Society was founded in 1959 by Professor Stuart Kind

and with over 2500 members it is one of the oldest and largest forensic associations in the world.

18A, Mount Parade, Harrogate, North Yorkshire, HG1 1BX, UK
Phone: +44-(0)1423-506-068
Web: http://www.forensic-science-society.org.uk/stoppress.html

In Vitro Toxicology Society (IVTS)

IVTS is a toxicological society that provides a forum for discussion for scientists actively involved in the study, practice, or development of in vitro toxicology. It organizes scientific meetings on the subject of in vitro toxicology and its practical applications, and promotes an exacting scientific approach to the practice of in vitro toxicology.
Contact via Dr Val Baker (IVTS Committee Chairman), Sanofi-Aventis, Alnwick Research Centre, Willowburn Ave, Alnwick, Northumberland NE66 2JH, UK
Phone: +44-(0)1665-608592
Fax: +44-(0)1665-608503
Email: val.baker@sanofi-aventis.com
Web: http://www.ivts.org.uk/

Institute of Biology (IOB)

This is a professional body for UK biologists that operates under a Royal Charter.
IOB, 9 Red Lion Court, London EC4A 3EF, UK
Phone: +44-(0)20-7936-5900
Fax: +44-(0)20-7936-5901
Email: info@iob.org
Web: http://www.iob.org/

Occupational and Environmental Toxicology Group (OETG)

This group represents and informs members in the RSC of matters pertaining to the risks from chemicals in the work place and in the environment.
Dr Sean McWhinnie Manager Science Policy, Royal Society of Chemistry, Burlington House, Piccadilly, London W1J 0BA, UK
Phone: +44-(0)20-7440-3309
Fax: +44-(0)20-7437-8883
Web: http://www.rsc.org/Membership/Networking/InterestGroups/Toxicology/index.asp

Pathological Society of Great Britain and Ireland

The objective of the Society is to advance pathology and facilitate communication between pathologists.
2 Carlton House Terrace, London SW1Y 5AF, UK
Phone: +44-(0)20-7976-1260
Fax: +44-(0)20-7976-1267
Web: http://www.pathsoc.org.uk/index.php?option=com_frontpage&Itemid=1

Research Defence Society (RDS)

RDS was founded in 1908 by Dr Stephen Paget FRCS. It represents medical researchers in the public debate about the use of animals in medical research and testing.
RDS, 25 Shaftesbury Avenue, London W1D 7EG, UK
Phone: 020-7287-2818
Fax: 020-7287-2627
Email: info@rds-net.org.uk
Web: http://www.rds-net.org.uk/pages/home.asp?i_ToolbarID=8&i_PageID=94

Royal College of Pathologists (RCPath)

Promotes excellence in the practice of pathology and to be responsible for maintaining standards through training, examinations, and professional development.
2 Carlton House Terrace, London SW1Y 5AF, UK
Phone: +44-(0)20-7451-6700
Fax: +44-(0)20-7451-6701
Email: info@rcpath.org
Web: http://www.rcpath.org/

Royal College of Physicians (RCP)

The Royal College of Physicians was established in 1962 to co-ordinate the development and maintain the internationally renowned standards and reputation of British pathology, and has charitable status. It sets standards in clinical practice and education and training, conducts assessments and examinations, quality assures external audit programmes, supports doctors in their practice of medicine, and advises the government, public and the profession on health care issues.
11 St Andrews Place, Regent's Park, London NW1 4LE, UK
Phone: +44-(0)20-7935-1174 (main switchboard)
Fax: +44 (0)20 7487 5218
Web: http://www.rcplondon.ac.uk/index.asp

Royal Society

An independent charity operating under Royal Charter since 1662, the Society acts to influence science policy, debates, and scientific issues with the public.
6–9 Carlton House Terrace, London SW1Y 5AG, UK
Phone: +44-(0)20-7451-2500
Fax: +44-(0)20-7930-2170
Web: http://www.royalsoc.ac.uk/

Royal Society of Chemistry (RSC)

The RSC's original Charter was granted in 1848. The current Charter, granted in 1980, defines its objectives as: the general advancement of chemical science and its application, to establish, uphold and advance the standards of qualification, competence and conduct of

those who practise chemistry as a profession; and to serve the public interest by acting in an advisory, consultative or representative capacity in matters relating to the science and practice of chemistry.
Royal Society of Chemistry, Burlington House, Piccadilly, London W1J 0BA, UK
Phone: +44-(0)20-7437-8656
Fax: +44-(0)20-7437-8883
Web: http://www.rsc.org/

Society of Environmental Toxicology and Chemistry United Kingdom Branch (SETAC-UK)

Promotes a scientific forum for environmental toxicologists and chemists in the UK, multidisciplinary research into environmental problems, and application and development of fundamental research to applied problem.
Contact: Dr Richard Handy, School of Biological Sciences, the University of Plymouth, Drake Circus, Plymouth PL4 8AA, UK
Phone. +44-(0)1752-232900
Fax: +44-(0)1752-232970
Email: r.handy@plymouth.ac.uk
Web: http://www.setac-uk.org.uk/

The Society for Experimental Biology (SEB)

A non-profit organization that supports and promotes experimental biology to both the scientific community and the general public.
SEB, 3 The Carronades, New Road, Southampton, Hants SO14 0AA, UK
Phone: +44-(0)23-8022-4824
Fax: +44-(0)23-8022-6312
Web: http://www.sebiology.org/index.asp

United Kingdom Environmental Mutagen Society (UKEMS)

The UK branch of the European Environmental Mutagen Society (EEMS), representing scientists involved in research on genetic damage caused by environmental agents (chemicals and radiation).
UKEMS, School of Biological Sciences, University of Wales Swansea, Singleton Park, Swansea SA2 8PP, UK
Web: http://www.ukems.org/

Poison Control Centers

A clinical toxicology service for healthcare professionals working in the NHS and is a service commissioned by the HPA. Provides information and advice on the diagnosis, treatment and management of patients who may have been accidentally or deliberately poisoned. Operates through a number of centers. Provides comprehensive expert advice and support for chemical incidents across England and Wales in order to anticipates and prevent the adverse effects of acute and chronic exposure to hazardous chemicals and other poisons.

Chemical Hazards

Birmingham
Birmingham Research Park, 97 Vincent Drive, Birmingham B15 2SQ, UK
Phone: +44-(0)121-414-3368
Fax: +44-(0)121-414-3827
Email: chemicals.birmingham@hpa.org.uk

Cardiff
University of Wales Institute Cardiff, Colchester Avenue, Penylan, Cardiff CF23 9XR, UK
Phone: +44-(0)2920-416388
Email: chemicals.cardiff@hpa.org.uk

London
Health Protection Agency Central Office
7th Floor Holborn Gate, 330 High Holborn, London WC1V 7PP, UK
Phone: +44-(0)20-7759-2871
Fax: +44-(0)20-7759-2890
Email: chemicals.london@hpa.org.uk

Newcastle
The Wolfson Unit (1st Floor), University of Newcastle upon Tyne NE2 4HH United Kingdom
Tel: +44 (0)191 222 7195
Email: chemicals.newcastle@hpa.org.uk

National Poisons Information Service Centres

Web: http://www.hpa.org.uk/chemicals/npis.htm

Belfast
Royal Victoria Hospital, Grosvenor Road, Belfast BT9 7BL

Birmingham
City Hospital, Dudley Road, Birmingham B18 7QH, UK
Web: http://www.npis.org/NPIS/npis.htm

Cardiff
Llandough Hospital, Penarth, Cardiff CF64 2XX, UK
Web: http://www.cardiff.ac.uk/medicine/pharmacology/ttc/npis/index.html

Edinburgh
The Royal Infirmary, Edinburgh EH16 4SA, UK
Web: http://www.spib.scot.nhs.uk/

Newcastle
Wolfson Unit, Claremont Place, Newcastle-upon-Tyne NE2 4HH, UK
Web: http://www.nyrdtc.nhs.uk/Services/poisons/poisons.html

Radiation Protection Division

Web: http://www.hpa.org.uk/radiation/default.htm

Health Protection Agency, Centre for Radiation, Chemical and Environmental Hazards
Chilton, Didcot, Oxon OX11 0RQ, UK
Phone: +44-(0)1235-831600
Fax: +44-(0)1235-833891
Email: rpd@hpa-rp.org.uk

Legislation

The UK does not have a single unified body of legislation but is divided into three states, each with its own laws and legal systems. These comprise England and Wales (English law), Scotland (Scottish Law), and Northern Ireland and Wales for which some specific legislation applies.

Laws enacted by Parliament are termed 'Acts' and represent the primary legislation of the nation. However, most secondary legislation in the UK is in the form of Statutory Instruments. These, produced for example as orders or regulations, are made by a Minister or by the Queen-in-Council, and are assigned a unique number, with a new series of numbers being started each year. In Northern Ireland, however, secondary legislation is produced as Statutory Rules.

In addition, the legislative framework in the UK is influenced by the laws of the European Union. Of these, European Union Regulations are legislative acts which apply directly across all Member States and make up one of the most powerful forms of EU law which must be given immediate force in all Member States. In particular individual countries do not need to pass local laws to bring EU regulations into effect. In contract, the European Union also produces Directives, which are collective legislative acts which can be adopted by each Member State through a variety of legislative procedures depending on subject matter, and are only binding on those Member States to which they are addressed. How each country puts a Directive into effect depends on its particular legal structure. In the UK, most Directives are enacted via Statutory Instruments although some Directives create such major changes to law that Parliament passes a separate Act to incorporate the change.

There are many UK laws that relate to hazardous chemicals and that impinge on toxicology and experimental research in the UK, and although they are not published in a particular order or under particular headings, for convenience the most recent of these are presented below under a number of topic areas: General legislation on chemicals; Legislation on specific substances/chemicals; Restriction of use in certain products; Food related; Transport of chemicals; and Planning, environment, waste and accident related. The following text presents only a selection of the most recent modification to the legislative base. Full details of current UK legislation may be found at: http://www.opsi.gov.uk/legislation/uk.htm.

England and Wales

General Legislation on Chemicals

Statutory Instrument 2005 No. 2571: The Chemicals (Hazard Information and Packaging for Supply) (Amendment) Regulations 2005: http://www.opsi.gov.uk/si/si2005/20052571.htm

Statutory Instrument 1993 No. 3050: The Notification of New Substances Regulations 1993: http://www.opsi.gov.uk/si/si1993/Uksi_19933050_en_1.htm

Statutory Instrument 2004 No. 3386: The Control of Substances Hazardous to Health (Amendment) Regulations 2004: http://www.opsi.gov.uk/si/si2004/20043386.htm

Statutory Instrument 1990 No. 1255: The Classification, Packaging and Labelling of Dangerous Substances (Amendment) Regulations 1990: http://www.opsi.gov.uk/si/si1990/Uksi_19901255_en_1.htm

Legislation on Specific Substances/Chemicals

Asbestos

Statutory Instrument 2006 No. 2739: The Control of Asbestos Regulations 2006: http://www.opsi.gov.uk/si/si2006/20062739.htm

Pesticides

Statutory Instrument 2006 No. 1742: The Pesticides (Maximum Residue Levels in Crops, Food and Feeding Stuffs) (England and Wales) (Amendment) (No. 2) Regulations 2006: http://www.opsi.gov.uk/si/si2006/20061742.htm

Pesticides Act 1998 (c. 26): http://www.opsi.gov.uk/acts/acts1998/19980026.htm

Creosote

Statutory Instrument 2003 No. 1511: The Creosote (Prohibition on Use and Marketing) (No. 2) Regulations 2003: http://www.opsi.gov.uk/si/si2003/20031511.htm

Nickel

Statutory Instrument 2005 No. 2001: The Dangerous Substances and Preparations (Nickel) (Safety) Regulations 2005: http://www.opsi.gov.uk/si/si2005/20052001.htm

Medicines

Health Act 2006 (c. 28): http://www.opsi.gov.uk/acts/acts2006/20060028.htm

Health (Wales) Act 2003 c. 4: http://www.opsi.gov.uk/acts/acts2003/20030004.htm

Statutory Instrument 2006 No. 1952: The Medicines for Human Use (National Rules for Homoeopathic Products Regulations 2006: http://www.opsi.gov.uk/si/si2006/20061952.htm

Statutory Instrument 2005 No. 3324: The Medicines for Human Use (Prescribing) (Miscellaneous Amendments) (No. 2) Order 2005: http://www.opsi.gov.uk/si/si2005/20053324.htm

Statutory Instrument 2003 No. 2915: The Prescription Only Medicines (Human Use) Amendment (No. 2) Order 2003: http://www.opsi.gov.uk/si/si2003/20032915.htm

Statutory Instrument 2006 No. 395: The Medicines (Traditional Herbal Medicinal Products for Human Use) (Consequential Amendment) Regulations 2006: http://www.opsi.gov.uk/si/si2006/20060395.htm

Statutory Instrument 2006 No. 2407: The Veterinary Medicines Regulations 2006: http://www.opsi.gov.uk/si/si2006/20062407.htm

Statutory Instrument 2005 No. 2745: The Veterinary Medicines Regulations 2005: http://www.opsi.gov.uk/si/si2005/20052745.htm

Restriction of Use in Certain Products

Statutory Instrument 2006 No. 1463: The Restriction of the Use of Certain Hazardous
Substances in Electrical and Electronic Equipment Regulations 2006: http://www.opsi.gov.uk/si/si2006/20061463.htm

Statutory Instrument 2001 No. 2551: The Batteries and Accumulators (Containing Dangerous Substances) (Amendment) Regulations 2001: http://www.opsi.gov.uk/si/si2001/20012551.htm

Statutory Instrument 2000 No. 1460: The Sulphur Content of Liquid Fuels (England and Wales) Regulations 2000: http://www.opsi.gov.uk/si/si2000/20001460.htm

Statutory Instrument 2006 No. 1198: The Cosmetic Products (Safety) (Amendment) Regulations 2006: http://www.opsi.gov.uk/si/si2006/20061198.htm

Statutory Instrument 2005 No. 2469: The Detergents Regulations 2005: http://www.opsi.gov.uk/si/si2005/20052469.htm

Food Related

Food Standards Act 1999 (c. 28): http://www.opsi.gov.uk/acts/acts1999/19990028.htm

Statutory Instrument 2006 No. 3116: The Food for Particular Nutritional Uses (Addition of Substances for Specific Nutritional Purposes) (England) (Amendment) Regulations 2006: http://www.opsi.gov.uk/si/si2006/20063116.htm

Statutory Instrument 2006 No. 1464: The Contaminants in Food (England) Regulations 2006: http://www.opsi.gov.uk/si/si2006/20061464.htm

Statutory Instrument 2005 No. 775: The Contaminants in Food (England) (Amendment) Regulations 2005: http://www.opsi.gov.uk/si/si2005/20050775.htm

Statutory Instrument 2006 No. 15: The Official Feed and Food Controls (England) Regulations 2006: http://www.opsi.gov.uk/si/si2006/20060015.htm

Statutory Instrument 2006 No. 2808: The Feeding Stuffs (England) (Amendment) Regulations 2006: http://www.opsi.gov.uk/si/si2006/20062808.htm

Statutory Instrument 2006 No. 113: The Feeding Stuffs and the Feeding Stuffs (Sampling and Analysis) (Amendment) (England) Regulations 2006: http://www.opsi.gov.uk/si/si2006/20060113.htm

Statutory Instrument 2006 No. 3120: The Feed (Specified Undesirable Substances) (England) Regulations 2006: http://www.opsi.gov.uk/si/si2006/20063120.htm

Transport of Chemicals

Railways and Transport Safety Act 2003: http://www.opsi.gov.uk/acts/acts2003/20030020.htm

Merchant Shipping (Pollution) Act 2006 (c.8): http://www.opsi.gov.uk/acts/acts2006/20060008.htm

Road Traffic Act 1991 (c. 40): http://www.opsi.gov.uk/acts/acts1991/Ukpga_19910040_en_1.htm

Radioactive Material (Road Transport) Act 1991 (c. 27): http://www.opsi.gov.uk/acts/acts1991/Ukpga_19910027_en_1.htm

Statutory Instrument 2004 No. 568: The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2004: http://www.opsi.gov.uk/si/si2004/20040568.htm

Statutory Instrument 2003 No. 1431: The Carriage of Dangerous Goods and Transportable Pressure Vessels (Amendment) Regulations 2003: http://www.opsi.gov.uk/si/si2003/20031431.htm

Statutory Instrument 2005 No. 928: The Export and Import of Dangerous Chemicals Regulations 2005: http://www.opsi.gov.uk/si/si2005/20050928.htm

Planning, Environmental, Waste and Accident Related

Clean Neighbourhoods and Environment Act 2005 (c. 16): http://www.opsi.gov.uk/acts/acts2005/20050016.htm

Merchant Shipping (Pollution) Act 2006 (c. 8): http://www.opsi.gov.uk/acts/acts2006/20060008.htm

Pollution Prevention Control Act 1999 (c. 24): http://www.opsi.gov.uk/acts/acts1999/19990024.htm

Environment Act 1995 (c. 25): http://www.opsi.gov.uk/acts/acts1995/Ukpga_19950025_en_1.htm

Statutory Instrument 2005 No. 895: The List of Wastes (England) Regulations 2005: http://www.opsi.gov.uk/si/si2005/uksi_20050895_en.pdf

Statutory Instrument 2006 No. 937: The Waste Management (England and Wales) Regulations 2006: http://www.opsi.gov.uk/si/si2006/20060937.htm

Statutory Instrument 2006 No. 1289: The Protection of Water Against Agricultural Nitrate Pollution (England and Wales) (Amendment) Regulations 2006: http://www.opsi.gov.uk/si/si2006/20061289.htm

Statutory Instrument 2006 No. 1283: The Planning (Listed Buildings, Conservation Areas and Hazardous Substances) (Amendment) (England) Regulations 2006: http://www.opsi.gov.uk/si/si2006/20061283.htm

Statutory Instrument 2006 No. 2916: The Dangerous Substances and Preparations (Safety) Regulations 2006: http://www.opsi.gov.uk/si/si2006/20062916.htm

Statutory Instrument 2005 No. 1088: The Control of Major Accident Hazards (Amendment) Regulations 2005: http://www.opsi.gov.uk/si/si2005/20051088.htm

Other

Animal Welfare Act 2006: http://www.opsi.gov.uk/acts/acts2006/20060045.htm

Statutory Instrument 2006 No. 755: The Animals and Animal Products (Examination for Residues and Maximum Residue Limits) (Amendment) Regulations 2006: http://www.opsi.gov.uk/si/si2006/20060755.htm

Wales

Food Related

Welsh Statutory Instrument 2004 No. 2731 (W.238): The Food Safety (Act of Accession concerning the Czech Republic and other States) (Consequential Amendments) (Wales) Regulations 2004: http://www.opsi.gov.uk/legislation/wales/wsi2004/20042731e.htm

Welsh Statutory Instrument 2006 No. 1534 (W.151): The Food Hygiene (Wales) (Amendment) Regulations 2006: http://www.opsi.gov.uk/legislation/wales/wsi2006/20061534e.htm

Welsh Statutory Instrument 2005 No. 363 (W.30): The Food Safety (General Food Hygiene) (Amendment) (Wales) Regulations 2005: http://www.opsi.gov.uk/legislation/wales/wsi2005/20050363e.htm

Welsh Statutory Instrument 2006 No. 1850 (W.193): The Contaminants in Food (Wales) (No. 2) Regulations 2006: http://www.opsi.gov.uk/legislation/wales/wsi2006/20061850e.htm

Planning, Environment, Waste and Accident Related

Welsh Statutory Instrument 2005 No. 1806 (W.138): The Hazardous Waste (Wales) Regulations 2005: http://www.opsi.gov.uk/legislation/wales/wsi2005/20051806e.htm

Welsh Statutory Instrument 2005 No. 1820 (W.148): The List of Wastes (Wales) Regulations 2005: http://www.opsi.gov.uk/legislation/wales/wsi2005/20051820e.htm

Welsh Statutory Instrument 2006 No. 1388 (W.138): The Planning (Listed Buildings, Conservation Areas and Hazardous Substances) (Amendments relating to Crown Land) (Wales) Regulations 2006: http://www.opsi.gov.uk/legislation/wales/wsi2006/20061388e.htm

Scotland

Legislation on Specific Classes/Chemicals

Pesticides

Scottish Statutory Instrument 2005 No. 66 The Possession of Pesticides (Scotland) Order 2005: http://www.opsi.gov.uk/legislation/scotland/ssi2005/20050066.htm

Scottish Statutory Instrument 2005 No. 599: The Pesticides (Maximum Residue Levels in Crops, Food and Feeding Stuffs) (Scotland) Regulations 2005: http://www.opsi.gov.uk/legislation/scotland/ssi2005/20050599.htm

Food Related

Scottish Statutory Instrument 2006 No. 556: The Food for Particular Nutritional Uses (Addition of Substances for Specific Nutritional Purposes) (Scotland) Amendment Regulations 2006: http://www.opsi.gov.uk/legislation/scotland/ssi2006/20060556.htm

Scottish Statutory Instrument 2005 No. 214: The Miscellaneous Food Additives Amendment (Scotland) Regulations 2005: http://www.opsi.gov.uk/legislation/scotland/ssi2005/20050214.htm

Scottish Statutory Instrument 2006 No. 306: The Contaminants in Food (Scotland) Regulations 2006: http://www.opsi.gov.uk/legislation/scotland/ssi2006/20060306.htm

Scottish Statutory Instrument 2006 No. 517: The Plastic Materials and Articles in Contact with Food (Scotland) (No. 2) Regulations 2006: http://www.opsi.gov.uk/legislation/scotland/ssi2006/20060517.htm

Scottish Statutory Instrument 2006 No. 230: The Ceramic Articles in Contact with Food (Scotland) Regulations 2006: http://www.opsi.gov.uk/legislation/scotland/ssi2006/20060230.htm

Scottish Statutory Instrument 2005 No. 479: The Tryptophan in Food (Scotland) Regulations 2005: http://www.opsi.gov.uk/legislation/scotland/ssi2005/20050479.htm

Scottish Statutory Instrument 2005 No. 1: The Food Labelling (Added Phytosterols or Phytostanols) (Scotland) Regulations 2005: http://www.opsi.gov.uk/legislation/scotland/ssi2005/20050001.htm

Scottish Statutory Instrument 2006 No. 516: The Feeding Stuffs (Scotland) Amendment Regulations 2006: http://www.opsi.gov.uk/legislation/scotland/ssi2006/20060516.htm

Planning, Environmental, Waste and Accident Related

Environmental Assessment (Scotland) Act 2005: http://www.opsi.gov.uk/legislation/scotland/acts2005/20050015.htm

Scottish Statutory Instrument 2005 No. 101: The Pollution Prevention and Control (Scotland) Amendment Regulations 2005: http://www.opsi.gov.uk/legislation/scotland/ssi2005/ssi_20050101_en.pdf

Northern Ireland

General Legislation on Chemicals

Statutory Rule 2005 No. 463: The Chemicals (Hazard Information and Packaging for Supply) (Amendment) Regulations (Northern Ireland) 2005: http://www.opsi.gov.uk/sr/sr2005/20050463.htm

Statutory Rule 2005 No. 165: The Control of Substances Hazardous to Health (Amendment) Regulations (Northern Ireland) 2005: http://www.opsi.gov.uk/sr/sr2005/20050165.htm

Legislation on Specific Classes/Chemicals

Asbestos

Statutory Rule 2000 No. 99: Asbestos (Prohibitions) (Amendment) Regulations (Northern Ireland) 2000: http://www.opsi.gov.uk/sr/sr2000/20000099.htm

Food Related

Statutory Rule 1995 No. 451: Feeding Stuffs Regulations (Northern Ireland) 1995: http://www.opsi.gov.uk/sr/sr1995/Nisr_19950451_en_1.htm

Transport of Chemicals

Statutory Rule 1997 No. 247: Carriage of Dangerous Goods (Classification, Packaging and Labelling) and Use of Transportable Pressure Receptacles Regulations (Northern Ireland) 1997: http://www.opsi.gov.uk/sr/sr1997/Nisr_19970247_en_1.htm

Planning, Environment, Waste and Accident Related

Statutory Rule 2005 No. 320: The Planning (Hazardous Substances) (Amendment) Regulations (Northern Ireland) 2005: http://www.opsi.gov.uk/sr/sr2005/20050320.htm

Statutory Rule 2005 No. 305: The Control of Major Accident Hazards (Amendment) Regulations (Northern Ireland) 2005: http://www.opsi.gov.uk/sr/sr2005/20050305.htm

Miscellaneous Resources

Reports

Spurgeon DJ, Svendsen C, Hankard PK, et al (2004)
Application of Sublethal Ecotoxicological Tests for Measuring Harm in Terrestrial Ecosystems
Environment Agency, 108 pp
Web: http://publications.environment-agency.gov.uk/epages/eapublications.storefront/4732ff27002cc6ba273fc0a802960686/Product/View/SCHO0504BIFL &2DE&2DE

This research by the Environment Agency and the Centre of Ecology & Hydrology Monks Wood has recommended a number of biological methods for measuring harm to terrestrial ecosystems. Assessing risks to ecological receptors from contaminants in soil is a requirement under Part IIA of the Environmental Protection Act 1990 and other regulations, such as the Habitats Directive.

Royal Commission on Environmental Pollution (2003)
Chemicals in Products: Safeguarding the Environment and Human Health. Twenty-fourth Report. Cm 5827

The Stationery Office, 307 pp
Web: http://www.rcep.org.uk/chemicals/ch00-rep.pdf.

The report focuses on chemicals used in products which can gradually find their way into the environment and people's bodies.

EA & Defra (2002)
Contaminants in Soils: Collation of Toxicological Data and Intake Values for Humans for Arsenic
Environment Aency
Web: http://publications.environment-agency.gov.uk/epages/eapublications.storefront/473303ca004946dc273fc0a802960602/ Product/View/STOX1&2DE&2DE

This document summarizes international approaches to deriving human health criteria values for arsenic. Human health criteria values and background intake data on arsenic are presented for use in deriving Soil Guideline Values.

EA & Defra (2003)
Contaminants in Soil: Collation of Toxicological Data and Intake Values for Humans. Benzene
Environment Agency, 29 pp
Web: http://publications.environment-agency.gov.uk/epages/eapublications.storefront/4732ff27002cc6ba273fc0a802960686/Product/View/STOX11&2DE&2DE

This report provides details of the derivation of index doses for benzene and is for use by those concerned with the assessment of contaminated land. The report describes the compound and discusses toxicity, carcinogenicity, and genotoxicity. The derivation of the index doses and the intake of benzene from food, water, and air are reported.

EA & Defra (2002)
Contaminants in Soil: Collation of Toxicological Data and Intake Values for Humans. Benzo(a)pyrene
Environment Agency, 24 pp
Web: http://publications.environment-agency.gov.uk/epages/eapublications.storefront/4732ff27002cc6ba273fc0a802960686/Product/View/STOX2&2DE&2DE

The aim of this report is to set out authoritative health criteria values for benzo(a)pyrene, which have been established through a review of the scientific literature and a subsequent peer-review process. The health criteria values presented herein will be used to derive Soil Guideline Values (SGVs) for benzo(a)pyrene.

EA & Defra (2002)
Contaminants in Soils: Collation of Toxicological Data and Intake Values for Humans for Cadmium
Environment Agency, 20 pp
Web: http://publications.environment-agency.gov.uk/epages/eapublications.storefront/4732ff27002cc6ba273fc0a802960686/Product/View/STOX3&2DE&2DE

The aim is to derive an oral tolerable daily intake (TDI) and derive Soil Guideline Values (SGVs) for cadmium in soil that will pose no significant threat to health.

Toxicology Advice and Consulting (2005)
Contaminants in Soil: Collation of Toxicological Data and Intake Values for Humans. Carbon tetrachloride
Environment Agency, 23 pp
Web: http://publications.environment-agency.gov.uk/epages/eapublications.storefront/4732ff27002cc6ba273fc0a802960686/Product/View/&20SCHO0904BIEY&2DE&2DE

This document summarizes international approaches to deriving human health criteria values for carbon tetrachloride. Human health criteria values and background intake data are presented for use in deriving Soil Guideline Values.

EA & Defra (2002)
Contaminants in Soils: Collation of Toxicological Data and Intake Values for Humans for Chromium
Environment Agency, 20 pp
Web: http://publications.environment-agency.gov.uk/epages/eapublications.storefront/4732ff27002cc6ba273fc0a802960686/Product/View/STOX4&2DE&2DE

The aim is to derive an oral tolerable daily intake (TDI) and an inhalation Index Dose, which in turn are needed to derive Soil Guideline Values (SGVs) for chromium, that is concentrations of chromium in soil that will pose no significant threat to health.

Toxicology Advice and Consulting (2004)
Contaminants in Soil: Collation of Toxicological data and Intake Values for Humans. 1,2-Dichloroethane
Environment Agency, 27 pp
Web: http://publications.environment-agency.gov.uk/epages/eapublications.storefront/4732ff27002 cc6ba273fc0a802960686/Product/View/SCHO0804BICI&2DE&2DE

This document summarizes international approaches to deriving human health criteria values for 1,2-dichloroethane. Human health criteria values and background intake data on 1,2-dichloroethane are presented for use in deriving Soil Guideline Values.

EA & Defra (2003)
Contaminants in Soil: Collation of Toxicological Data and Intake Values for Humans. Dioxins, Furans and Dioxin-like PCBs
Environment Agency, 39 pp

Web: http://publications.environment-agency.gov.uk/epages/eapublications.storefront/4732ff27002cc6ba273fc0a802960686/Product/View/STOX12&2DE&2DE

The toxicity, carcinogenicity, and genotoxicity of chlorinated dibenzo-p-dioxins and dibenzofurans and related PCBs are reviewed with the aim of deriving tolerable daily intakes (TDI) needed to derive Soil Guideline Values (SGV).

EA & Defra (1999)
Contaminants in Soil: Collation of Toxicological Data and Intake Values for Humans. Ethylbenzene
Environment Agency, 24 pp
Web: http://publications.environment-agency.gov.uk/epages/eapublications.storefront/4732ff27002cc6ba273fc0a802960686/Product/View/STOX17&2DE&2DE

This publication details the derivation of health criteria values for ethylbenzene. The report has been written for technical professionals who are familiar with the risks posed by land contamination to human health but who are not necessarily experts in risk assessment. It is expected to be of use to all parties involved with or interested in contamination, but in particular to those concerned with the assessment of land contamination.

EA & Defra (2004)
Contaminants in Soil: Collation of Toxicological Data and Intake Values for Humans. Ethylbenzene
Environment Agency, 23 pp
Web: http://publications.environment-agency.gov.uk/epages/eapublications.storefront/4732ff27002cc6ba273fc0a802960686/Product/View/STOX17-E-E#

The aim of this report is to set out authoritative health criteria values for ethylbenzene, which have been established through a review of the scientific literature and a subsequent peer-review process. The health criteria values presented herein will be used to derive Soil Guideline Values (SGVs) for ethylbenzene; these are concentrations of ethylbenzene in soil below which there will be no significant harm to human health.

EA & Defra (2002)
Contaminants in Soils: Collation of Toxicological Data and Intake Values for Humans for Inorganic Cyanide
Environment Agency, 20 pp
Web: http://publications.environment-agency.gov.uk/epages/eapublications.storefront/4732ff27002cc6ba273fc0a802960686/Product/View/STOX5&2DE&2DE

The aim is to derive tolerable daily intakes (TDIs), which in turn are needed to derive Soil Guideline Values (SGVs) for inorganic cyanide, that is, concentrations of inorganic cyanide in soil that will pose no significant threat to health.

EA & Defra (2002)
Contaminants in Soils: Collation of Toxicological Data and Intake Values for Humans for Lead
Environment Agency, 20 pp
Web: http://publications.environment-agency.gov.uk/epages/eapublications.storefront/4732ff27002cc6ba273fc0a802960686/Product/View/STOX6&2DE&2DE

The aim is to derive a blood lead concentration, which in turn is needed to derive Soil Guideline Values (SGVs) for lead, that is, concentrations of lead in soil that will pose no significant threat to health.

EA & Defra (2002)
Contaminants in Soils: Collation of Toxicological Data and Intake Values for Humans for Mercury
Environment Agency, 29 pp
Web: http://publications.environment-agency.gov.uk/epages/eapublications.storefront/4732ff27002cc6ba273fc0a802960686/Product/View/STOX7&2DE&2DE

The aim is to derive oral tolerable daily intakes (TDIs), which in turn are needed to derive Soil Guideline Values (SGVs) for mercury, that is concentrations of mercury in soil that will pose no significant threat to health.

EA & Defra (2003)
Contaminants in Soil: Collation of Toxicological Data and Intake Values for Humans. Naphthalene
Environment Agency, 23 pp
Web: http://publications.environment-agency.gov.uk/epages/eapublications.storefront/4732ff27002cc6ba273fc0a802960686/Product/View/STOX20&2DE&2DE

This document summarizes international approaches to deriving human health criteria values for naphthalene. Human health criteria values and background intake data on naphthalene are presented for use in deriving Soil Guideline Values.

EA & Defra (2002)
Contaminants in Soils; Collation of Toxicological Data and Intake Values for Humans for Nickel
Environment Agency
Web: http://publications.environment-agency.gov.uk/epages/eapublications.storefront/4732ff27002cc6ba273fc0a802960686/Product/View/STOX8&2DE&2DE

The aim is to derive an oral tolerable daily intake (TDI) and an inhalation Index Dose, which in turn are needed to derive Soil Guideline Values (SGVs) for nickel, that is, concentrations of nickel in soil that will pose no significant threat to health.

EA & Defra (2002)
Contaminants in Soils; Collation of Toxicological Data and Intake Values for Humans for Phenol
Environment Agency
Web: http://publications.environment-agency.gov.uk/epages/eapublications.storefront/4732ff27002cc6ba273fc0a802960686/Product/View/STOX9&2DE&2DE

The aim of this report is to set out authoritative health criteria values for phenol, which have been established through a review of the scientific literature and a subsequent peer-review process. The health criteria values presented herein will be used to derive Soil Guideline Values (SGVs) for phenol; these are concentrations of phenol in soil below which there will be no significant risk to human health.

EA & Defra (2002)
Contamination in Soils; Collation of Toxicological Data and Intake Values for Humans for Selenium
Environment Agency
Web: http://publications.environment-agency.gov.uk/epages/eapublications.storefront/4732ff27002cc6ba273fc0a802960686/Product/View/STOX10&2DE&2DE

This document summarizes international approaches to deriving human health criteria values for selenium. Human health criteria values and background intake data on selenium are presented for use in deriving Soil Guideline Values.

Toxicology Advice and Consulting (2004)
Contaminants in Soil: Collation of Toxicological Data and Intake Values for Humans. Trichloroethene
Environment Agency, 28 pp
Web: http://publications.environment-agency.gov.uk/epages/eapublications.storefront/4732ff27002cc6ba273fc0a802960686/Product/View/SCHO0904BIEZ&2DE&2DE

This document summarizes international approaches to deriving human health criteria values for trichloroethene. Human health criteria values and background intake data on trichloroethene are presented for use in deriving Soil Guideline Values.

EA & Defra (2004)
Contaminants in Soil: Collation of Toxicological Data and Intake Values for Humans. 1,1,1-Trichloroethane
Environment Agency, 31 pp
Web: http://publications.environment-agency.gov.uk/epages/eapublications.storefront/4732ff27002cc6ba273fc0a802960686/Product/View/STOX25-E-E

The aim of this report is to set out authoritative health criteria values for 1,1,1-trichloroethane, which have been established through a review of the scientific literature and a subsequent peer-review process. The health criteria values presented herein will be used to derive Soil Guideline Values (SGVs) for 1,1,1-trichloroethane.

EA & Defra (2004)
Contaminants in Soil: Collation of Toxicological Data and Intake Values for Humans. 1,1,2,2- and 1,1,1,2-tetrachloroethane
Environment Agency, 25 pp
Web: http://publications.environment-agency.gov.uk/epages/eapublications.storefront/4732ff27002cc6ba273fc0a802960686/Product/View/STOX16-E-E

The aim of this report is to set out authoritative health criteria values for tetrachloroethanes, which have been established through a review of the scientific literature and a subsequent peer-review process. The health criteria values presented herein will be used to derive Soil Guideline Values (SGVs) for tetrachloroethanes.

EA & Defra (2004)
Contaminants in Soil: Collation of Toxicological Data and Intake Values for Humans. Tetrachloroethene
Environment Agency, 34 pp
Web: http://publications.environment-agency.gov.uk/epages/eapublications.storefront/4732ff27002cc6ba273fc0a802960686/Product/View/STOX23-E-E

The aim of this report is to set out authoritative health criteria values for tetrachloroethene, which have been established through a review of the scientific literature and a subsequent peer-review process. The health criteria values that are presented herein will be used to derive Soil Guideline Values (SGVs) for tetrachloroethene.

EA & Defra (2004)
Contaminants in Soil: Collation of Toxicological Data and Intake Values for Humans. Toluene
Environment Agency, 26 pp
Web: http://publications.environment-agency.gov.uk/epages/eapublications.storefront/4732ff27002cc6ba273fc0a802960686/Product/View/STOX14&2DE&2DE

The document summarizes international approaches to deriving human health criteria values for toluene. Human health criteria values and background intake data on toluene are presented for use in deriving Soil Guideline Values.

EA & Defra (2004)
Contaminants in Soil: Collation of Toxicological Data and Intake Values for Humans. Vinyl Chloride
Environment Agency, 25 pp
Web: http://publications.environment-agency.gov.uk/epages/eapublications.storefront/4732ff27002cc6ba273fc0a802960686/Product/View/STOX18&2DE&2DE

The aim of this report is to set out authoritative health criteria values for vinyl chloride, which have been established through a review of the scientific literature and a subsequent peer-review process. The health criteria values presented herein will be used to derive Soil Guideline Values (SGVs) for vinyl chloride.

Toxicology Advice and Consulting (2004)
Contaminants in Soil: Collation of Toxicological Data and Intake Values for Humans. Xylene
Environment Agency, 28 pp
Web: http://publications.environment-agency.gov.uk/epages/eapublications.storefront/4732ff27002cc6ba273fc0a802960686/Product/View/SCHO0904BIFI&2DE&2DE

This document summarizes international approaches to deriving human health criteria values for xylene. Human health criteria values and background intake data on xylene are presented for use in deriving Soil Guideline Values.

Royal Commission on Environmental Pollution (2005)
Crop Spraying and the Health of Residents and Bystanders: Summary of the Royal Commission on Environmental Pollution's Report
The Stationery Office, 20 pp
Web: http://www.rcep.org.uk/chemicals/ch25-sum.pdf.

This report addresses a complex and controversial issue: the human health risks associated with the use of agricultural pesticides.

Boucard T (2006)
Environment Agency Workshop on Chronic Aquatic Ecotoxicity Testing of Human Pharmaceuticals
Environment Agency
Web: http://publications.environment-agency.gov.uk/epages/eapublications.storefront/4732e37e0215562c273fc0a802960644/Product/View/SCHO0506BKTJ&2DE&2DE#

The workshop aimed to establish a consensus on how and when to assess chronic impact through low-level exposure of pharmaceuticals in the aquatic environment. This report summarizes the main discussion points, the conclusions and the overall research needs and recommendations identified.

Leverett D (2006)
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Environment Agency, 41 pp
Web: http://publications.environment-agency.gov.uk/epages/eapublications.storefront/4732ff27002cc6ba273fc0a802960686/Product/View/SCHO0106BKDP&2DE&2DE

This guidance gives advice on conducting DTA testing specifically for the purposes of meeting the requirements under the PPC Regulations.

Environment Agency (2006)
Performance Standard for Laboratories Undertaking Direct Toxicity Assessment
Environmental Agency, 24 pp
Web: http://publications.environment-agency.gov.uk/epages/eapublications.storefront/4732ff27002cc6ba273fc0a802960686/Product/View/GEHO0206BLGH&2DE&2DE

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Review of Ecotoxicological and Biological Test Methods for the Assessment of Contaminated Land, R&D Technical Report P300
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Coleman P, Mascarenhas R, Rumsby P, et al (2005)
A Review of the Toxicity and Environmental Behaviour of Bromine in Air
Environment Agency, 51 pp
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A peer-reviewed dossier of toxicological and environmental information on bromine supporting the EPAQS (Department of Health's Expert Panel on Air Quality Standards) human health-related air quality guideline derivation process.

Coleman P, Mascarenhas R, Rumsby P, et al (2005)
A Review of the Toxicity and Environmental Behaviour of Chlorine in Air
Environment Agency, 59 pp
Web: http://publications.environment-agency.gov.uk/epages/eapublications.storefront/4732e3b200bb86dc2740c0a8029606dd/Product/View/SCHO0105BIMU&2DE&2DE#

A peer-reviewed dossier of toxicological and environmental information on chlorine supporting the EPAQS (Department of Health's Expert Panel on Air Quality Standards) human health-related air quality guideline derivation process.

Coleman P, Mascarenhas R, Rumsby P, et al (2005)
A Review of the Toxicity and Environmental Behaviour of Hydrogen Bromide in Air
Environment Agency, 40 pp
Web: http://publications.environment-agency.gov.uk/epages/eapublications.storefront/4732e3b200bb86dc2740c0a8029606dd/Product/View/SCHO0105BIMW&2DE&2DE

A peer-reviewed dossier of toxicological and environmental information on hydrogen bromide supporting the EPAQS (Department of Health's Expert Panel on Air Quality Standards) human health-related air quality guideline derivation process.

Coleman P, Mascarenhas R, Rumsby P, et al (2005)
A Review of the Toxicity and Environmental Behaviour of Hydrogen Chloride in Air
Environment Agency, 72 pp
Web: http://publications.environment-agency.gov.uk/epages/eapublications.storefront/4732fd65001c7b7c273fc0a802960698/Product/View/SCHO0105BIMX&2DE&2DE

A peer-reviewed dossier of toxicological and environmental information on hydrogen chloride supporting the EPAQS (Department of Health's Expert Panel on Air Quality Standards) human health-related air quality guideline derivation process.

Coleman P, Mascarenhas R, Rumsby P, et al (2005)
A Review of the Toxicity and Environmental Behaviour of Hydrogen Fluoride in Air
Environment Agency, 67 pp
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A peer-reviewed dossier of toxicological and environmental information on hydrogen fluoride supporting the EPAQS (Department of Health's Expert Panel on Air Quality Standards) human health-related air quality guideline derivation process.

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Report of the Animal Procedures Committee for 2005
The Stationery Office, 61 pp
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The Stationery Office (TSO), 94 pp
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The statistics in this publication relate to experiments or other scientific procedures performed on living animals that were subject to the provisions of the Animals (Scientific Procedures) Act 1986 during the year from 1 January 2005 in accordance with section 21(7) of the Act.

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CHAPTER

107

Uruguay

A. NEGRIN, P. SCARABINO, V. COLLAZO, A. LABORDE, AND M. BURGER

INTRODUCTION

In our country, Toxicology finds its roots in 1975 when the Information and Assessment Toxicology Center (CIAT) was founded by the Faculty of Medicine of the Republic University.

It was created due to an increasing concern about potentially toxic chemicals and their impact on human health. Since Uruguay has an agriculture-based economy, pesticides were of particular concern.

Many Professors from the Emergency, Legal Medicine, and Internal Medicine Departments supported the development of the CIAT. Professor Eva Fogel was one of the pioneers and its first Professor Director. Eventually the poison center became the Toxicology Department and developed the post graduation program for Clinical Toxicology specialists in 1981.

The Uruguayan population is three million, so there is only one poison control center which offers its services to the community and health professionals all over the country. It is placed at the University Hospital, 'Hospital de Clinicas', and it works the whole year, 24 hours a day, giving information and assessment by the phone number 1722 . Selected antidotes in accordance with the local epidemiology are kept at the poison center, although many of them are available at the emergency rooms.

The CIAT also provides hospital-based assistance when required by the medical doctors from the hospital.

Consultation to the poison center continuously increased since 1976, from 1000 to 11 000 in 2006. As an example, Figure 107.1 shows the general distribution of consultation in 2005.

Other activities of the Toxicology Department and the poison center itself are the assistance of the hospitalized and ambulatory patients, medical school teaching and professional advice on areas such as occupational and environmental health, drug abuse, chemical risk assessment, and regulations.

Several activities of the CIAT are aimed at contributing with risk management on chemicals and participating in government commissions. In this frame the CIAT assists the Agriculture Ministry at national registration of agricultural pesticides.

The Toxicology Department has a library that offer on-site reading and copies to students and professionals.

The CIAT has participated in the INTOX Program development (INTOX Data Base and INTOX Poison Information System). This Program belongs to the

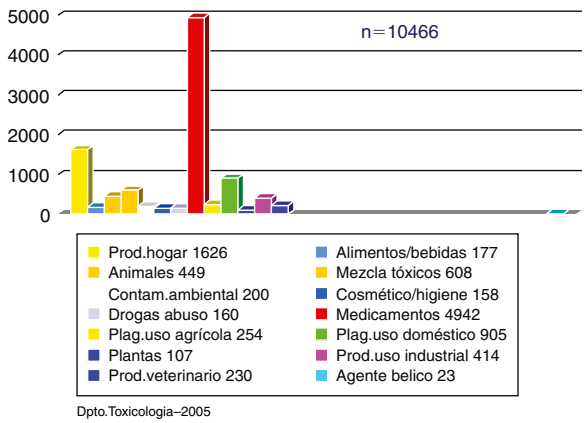

FIGURE 107.1

International Program on Chemical Safety (IPCS) of the World Health Organization (WHO) and was performed with the contribution of the Canadian Center on Occupational and Health Security (CCOHS).

The Specialization in Clinical Toxicology is a 3-year postgraduate course given by the Postgraduate School of the Faculty of Medicine. A 9-month course is given for Spanish-speaking foreign doctors; many Latin American toxicologists have been trained in Uruguay.

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Ricciardi N. Biotrrrorismo. Departamento de Medicina Legal Facultad de Medicina. UDELAR. Available online: http://www.mednet.org.uy/dml/

Professional Societies

Plaguicides and Alternatives Action Network in Uruguay and Latin America (Red de Acción en Plaguicidas y sus alternativas en América Latina Uruguay)
Web: http://www.rap-al.org/v2/
RAPALUY Maldonado 1858, CP 11200
Phone: (005982)-4132989/(005982)-4100985
Email: rapaluy@chasque.net

Uruguayan Society of Toxicology and Ecotoxicology (SUTE) (Sociedad Uruguaya de Toxicología y Ecotoxicología)
Web: http://webs.montevideo.com.uy/sute/

Legislation

Legislative Palace (Parlament)
Web: http://www.parlamento.gub.uy

Decreto-Ley NÍ 10.415. Gases y Explosivos
Web: www.parlamento.gub.uy/leyes/ley10415.htm

Ley NÍ 17.016. Estupefacientes
Web: www.parlamento.gub.uy/leyes/ley17016.htm

Ley Nº 16.466, Medio Ambiente
Web: www.dinama.gub.uy/modules

Ley Nº 17.593. Convenio de Rotterdam para la Aplicación del Procedimiento de Consentimiento Fundamentado Previo a Ciertos Plaguicidas y Productos Químicos Peligrosos Objeto de Comercio Internacional
Web: www.dinama.gub.uy/modules

Ley 17.828 promulgada por el Poder Ejecutivo. Se aprueba el Convenio Internacional del Trabajo Nº 184 sobre Seguridad y Salud en la Agricultura
Web: www.nip.gub.uy/docu/ley_17828.pdf

Ley 17.775 Contaminaciσn por plomo. Regulación y prohibiciones
Web: www.elderechodigital.com.uy/smu/legisla/ley17775.html

LEY N° 17.774 Normas Para la Prevenciσn y Control de la Exposiciσn al Plomo a Nivel Ocupacional
Web: www.presidencia.gub.uy/ley/2004052101.htm

Dto. 373/003 – Baterías de Plomo – Ácido usadas o a ser Desechadas
Web: www.mec.gub.uy/munhina/vs/info-legis.htm

Dto. 367/968 y 410/969 Normas sobre Plaguicidas, Dto. 100/977 – Control de Uso y Destino de Plaguicidas, Resolución 12/01/1977 – Prohibición de Pesticidas Clorados, Dto. 113/990 – Venta y Uso de Plaguicidas Peligrosos, Dto. 457/001 – Control de la Aeroaplicación, Dto. 264/004 – Aplicación Terrestre de Plaguicidas
Web: www.mec.gub.uy/munhina/vs/info-legis.htm

Miscellaneous Resources

Poder Judicial
Web: www.poderjudicial.gub.uy

Toxicology Department Vet Laboratories División 'Miguel C. Rubino', (Departamento de Toxicología División de Laboratorios Veterinarios. 'Miguel C. Rubino', Dirección General de Servicios Ganaderos del Ministerio de Ganaderia Agricultura y Pesca)
Web: http://www.mgap.gub.uy/DGSG/DILAVE/Dilave.htm

Ruta 8 Brig. Gral. J. A. Lavalleja Km. 17.500, Montevideo, Uruguay
Phone: (598-2)-222-1063
Fax: (598-2)-222-11-57
Email: dilave@mgap.gub.uy

Technological Laboratories of Uruguay (Laboratorio Tecnológico del Uruguay)
Web: http://www.latu.org.uy or http://www.latu.org.uy/portal/page?_pageid=514,1&_dad=portal&_schema=PORTAL Avda Italia 6201,- C.P. 11500, Montevideo, Uruguay
Phone: (598-2)-601-3724
Fax. (598-2)-600-2291
Email: postmaster@latu.org.uy

Government Organizations

Ministry of Public Health/Ministerio de Salud Publica
Web: http://www.msp.gub.uy/
18 de Julio 1892; Montevideo, Uruguay; CP 11200
Phone: (00582)-400-01-01
Email: comunicacionesmsp@msp.gub.uy

Environmental and Occupational Health Department/Dirección de Salud Ambiental y Ocupacional
Web: http://www.msp.gub.uy/categoria_22_1_1.html

Food Diseases Surveillance/Vigilancia de Enfermedades Transmitidas por Alimentos (VETA) Web: http://www.msp.gub.uy/noticia_337_1.html

National Committee on Snake Envenomation/Comision Nacional de Ofidismo
Web: http://serpentario.edu.uy/comision_asesora.html

Cattle, Agriculture and Fishing Ministry/Ministerio de Ganadería Agricultura y Pesca (MGAP)
Web: http://www.mgap.gub.uy/
Constituyente 1476; Montevideo, Uruguay;- C.P.: 11.200
Phone: (598-2)-410-41-55/58
Email: webmaster@mgap.gub.uy

Agricultural Pesticides Registry Revision Committee/Comisión de Revisión de Registros de Plaguicidas de Uso Agrícola

Housing, Territorial Ordaining and Environment Ministry/Ministerio de Vivienda, Ordenamiento Territorial y Medio Ambiente
Web: http://www.mvotma.gub.uy/

National Environment Office/Dirección Nacional de Medio Ambiente (DINAMA)
Web: http://www.dinama.gub.uy/

Environment Quality Evaluation/DINAMA – Evaluación de Calidad Ambiental
Web: http://www.dinama.gub.uy/modules.php?op=modload&name=Search&file=index&action=search&overview=1&active_weblinks=1&active_downloads=1&bool=OR&q=calidad+ambiental

Stockholm Agreement National Implementation Plan/Plan Nacional de Implementación (NIP) del Convenio de Estocolmo
Web: http://www.nip.gub.uy

Departamento de Sustancias Peligrosas
Phone: 598(2)-917-0710 int 4106/4107
Email: consultas@nip.gub.uy or suspel@adinet.com.uy

Clemente Estable Institute of Biological Research (Instituto de Investigaciones Biológicas Clemente Estable (IIBCE))
Web: http://www.iibce.edu.uy/

Avenida Italia 3318; Montevideo, Uruguay
Phone: (598-2)-487-1616
Fax: (598-2)-487-5548
Web: asistentes@iibce.edu.uy

Program in Environmental Sciences at IIBCE (Programa de Ciencias Ambientales en IIBCE

UNIVERSITIES

University of the Republic of Uruguay (Universidad de la República Uruguay)
Web: http://www.universidad.edu.uy/index.php

Av 18 de Julio 1968, Montevideo, Uruguay
Phone: (005982)-400-9201

School of Chemistry (Facultad de Química)
Web: http://www.fq.edu.uy

Analytical and Environmental Toxicology Department (Cátedra de Toxicología Analítica e Higiene Ambiental)

Facultad de Química, Gral. Flores 2124, P.O. Box 11800, Catedra de toxicología e Higiene ambiental

Phone: (005982)9241908 int 231
Fax (005982)9241906

Centro Especializado en Química Toxicológica (CEQUIMTOX)
Web: http://www.urueco.org.uy/menu/Consultoria/cequimtox.htm

Facultad de Química, Gral. Flores 2124, P.O. Box 1157, Catedra de toxicología e Higiene ambiental
Phone: (005982)9241908 int 231
Fax (005982)9241906
Email: cequimtox@fq.edu.uy

School of Chemistry Technologic Development Area (Polo tecnologico de la Facultad de Quimica)
Web: http://www.polotecnologico.fq.edu.uy/

Cno Aparicio Saravia s/n Pando – C.P. 91000 Canelones, Uruguay
Phone/Fax: (598-2)-292-2053/(598-2)-292-2021

School of Medicine (Facultad de Medicina)
Web: http://www.fmed.edu.uy

Avenida General Flores 2125 C.P. 11800, Montevideo, Uruguay
Phone: (+598-2)-9243414
Fax: (+598-2)-9243414 int. 3338
Legal Medicine Department/Catedra de Medicina Legal
Web: http://www.mednet.org.uy/dml/

Snake Laboratory – Serpentario (School of Medicine & School of Science)
Web: http://www.serpentario.edu.uy/

Instituto de Higiene, A. Navarro 3051, CP11600, Montevideo, Uruguay
Web: consultas@serpentario.edu.uy

Toxicology Department/Departamento de Toxicologia
Web: http://www.ciat.hc.edu.uy

Hospital de Clínicas, Av. Italia s/n, Piso 7, Sala 1, Montevideo, Uruguay
Phone: (+598-2)-4804000
Fax: (+598-2)-4870300
Email: hcciat@hc.edu.

School of Science (Facultad de Ciencias)
Web: http://www.fcien.edu.uy/

Iguá 4225 Esq. Mataojo; C.P. 11400; Montevideo, Uruguay
Phone: (598-2)-525-8618/23
Fax:(598-2)-525-8617

Chemical and Ecotoxicological Investigation Group (Grupo de Investigación en Ecotoxicología y Química Ambiental)
Web: http://ecotox.fcien.edu.uy/ Piso 11, Facultad de Ciencias, Universidad de la República, Igua 4225, Montevideo, Uruguay
Phone: + 598-2-5258618, ext. 162
Fax: +598-2-5258617

School of Veterinary Science (Facultad de Veterinaria)
Web: http://www.fvet.edu.uy/

Toxicology Department (Catedra de Toxicología) Lasplaces 1620, Montevideo, Uruguay
Phone: (005982)-6287672
Email: toxicología@fvet.edu.uy

Thematical Environmental Network (Red Tematica de Medio Ambiente (RETEMA))
Web: http://www.rau.edu.uy/universidad/retema/ carpani@fing.edu.uy http://www.retema.hc.edu.uy/ ; idol @fq.edu.uy

Poison Control Center

Clinical Hospital – Toxicology Department/Hospital de Clínicas – Departamento de Toxicologia
Web: http://www.ciat.hc.edu.uy
Av. Italia s/n, Piso 7, Sala 1, Montevideo, Uruguay
Phone: (+598-2)-4804000
Fax: (+598-2)-4870300

Information and Assessment Toxicology Center/ Centro de Información y Asesoramiento Toxicológico (CIAT)
Email: hcciat@hc.edu.uy

Pharmacovigilance National Center/Centro Nacional de Farmacovigilancia (CNFV)
Email: ccfv@hc.edu.uy

Occupational Toxicology Diagnostic Unit/Unidad de Diagnóstico en Toxicología Ocupacional
Email: hcciat@hc.edu.uy

Drug Abuse Programme/Programa de Uso Indebido de Drogas (PUID)
Email: hcciat@hc.edu.uy

CHAPTER

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Venezuela

ARISLEIDA J. RODRÍGUEZ AND MAYLIN E. VELÁSQUEZ

TOXICOLOGY IN VENEZUELA

Forensic Toxicology in Venezuela could be said to have originated on May 7th, 1878 with the Medical-Forensic Code of Instructions Promulgation, which described in the Third Section of Title III, named Chemical Expertise, the standards for taking samples, conservation, and procedures to follow in cases of poisoning with homicidal intent.

Teaching at the Graduate Level

The first decree on teaching Clinical Toxicology relating to Venezuela Superior and Scientific Instruction, appeared in September 1883. This called for the study of Toxicology in Medical Schools where, for the first time, it was linked to Legal Medicine, and was offered as a single course in the sixth year of the program. Later, it was eliminated from the program of studies in compliance with decree 347 of October 6, 1945, promulgated by President Isaías Medina Angarita, when medical schools fell under a new regulation.

This situation continued until 1954, when Toxicology was incorporated, linked again to Legal Medicine, in the program of studies of Venezuela Central University School of Medicine (UCV), Zulia University (LUZ), Center-Westerly 'Lisandro Alvarado' University (UCLA), Easterly University (UDO), Andes University (ULA), and Carabobo University (UC).

In 1894 the first law of Pharmacy was promulgated, establishing in its article 6 that the faculties of Pharmacy should be responsible for teaching Toxicology. By 1912 the programs were oriented mainly to the properties and mechanisms of action of drugs. Years later, on July 24, 1940, under the government of General Eleazar López Contreras, the Education Law was promulgated by the Sovereign Republic Congress and countersigned by the Education Ministry; this brought meaningful changes in Pharmacy studies, among them the widening of Toxicology studies with an experimental basis and the establishment for the subject of the name Toxicology and Toxicological Expertise.

About 1960, the University Counsels were authorized to approve the Faculty Regulations according to the Universities Law of 1958, promulgated by the Government Executive Board. This law allowed the University Counsels to approve the creation of Mentions or Pre-specializations, so they approved and created, among others, the figures of Toxicology and Industrial Hygiene for the UCV Pharmacy Faculty and Toxicology for the ULA Pharmacy Faculty. These studies have evolved until now following the development of Toxicology as an integrated science.

Also, in the Schools of Bioanalysis, the studies of Toxicology were initiated in the UCV and ULA in October of 1966, followed by the Aragua Nucleus of the UC in 1970 and the Main Campus of the UC in 1976.

A Chair in Veterinary Toxicology was created for the first time in LUZ in 1975. This was followed by the UCLA in Barquisimeto, Lara State. At present, Toxicology is also taught in the UCV Veterinary Faculty.

At the School of Medicine 'Dr. Witremundo Torrealba' and since the founding of the Legal Medicine Chair in Aragua on November 3, 1978, a Toxicology Module, which includes four theoretical subjects and a practical module named Laboratory of

Toxicological Expertise, has been conducted. Included in the new program are studies of Clinical Toxicology in the Program of the Pharmacology Chair; this is also included in the Medical study program of the Carabobo nucleus but as an optional feature.

At present, other University careers such as Industrial Engineering and Agronomical Engineering have developed study subjects in conformance with Toxicology as an Integrated Science.

Teachings at the Postgraduate Level

The teachings of Clinical Toxicology in Venezuela have been the responsibility of a multidisciplinary team, including Dr. Manuel Arellano Parra as a pioneer with several teachers, pharmaceuticals, toxicologists and physicians as collaborators; among them we can mention Cristina Zombi from Valera, Rafael Angeli, Gladis Arias Delgado, Norath Arrieta Sánchez, Elva Luz Bermúdez, Héctor R. Campos, Luís LaCruz Ochoa, Diego Piña, Nelson Vicuña Fernández among others.

One-year specialization courses were initiated in 1973, being sponsored by national and international organizations related to Toxicology until the 1980s. By 1983 in Maracay Aragua State, by the initiative of Dr. Yelitza C. Reyes F., Pharmaceutical Toxicologist, Director of the Regional Toxicology Unit (UTR) in the Civil Hospital of Maracay, with the collaboration of CIATOX under the Direction of Dr. Vanesa de París and support from the Faculty of Pharmacy, a module of Clinical Pediatric Toxicology was proposed at the level of Pediatric Postgraduate Residence at Central Hospital of Maracay to be completed in the two first years of residence, and constituting the first toxicological studies at Hospital Postgraduate level with University support. It was offered only until 1988 due to lack of support from the Hospital Center administration.

In 1990, in Caracas, the 3-year Postgraduate Residence of Clinical Toxicology at the Hospital 'Leopoldo Manrique Terrero' was established, under the direction of Dr. Alfredo González Carrero, Physician Toxicologist. Unfortunately, this course, in spite of its superior program of studies at the Postgraduate level, does not receive University support.

In 1995, in the Toxicology Unit of Aragua State, a basic course of Clinical Toxicology was created, sponsored by the UC Medicine Faculty under the co-ordination of Dr. Yelitza C. Reyes and the support of Teaching Collaborators, Toxicologist Physicians, Toxicologist Pharmaceutics, Epidemiological Physicians and Pathologists; among them Betty Omaña, Carmen Rodríguez, Maria J. Yeguez S., Juanita Rojas de Carrasco, José Trujillo, Solanuela Mendoza, Ivonne Romero, Mireya Abreu and Carmela Martínez.

The main goal of this course was to offer basic tools to new graduate physicians from different schools, so they could attend toxicological accidents. It was designed with 180 theoretical and 100 experimental hours, the classes being imparted at the Maracay Central Hospital Emergency Services and the 'Leopoldo Manrique Terrero' Hospital with support from the Toxicology Service, by then with a duration of 6 months. The course was suspended in November 2003 due to budgetary constraints.

At the Barquisimeto hospital 'Dr. Antonio María Pineda' from Lara State, The Clinical Toxicological Postgraduate Program has the support of the UCLA and the Center Occidental Toxicological Center, which was initiated in 1978 with duration of 3 years of residence under the direction of Dr. Elva Luz Bermúdez, Toxicologist Pharmaceutical.

In 1980, the ULA Medicine Faculty initiated the 3-year Clinical Toxicology Postgraduate Program under the direction of Dr. Luis LaCruz, Toxicologist Physician.

In 1986, the UCV Pharmacy Faculty University Counsel approved as a postgraduate study the 3-year specialization in Analytic Toxicology, initiating its activities that year under the coordination of Dr. Gladis de Galiz, Toxicologist Pharmaceutical, and geared to pharmacy professionals.

By 1980, the UCV developed a Multidisciplinary Master Program directed by Dr. Gladis Carmona, Physician Toxicologist. This program was restructured in 1990, being split into two programs, one with the name of Clinical Toxicology under the direction of Dr. Carmona and the other as Analytical Toxicology, under the direction of Dr. Yoolitza Aular, Pharmaceutical Toxicologist, both of 2 years' duration. At present, the Clinical Toxicological Master Program is suspended.

Centers, Services and Toxicological Units

In chronologic order, we have:

- 1943, Toxicology Service of the Paraíso National Hippodrome, renamed in 1976 as Toxicology Direction of the Hippodrome National Institute a laboratory model and pioneer in equine anti-doping control. Founded by Dr. José Luis Andrade, this laboratory processes samples from animals of all the hippodromes of the country and cooperates with hippodromes from the Caribbean islands, Curacao and Aruba.
- 1946, Forensic Medicine Service of the Laboratory of Toxicological Expertise, it operated from January 10,

1946 until 1951. The services were performed in the UCV Pharmacy Faculty from 1951 until 1958 in a private laboratory under the direction of Dr. Alfredo Sandoval. In 1958, The Judicial Police Technical Body (CTP) was created, today called the Penal and Criminality Research Body, where the first laboratory of Toxicology was formed; its first Director was Dr. Fernando Azuaje, Pharmaceutical Toxicologist. At present, the Forensic Toxicologist Laboratory is annexed to the Legal Medicine Institute, with laboratories in almost all the country states. It is important to highlight the one created in 1965 by covenant with the UC in the 'Enrique Tejeras' Hospital of Valencia, Carabobo State, annexed to the Legal Medicine Cathedra and directed at the beginning by the Pharmaceutical Dr. Judith Chafardet.

- 1954, Industrial Toxicology Laboratory of the Venezuela Institute of Social Security (IVSS), its founder and first director was Pharmaceutical Dr. Pedro Rodriguez Muriño, and was located in the Hospital 'Pérez Carreño' known as the big neck of Caracas; also, two more laboratories existed in Valencia, Carabobo State and Maracaibo, Zulia State.
- 1960, Malaria Toxicological Clinical Studies Section, created for biological monitoring of workers.
- 1970, Medical Service of Malaria Sanitary Hygiene located in Maracay City, Aragua State. It oversaw health and agricultural aspects from the point of view of Toxicology in two main areas: Plaguecides Toxicology and Industrial Toxicology. This service was dissolved when the Malaria unit was restructured in 1997.
- 1971, Center of Information and Toxicological Advice CIATOX 'Dr. Julio C. Velasco' (actually SIMET) founded by Drs. Asdrúbal Lárez A. and Manuel Arellano Parra, located in the Pharmacy Faculty of Venezuela Central University, actually under the co-ordination of Dr. Daniela Pascualato, offers information services, advice and teaching. In 1986, this center was separated from the analysis section then named the Toxicological Analysis Service (SATOX). Currently, it is directed by Dr. Yvonne León in Caracas, Metropolitan District.
- 1972, Center of Toxicological Advice (CATOX) 'Dr. Jorge Lizarraga', actually named Toxicology Department CATOX, founded by Dr. Gladis Carmona, under the leadership of Dr. Isaura Moleiro de Ovalle. It is located at the city hospital 'Enrique Tejera' in Valencia Central Hospital. It offers information, advice, clinical appointments, toxicological analysis, and teaching.
- 1974, Center of General Intoxications, today Coche Toxicological Service, it functions in 'Dr. Leopoldo Manrique Terrero, Hospital, it was founded by Drs. Asdrúbal Lárez A. and Manuel Arellano Parra; in charge of the direction is Dr. Betty Omaña. This center supplies information, advice, ambulatory services, hospitalization, teaching and toxicological analysis services.
- 1974, The Advice Center 'Dr. Pablo Paredes' from the ULA Faculty of Pharmacy is reinstalled, it counts with a Toxicology Laboratory in the Andes University Hospital, being its founder Dr. Angel Garrido. Since 2000 it has had a Center of Drugs Information (CIMRA) directed by Dr. Alexis Morales.
- 1975, Regional Toxicology Unit Dr. Yelitza Coromoto Reyes Figuera, depending from the Health Corporation of Aragua State, founded and directed to the present day by Dr. Yelitza C. Reyes F. It is an Analysis Unit, but it has in its program an Advice and Information Modulus, Social Work for the Community, teaching and Investigation. The unit is part of a Health Program named 'Toxicology Programmatic Unit', tightly related to the Toxicological consultations from different Hospital Centers of the Corporation Net. Dr. Reyes F is the Regional Program Coordinator.
- 1977, Toxicological Center of the Center-Occidental Region 'Dr. Elba Luz Bermúdez' (CTRCO), founded by Dr. Omaira Bastida de Espinosa and directed by Dr. Elba Luz Bermúdez, it provides information, advice, ambulatory clinical consultations and, under hospitalization, teaching and toxicological analysis.
- 1978, Barinas Toxicological Center (FUNCETOXBA), founded by the current director Dr. Olga F. de Mazzei, it supplies information, advice, laboratory analysis and teaching.
- 1990, Carabobo University Toxicological Investigations Center (CITUC), founded by Dr. Maritza Rojas. Its present co-ordinator is Dr. Guido Esquillante. Initially, it was a Center of Advice, but it also has a Toxicological Analysis Section, also producing Scientific Investigation Studies.
- 1995, Chiquinquirá Toxicological Center (CETOXCHI), located in the 'Lady of Chiquinquirá' Hospital in Maracaibo, Zulia State, co-ordinated by Drs. Angélica Quiroz Durán and Víctor Núñez Pinto, the latter dedicated to offering advice and training to professionals, and health care and treatment of the hospitalized patient.

In Venezuela, the study of toxicology within Toxicological Centers has developed erratically, due in some measure to lack of governmental support and/or sponsorship from national universities.

Similarly, there is a dissociation between Clinical and Analytical Toxicology, thus impeding excellence

in training professionals and in the development of programs that permit a mutual strengthening of both subjects.

There is no Toxicologist's registry at the national level despite several independent efforts from interested people, this probably has occasioned a dispersion of these professionals' resources, which are definitely lost when they are forced to acquire other specialties to fulfill their economical sustenance.

It is expected, with great enthusiasm, that further technological and communication breakthroughs will give to Toxicology the relevance it deserves, allowing to it extend its field of action to other scenarios.

RESOURCES

Books

Carmona G, Castillo E, Castillo M (2002)
Toxicología Pediatrica (Pediatric Toxicology), 3rd Edition
Caracas: Alfa Impresores, C.A.

Carmona G, Castillo E, Mock M (1977)
Normas de Prevención de la Contaminación Mercurial en la Profesión Odontológica (Norms of Mercury Contamination Prevention in Odontology Profession)
Valencia: UC

Fabré R, Truhana R, Granier-Doyeoux M (1962)
Compendio de Toxicología (Toxicology Compendium), Tomo I–II
Caracas: Ediciones de la Biblioteca de la UCV

Fabrega E (1988)
El mundo de las Drogas (The World of Drugs)
Mérida: Ediciones Estudios de Postgrado y Consejo de Publicaciones ULA

Foncied-Pdvsa-Conicit (2001)
Higiene Industrial. Soluciones para la Productividad en el Nuevo Milenio (Industrial Hygiene. Solutions to Productivity in the New Millenium)
Caracas

Granier-Doyeoux M, González A (1979)
Farmacodependencia (Pharmacodependency)
Caracas: Ediciones del Ministerio de Sanidad y Asistencia Social y de la Academia de Ciencias Físicas Matemáticas de la República de Venezuela

Larez A
Antidotario (Antidotery)
Caracas: Ediciones. Cámara de la Industria Farmacéutica (CIFAVE). Fundación José Maria Vargas. UCV

Lárez A (1973)
Compendio de Análisis Quimiotóxico en Emergencias Asistenciales (Compendium of Chemo toxic Analysis in Assistant Emergencies)
Caracas

Larez A (1984)
Toxicología Analítica y Experimental (Analytical and Experimental Toxicology)
Caracas: Ediciones de la Biblioteca de la UCV

Salazar M, Guerrero A (1975)
Actitud de un Grupo de Estudiantes Universitarios hacia las Drogas (Attitude of a Group of University Students towards drugs)
Valencia: Ediciones Escuela de Enfermería. UC

Salazar M, Ramos G (1994)
Diagnostico Epidemiológico del Consumo de Sustancias Psicoactivas en una Universidad Venezolana (Epidemiologic Diagnostic of Psicoactive Substances consumption in a Venezuelan University)
Valencia: Ediciones. Centro de Estudios sobre el problema de las drogas (CEPRODUC). UC

Saume F (1992)
Introducción a la Química y Toxicología de Insecticidas (Introduction to the Chemistry and Toxicology of Insecticides)
Maracay

Vicuña N, Garrido A (1995)
Intoxicación Medicamentosa Aguda. Manual de Toxicología Clínica y Analítica (Drug Intoxication Help, Manual of Clinical and Analytical Toxicology)
Caracas: Fondo Editorial del Centro Internacional de Educación y Desarrollo

Villalobos H, Ramírez G (2004)
Principios de la Toxicología Genética (Principles of Genetic Toxicology)
Maracaibo: Editorial de la Universidad del Zulia (EDILUZ). Ciudad Universitaria

Journals

Caracas Medical Gazette
Web: http://www.anm.org.ve/announcements.cfm

LUZ Agronomy Faculty Journal
Web: http://150.185.136.100/revistas/fagro/eaboutj.htm

LUZ Clinical Investigations
Web: http://www.scielo.org.ve/scielo.php?pid=0535-5133&script=sci_serial

Salus
Web: http://150.185.136.100/scielo.php?script=sci_serial&pid=1316-7138&lng=es&nrm=iso

UCV Agronomy Faculty Journal
Web: http://www.redpav-fpolar.info.ve/fagro/index.html

UCV Faculty of Medicine Journal
Web: http://www.scielo.org.ve/scielo.php?pid=0798-0469&script=sci_serial

UCV Pharmacy Faculty Journal
Web: http://www.ucv.ve/Farmacia/

ULA Pharmacy Faculty Journal
Web: http://www.revencyt.ula.ve/

Venezuelan Pharmacology and Therapeutics Archives
Web: www.scielo.org.ve

Venezuela Scientific Act
Web: http://acta.ivic.ve/

Workers Health
Web: http://www.iaesp.edu.ve/index.php?option=com_content&task=view&id=267&Itemid=107

Journal Articles

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ORGANIZATIONS (GOVERNMENT)

Ministry of Popular Power for Sciences and Technologies

Oversees communications and information policy of the National Government Administration.
Address: Av. Universidad. Esquina El Chorro. Torre MCT
City: Caracas
State: Gran Caracas
Phone: (58-212)-2103401–10
Fax: (58212)-2103536
Web: http://www.mct.gob.ve/publico/home/home.php

National Fund of Science, Technology and Innovation (FONACIT)

To finance the execution of plans, programs, and projects defined by the MTC to stimulate scientific, technological, and innovative knowledge, in order to contribute to the social development of the country.
Email: conicit@conicit.gov.ve
Web: http://www.fonacit.gov.ve/

Regional Foundation for Science and Technology (FUNDACITES)

Contributing to the development of science, technology, and innovation by means of support to institutions and individuals.
Web: http://www.mct.gob.ve/publico/enlaces/adsc_enlaces.php?tipo=1

Venezuelan Institute of Scientific Investigations (IVIC)

Its mission is to generate new knowledge through scientific investigation, technological development, and the formation of high-level resources.
Web: http://www.ivic.ve

Ministry of Popular Power for the Environment

This Ministry guarantees the rational use of the natural resources by means of a systemic administration and improvement in environment and quality of life.
Address: Centro de Documentación y Divulgación Ambiental, local 23, torre sur, Centro Simón Bolívar, nivel Plaza Caracas, El Silencio
City: Caracas
State: Gran Caracas
Phone: (58-212)408-20-96/20-86
Email: cedodia@marn.gov.ve
Web: http://www.marn.gov.ve

Ministry of Popular Power for the Health

Focused on strengthening the country's sovereignty and spurring research investigations and technological innovations for health and public health management.
Address: Av. Baralt, Centro Simón Bolívar, Edif. Sur, El Silencio
City: Caracas
State: Gran Caracas
Phone: (58-212)-4080000
Email: msds@msds.gov.ve
Web: http://www.mpps.gob.ve

Annexed Organisms
Autonomic Institute of Caracas University Hospital (HUC)

Its goal is to create, develop, and apply integrated health processes of the highest qualities, by means of prevention, assistance, research, and teaching activities; with the objective of attending patients, relatives, and institutions that request health services from the Medical Faculty and students of the Venezuela central University.
Address: Urbanización Parque Central. Ciudad Universitaria
City: Caracas
State: Gran Caracas
Phone: (58-212)-6617111/6617211
Email: huc@reacciun.ve
Web: www.huc.gov.ve

Autonomic Service Institute of Superior Studies 'Dr. Arnoldo Gabaldon' (IAESP)

The main goal of the Institute is contributing to the consolidation of a multidisciplinary team, of high technical and scientific capability, capable of responding to priorities in the social and health environment, according to the new directions in education, science, and technology, both at the national and the international levels.
Address: Av. Bermúdez Sur, Apartado
City: Maracay
State: Aragua
Phone: (58-243)-2325633/2320833
Ffax: (58-243)-2326933
Web: http://www.iaesp.edu.ve/

Biomedicine Institute

Directed to research and control of diverse endemic diseases from the perspective of integrated attention

to health, operational and socio-epidemiologic research, together with the development of human resources both in the University academic area as well as in programs and services.

Address: San Nicolás a Providencia, Parroquia San José
City: Caracas
State: Gran Caracas
Phone: (58-212)-8604630
Fax: (58-212)-8604636

José Félix Ribas Foundation

Its mission focuses on prevention, treatment, rehabilitation, and scientific investigation on the use and abuse of psychotropic and stupefacient substances; the administration and maintenance of Therapeutics Communities, Centers of Ambulatory Attention and the Centers of Preventive Integrated Education (CEPI).
Address: Esq. Jesuita, Torre Bandagros, Piso 5
City: Caracas
State: Gran Caracas
Phone: (58-212)-8619304/8616862
Email: funfr@reacciun.ve

National Institute of Hygiene 'Dr. RAFAEL RANGEL'

National Sanitary Reference Center for prevention and surveillance; supports the Ministry of Health and Social Development to fulfill the health politics of the Venezuelan state.
Address: Urbanización Parque Central. Ciudad Universitaria
City: Caracas
State: Gran Caracas
Phone: (58-212)-6624797/6932421
Web: http://www.msds.gov.ve/msd/modules.php?name=Content&pa=showpage&pid=58

Annexed Service
Autonomic Service of Pharmaceutical Products (SERFA-SUMED)

A servide of the Venezuelan State Institution, concerned with the production and supply of Medicines for the National Public Health System. It is in the control of and supported by the Ministry of Health and Social Development and its activities correspond to the alignment with the National Health Politics.
Address: Km. 0. Carretera Vieja Los Teques. Sector Las Adjuntas, Parroquia Macarao
City: Caracas
State: Distrito Capital
Phone: (58-212)-4339941/4339742
Email: contacto@sefar.gob.ve
Web: http://www.sefar.gob.ve/

Ministry of Popular Power for the Land and the Agriculture

Concerned with food safety, boosting agricultural development, and the just distribution of land.
Address: Av. Urdaneta entre esquina Platanal a Candilito a media cuadra de la Plaza La Candelaria, Parroquia La Candelaria
City: Caracas
State: Gran Caracas
Phone: (58-212)-5432050 (office attention for the worker farm)
Web: http://www.mat.gob.ve

Agricultural Sanitation Autonomic Service (SASA)

SASA guarantees the quality of agricultural products by means of the integrated development of sanitary programs to cover the needs of the production and agricultural sectors by way of modern technologies.

Address: Avenida Lecuna, Torre Este, Piso 12, Parque Central, El Conde
City: Caracas
State: Gran Caracas
Phone: (58-212)-5090379/5090240/5090247/5090378/5090499/5090595/5090597
SASA on line: (58-212)-5090211
Fax: (58-212)-5090376/5731756
Web: www.sasa.gob.ve

Ministry of Popular Power for the Work and Social Security

Its main function is to promote employment, dignified work and protection of human rights for both men and women, the development of a solid social system, and enhancing labor relations for all workers.
Address: Centro Simón Bolívar, Edificio Sur, Piso 5, Plaza Caracas, El Silencio
City: Caracas
State: Gran Caracas
Phone: (58-243)-4084200 (Master)
On line: 0800-8722256
Web: http://www.mintra.gov.ve

National Institute of Health and Labor Security

An Institute concerned with health promotion, disease prevention, and attention to health and labor security, and guaranteeing optimal working conditions and worker rights.
On line: 0800-46772735
Web: http://www.inpsasel.gov.ve/

Workers Center of Health Studies (CEST)

A center of Investigation from the University of Carabobo, focused in the study of workers' health

problems. It is part of the Investigative Direction of the School of Medicine 'Dr. J. Witremundo Torrealba' of the Aragua Nucleus of the above-mentioned University. Its main goal is to provide answers to occupational health and safety questions. The symbol CEST corresponds to the Spanish: Centro de Estudios en Salud de los Trabajadores.
Address: El Centro de Estudios en Salud de los Trabajadores (CEST) esta ubicado en el Instituto de Altos Estudios de Salud Pública 'Dr. Arnoldo Gabaldon', Av. Bermúdez Sur.
City: Maracay
State: Aragua
Phone: (58-243)-2321001
Fax: (58-243)-2324566
Email: cest@telcel.net.ve
Web: http://cest.fundacite.arg.gov.ve/

ORGANIZATIONS (NON-GOVERNMENTAL)

Association for the Environment and Natural Defense

Contributing to improve the quality of life of communities by promoting the integrated handling of solid waste, through education and discussion.
Address: Av. Francisco de Miranda, Torre La Primera, Piso 15, Espacios de entrenamiento de la USB, Campo Alegre
City: Caracas
State: Gran Caracas
Fax: (58-212)-9527450
Email: adan@adan.org.ve
Web: www.adan.org.ve

ECOCICLA Foundation

Its mission is to create an environmental conscience in communities, to implement municipal systems of integrated management of residues and solid wastes, according to the policies of ambient quality improvement.
Address: Av. Universidad. Talleres del CCEAS
City: Naguanagua – Valencia
State: Carabobo
Phone: (58-241)-8600110
Fax: (58-241)-8671201
Email: ecocicla@cantv.net
Web: www.fundacite.arg.gov.ve

Guayana Ecological Research Center

javascript:changeWindow('http://www.uneg.edu.ve')Its main concern is to renew and optimize the lines of investigation through postgraduate programs in Guayana.
Address: Experimental National University of Guayana – Headquarters Chilemex. General Coordination of Investigation and Postgraduate. Guayana Ecological Research Center. Chilemex Urbanization, Chile Street. Universidad Nacional Experimental de Guayana – Sede Chilemex. Coordinación General de Investigación y Postgrado. Centro de Investigaciones Ecológicas de Guayana (CIEG). Urbanización Chilemex, Calle Chile.
City: Puerto Ordaz – Ciudad Guayana
State: Bolívar
Phone: (58-286)-9240192
Fax: (58-286)-9234786
Email: cieg@uneg.edu.ve
Co-ordinator: Dr. Glenda Rodríguez
Email: grodriguez@uneg.edu.ve
Assistant: Hernán Castellano
Email: hcastell@uneg.edu.ve
Web: www.uneg.edu.ve (Link Organización – Link Estructura Organizativa – Link Vice-Rectorado Académico: Centros de Investigación) Centro de Investigaciones Ecológicas de Guayana (CIEG))

Marine Life Venezuelan Ecological Society 'Sea Vida'

Association dedicated to the investigation and conservation of sea wildlife and its habitat, and ecotourism oriented to sea mammals (dolphins and whales).
Address: Urbanización Blandín, Edif. Santa Teresa, apto 1-C
City: Maracay
State: Aragua
Phone: (58-244)-3958477
Email: seavida@yahoo.es

Specialists Association in Emergency Controls with Dangerous Materials (AsoHazMat)

Address: Av. 3Y entre calles 82 y 83 C.C. Los Pirineos Local 20
City: Maracaibo
State: Zulia
Email: Asohazmat@cantv.net, Asohazmat1@cantv.net, Asohazmat2@cantv.net
Phone: (58-261)-7920160
Fax: (58-261)-7920029
Web: www.asohazmat.com

Venezuela Ambient Foundation

Address: Centro Comercial Omnicentrol, Av. Universidad, Talleres del CCEAS
City: Naguanagua – Valencia
State: Carabobo
Phone: (58-241)-8600110
Fax: (58-241)-8671201
Email: ecocicla@cantv.net
Web: www.fundacite.arg.gov.ve

Venezuela System of Integrated Toxicology (SIVEINTOX)

Its principal objective is the invigoration and the normalization of the toxicological activity of the country in all its areas, national and international scientific exchange, and harmonization of protocols in handling of case reports and laboratory techniques.
Address: Unidad de Toxicología Regional 'Dr. Yelitza Coromoto Reyes Figuera'
City: Maracay
State: Aragua
Director: Dra. Yelitza C. Reyes F
Phone: (58-416)-6437342
Email: ycrfut@cantv.net

Universities

Andes University
Address: Avenida 3 Independencia, Edificio El Rectorado, piso 1
Phone: (58-274)-2402311/2402309/2402432/2403887
City: Mérida
State: Mérida
General Services Direction email: servigen@ula.ve
Web: http://www.ula.ve

Medicine Faculty
Web: http://www.ula.ve/ulaweb/raiz/institucion/index.php?id=1&id_detalles_nodo=14&id_detalles_nodo2=420
Address: Calle 35 entre Av. 4 y Do n Tulio Febres Cordero, Edificio Palomari, Piso 1
Phone: (58-074)-2403051
Fax: (58-074)-2403045
Postgraduate Clinical Toxicology
Phone: (58-274)-2403231

Pharmacy and Bioanalysis Faculty
Web: http://www.ula.ve/ulaweb/raiz/institucion/index.php?id=1&id_detalles_nodo=14&id_detalles_nodo2=419
Address: Sector Campo de Oro. Detrás del Hospital Universitario de Los Andes
Phone: (58-074)-403440/403441
Fax: (58-074)-403475
Postgraduate Analytical Toxicology
Phone: (58-274)-2403466

IAESP 'Dr. Arnoldo Gabaldon'
Address: Av. Bermúdez Sur, Apartado, Maracay, Estado Aragua
Phone: (58-243)-2325633/2320833
Fax: (58-243)-2326933
Postgraduate
Specialty in Occupational Health and Work Environment Hygiene
Web: http://www.iaesp.edu.ve/index.php?option=com_content&task=view&id=29&Itemid=56

Specialty in Public Health
Web: http://www.iaesp.edu.ve/index.php?option=com_content&task=view&id=276&Itemid=102

Orient University (UO)
Web: http://www.udo.edu.ve

Postgraduate Applied Biology Ecology Mention and Ambient Toxicology
Address: Coordinación de Postgrado, Biología Aplicada. Núcleo de Sucre. Cerro El Medio, Casa No. 13, Cumaná, Estado Sucre
Phone: (58-293)-4302270
Fax: (58-293)-4514754

University of Carabobo (UC)
Web: http://www.uc.edu.ve
Health Sciences Faculty
Address: Facultad de Ciencias de la Salud, detrás del Oncológico antiguo Anfiteatro de Bárbula Naguanagua Edo, Carabobo
Phone: (58-241)-8666258–8674264, ext. 120
Email: aeblen@thor.uc.edu.ve
Web: http://www.uc.edu.ve/pregrado/fcs/index.html

Bioanalysis School, Molecular Toxicology Unit
Address: Modulo 5
Coordinator: Prof. Exila Rivero
Web: http://www.bioanalisis.fcs.uc.edu.ve/Unidades_de_investigacion.htm

School of Medicine
Web: http://www.uc.edu.ve/pregrado/fcs/index.html

Postgraduate UC
Main Office: Área de Estudios de Postgrado de la Universidad de Carabobo Urb. Trigal Norte, Sector Mañongo, Valencia
Phone: (58-241)-8424780/8431802/8431937
Deanery: (58-241)-8422406
FACES/Academic Direction: (58-241)-8431074
Occupational Health Unit: (58-241)-8421215

Analytical Toxicology Master Program
Web: http://portal.postgrado.uc.edu.ve/index.php?module=htmlpages1&func=display&pid=25

Clinical Toxicology Master Program
Web: http://portal.postgrado.uc.edu.ve/index.php?module=htmlpages1&func=display&pid=24

Master Program in Occupational Health and Work Environment Hygiene
Web: http://portal.postgrado.uc.edu.ve/index.php?module=htmlpages1&func=display&pid=31

Occupational Health Specialization
Web: http://portal.postgrado.uc.edu.ve/index.php?module=htmlpages1&func=display&pid=63

Venezuela Central University (UCV)
Web: www.ucv.ve

Ambient Health and Work Division
Web: www.ucv.ve/dast.htm
Email: ericomana@yahoo.com

Bioanalysis School
Address: Universidad Central de Venezuela, Edif. Decanato de Medicina, Departamento de Bioquímica, Los Chaguaramos, Caracas
Department Head: Prof. Marisol Borges
Phone: (58-212)-605331/(58-212)-6053464
Web: www.med.ucv.ve/ftproot/Bioanalysis/departamentos/bioquimica

Medicine Faculty
Address: Universidad Central de Venezuela, Edif. Decanato de Medicina, Los Chaguaramos, Caracas
Email: webmaster@med.ucv.ve
Web: www.med.ucv.ve/escuelas

Pharmacy Faculty
Address: Av. Los Ilustres, Ciudad Universitaria, Edif. Facultad de Farmacia, Los Chaguaramos, Caracas
Web: http://www.ucv.ve/Farmacia

Information Service of Medicines and Toxics

Scientific and technical support to optimize the Drugs Therapy Act and handle the poisoned patient. Provides information to citizens on the use and drugs and the prevention of poisoning. The SIMET fulfill their activities through the Information Center of Medications (CEDIMED) and the Information Center and Assortment Toxicological (CIATO).

Coordinator: Fcta: Daniela Pasqualatto
Phone: (58-212)-6052686/6052732
Email: Simet@camelot.rect.ucv.ve

Toxicological Analysis Service

A unit oriented towards the toxicological analysis of biological and non biological samples, identification and quantification of agents, metabolites, alteration of biochemical parameters and others, with the objective of giving the analytical support required for the diagnosis, treatment and control of intoxication cases.

Co-ordinator: Prof. Ivonne León
Phone: (58-212)-6052687
Email: sa-tox@hotmail.com

Zulia University (LUZ)
Web: http://www.luz.edu.ve

Medicine Faculty – Bioanalysis School
Web: http://www.luz.edu.ve/Facultades/Medicina/Facultades+y+Nucleos+-+Facultad+de+Medicina+-+Pregrado.htm
Dean: Dr. Milagros Sánchez
Phone: (58-261)-7597202

Medicine Faculty – Institute of Work Medicine and Industrial Hygiene
Postgraduate Occupational Health Master Program
Co-ordinator: Dr. Adonías Lubo Palma
Phone: (58-261)-7597251
Movilcel: (58-416)-7604223
Address: Calle 65 esquina Av. 19 (Al lado del Hospital Universitario). Maracaibo, Estado Zulia

Professional Societies

Asociación Venezolana de la Industria Química y Petroquímica (ASOQUIM)
Web: http://www.asoquim.com
Address: Av. Francisco Solano López. Edificio Centro Solano. Piso 1, Oficina 1-A. Chacaito, Caracas
Phone: (58-212)-7625485/5104/4469
Fax: (58-212)-7620597
Email: direjecu@asoquim.com

Counsel of Scientific, Humanistic and Technologic Development (CONDES)
Address: Av. 4 (Bella Vista), con calle 74, Edificio Fundaluz. Piso 4 y 10
Phone: (58-261)-7596308/7596652/7596860
Electronic Hades: condes@luz.edu.ve
Email: luzcondes@cantv.net

Latin-American Toxicology Association (ALTA) Venezuela Chapter
Address: Universidad Central de Venezuela, Ciudad Universitaria, Facultad de Farmacia, Piso 6
City: Los Chaguaramos. Caracas
Contacto a través de SIMET
State: Distrito Capital

Toxicology National Network
Address: Clínica El Ávila, Av. San Juan Bosco con Sexta Transversal, Altamira, Caracas, Venezuela
Phone: (58-212)-2761111/1001/1052
Fax: (58-212)-2761035
Director: Dr. Manuel Arellano Parra
Phone: (58-212)-2519110/(58-416)-7285861

Email: arellanoparra@gmail.com/
info@clinicaelavila.com
Web: http://www.clinicaelavila.com

Venezuela Association for the Advancement of Science
Address: Calle Neverí. Colinas de Bello Monte
City: Caracas
State: Distrito Capital
Director: Haydee Cretarolo
Phone: (58-212)-7535802
Fax: (58-212)-7513810
Email: caracas@asovac.org.ve
Web: http://asovac.org.ve/portal/component/
option,com_frontpage/Itemid,1/

Venezuelan Society of Toxicology
Address: Universidad Central de Venezuela, Ciudad Universitaria, Facultad de Farmacia, Piso 6, Los Chaguaramos,
Contact through SIMET, Casilla Postal 1040, Caracas
Director: Daniela Pasqualatto B. Farmacólogo
Phone: (58-212)-6052686/6052732
Fax: (58-212)-6052736
Email: simet@camelot.rect.ucv.ve/
pasquald@camelot.rect.ucv.ve

Venezuela Toxicology Integral System (SIVEINTOX)
Address: Corporación de Salud del Estado Aragua, Maracay, Estado Aragua
Movilcel: (58-416)-6437342
Email: ycrfut@cantv.net

Toxicology Centers

Barinas – Estado Barinas
Hospital 'Dr. Luis Razetti', Toxicology Center (FUNCETOXBA)
Director: Dr. Olga Fontiveros de Mazzei
Address: Calle Cedeño, Barinas
Phone: (58-273)-5520294
Movilcel: (58-414)-1595813
Email: olgafontiveros@hotmail.com

Barquisimeto – Estado Lara
Hospital 'Dr. Antonio María Pineda', Toxicology Center (CTRCO)
Director: Dr. Omaira Bastidas
Address: Hospital Pediátrico 'Dr. Agustín Zubillaga', Área de Emergencia, Barquisimeto, Estado Lara
Phone: (58-251)-7181260

Caracas – Distrito Capital
Venezuela Central University (UCV) (SIMET-CIATO)
Director of Pharmacology: Daniela Pasqualatto B
Address: Universidad Central de Venezuela, Ciudad Universitaria, Facultad de Farmacia, Piso 6, Los Chaguaramos, Caracas
Phone: (58-212)-6052686/6052732
Fax: (58-212)-6052736
Email: simet@camelot.rect.ucv.ve/
pasquald@camelot.rect.ucv.ve
Web: http://www.ucv.ve

Maracaibo – Estado Zulia
Hospital 'Nuestra Señora de Chiquinquirá'
Chiquinquirá Toxicological Center (CETOXCHI)
Directors: Dr. Angélica Quiróz/Col. Dr. Victor Núñez Pinto
Address: Av. 13 Plaza 'San Juan de Dios' al lado de Basílica Nuestra Señora de Chiquinquirá, Maracaibo, Estado Zulia
Movilcel Dr. Angélica Quiróz: (58-416)-4661673
Movilcel Dr. Victor Núñez: (58-414)-6261469
Email Dr. Angélica Quiróz: ciezcatox@hotmail.com

Maracay – Estado Aragua
Civil Hospital of Maracay. Regional Toxicology Unit CORPOSALUD
Director: Dr. Yelitza Reyes Figueroa
Address: Calle Brion, frente a la Plaza Bolívar, Maracay, Estado Aragua
Phone: (58-243)-2327815
Movilcel: (58-416)-6437342
Email: ycrfut@cantv.net

Valencia – Estado Carabobo
Universidad of Carabobo, Toxicology Investigation Center (CITUC)
Director: Dr. Doris Nobrega
Address: Calle 144, No. Rio 211, La Ceiba, Valencia, Estado Carabobo
Phone: (58-241)-8247256
Fax: (58-241)-8237530
Email: cituc@intercable.net.ve
Web: http://www.uc.edu.ve

Legislation

Ambient Penal Law
Web: http://gp.cnti.ve/site/marnamazonas.gob.ve/
view/docs/LPA.pdf

Decree Nº 2635 'Norms for recuperation control of dangerous materials and handling of dangerous wastes'
Web: http://www.marn.gob.ve/images/acrobat/
Decreto%202635_546.pdf

Law about Substances, Materials and Dangerous wastes
Web: http://www.inpsasel.gov.ve/paginas/
leysustancias.htm

Normalization and Quality Certification Fund FONDONORMA
Web: http://www.fondonorma.org.ve/

Organic Law about Prevention, Conditions and Work Environment
Web: http://www.inpsasel.gov.ve/paginas/lopcymat.htm

Regalement about Hygiene Conditions and Work Security
Web: http://www.inpsasel.gov.ve/paginas/rchst.htm

Regalement of the Organic Law on Prevention, Conditions and Work Environment
Web: http://www.inpsasel.gov.ve/documentos/reg_lopcymat_2007.pdf

APPENDIX

I

Toxicology Data and Information Management

STEPHANIE HOLMGREN

ACKNOWLEDGMENT

A portion of this material is based on the previous 3rd edition written by Frederick W. Stoss and Philip Wexler.

Information is a source of learning. But unless it is organized, processed, and available to the right people in a format for decision making, it is a burden, not a benefit.

(C. William Pollard, *The Soul of the Firm*)

Knowledge is of two kinds: we know a subject ourselves, or we know where we can find information upon it

(Samuel Johnson, in James Boswell's *Life of Johnson*)

As the number of toxicology-related print (books, technical reports, etc.) and electronic resources (databases, computational tools, etc.) has grown, so too has the amount of literature describing these resources. This literature allows research scientists, policy makers, journalists, librarians, and other practitioners to keep pace with the latest developments and trends in the rapidly evolving field of toxicology.

What factors are behind the phenomenal growth in toxicology and environmental health resources? One of the primary driving forces has been and continues to be federal, state, and local legislative and regulatory initiatives. Environmental health and safety rules, worker and community right-to-know laws, and emergency planning and response programs mandate industry, research institutions, and the government to fully disclose and freely disseminate toxicology data and information. For example, the Toxic Substances List, the forerunner of the Registry of Toxic Effects of Chemical Substances (RTECS), was an outcome of the 1970 Occupational Safety and Health Act's call for 'a list of all known toxic substances by generic family or other useful grouping, and the concentrations at which such toxicity is known to occur.' (Section 20(a) (6)). Numerous other government initiatives and resulting regulations; such as The Toxic Substances Control Act (1976), Consumer Product Safety Act (1972), and the Safe Drinking Water Act (1977), are responsible for many of the private and public information systems available today.

The general public has also contributed to the demand for and supply of toxicology and environmental health information. As more information has become available in recent years, citizens have adopted a more pro-active 'local stakeholder' role. Increased citizen understanding of the issues has allowed them to collaborate with government, industry, and other interested parties to influence policy, make decisions, and implement community solutions. Furthermore, non-profit and grassroots groups, such as the Right to Know Network and the Children's Environmental Health Coalition, are not only users of information, but have missions to provide information as well.

Advances in computing technology have laid the foundation to meet the above demands for toxicology information. Faster computing speeds, larger storage capacity, data information systems, and telecommunication networks have provided the wherewithal for government, industry, and academia to make leaps not only in discovering new knowledge, but gains in effectively, efficiently,

and equitably making this information available to the public. Ironically, it is the unprecedented pace and breadth of information dissemination that makes staying current even more of a challenge in the Internet age.

The application of microarrays, high-throughput, and 'in silico' testing methods, is generating an extraordinary mass of data. As a result, data management systems have been challenged to cope with storing, organizing, and retrieving this extensive quantity of data. Taxonomies, standards, and data quality measures are playing a critical role in creating more effective data management systems. This is especially important because, increasingly, data sets from different disciplines are being integrated to discover new patterns or insights. For example, TOXMAP overlays geospatial maps, demographic and health data, with information from the Toxic Release Inventory and Superfund sites (National Library of Medicine). In addition, as more original research data are being made available online for other investigators to use, it becomes important that they can incorporate diverse data files into their existing systems.

Converting the data to knowledge has required substantial progress in computational tools, data and text mining applications, biostatistics, and informatics to extract meaning from the data. The resulting discoveries improve our understanding of the body's biological mechanisms and enhance our ability to better assess toxic exposure and risk.

PERIODICALS

Practical information about the development of new, or enhancements to existing, databases and information resources can be found in many periodicals. Some publications now provide dedicated coverage (similar to the book review sections) to electronic and online data and information resources. The following is a select list of trade magazines, scholarly journals, and newsletters that frequently monitor information and data management tools for toxicology and environmental health information.

Information Science Journals

CD-ROM (Online, Inc., Weston, CT)

Database (Online, Inc., Weston, CT)

ERMD News (Special Libraries Association, Environment & Resource Management Division, Washington, DC)

Online (Online, Inc., Weston, CT)

Online Information Review (Emerald Group Publishing, West Yorkshire, England)

Sci-Tech News (Special Libraries Association, Science and Technology Division, Washington, DC)

Searcher (Information Today, Medford, NJ)

Scholarly Journals/Trade Publications

Chemical & Engineering News (American Chemical Society, Washington, DC)

Chemical Health and Safety (American Chemical Society, Washington, DC)

Clinical Toxicology (Taylor and Francis, Oxfordshire, England)

Environmental Health Perspectives (National Institute of Environmental Health Sciences, Research Triangle Park, NC)

Environmental Manager (Air and Waste Management Association, Pittsburgh, PA)

Environmental Progress (American Institute of Chemical Engineers, New York)

Environmental Science and Technology (American Chemical Society, Washington, DC)

Journal of Analytical Toxicology (Preston Publications, Niles, IL)

Journal of Chemical Information and Modeling (American Chemical Society, Washington, DC)

Journal of Environmental Health (National Environmental Health Association, Denver, CO)

Occupational Hazards (Penton Media, Cleveland, OH)

Occupational Health and Safety (1105 Media, Chatsworth, CA)

Pollution Engineering (BNP Media, Troy, MI)

Public Health Reports (Association of Schools of Public Health, Washington, DC)

Toxicological Sciences (Oxford University Press, Oxford, England)

Toxicology (Elsevier, Shannon, Ireland)

DATABASES

Several online bibliographic databases are also quite useful for retrieving relevant resources on information and data management for toxicology and environmental health.

AGRICOLA

Biological and Agricultural Index

Biosis Previews

Chemical Abstracts Service

Environmental Sciences and Pollution Abstracts

ERIC (Educational Resources Information Clearinghouse)

InfoSci-Online

Library and Information Science Abstracts

Library Literature and Information Science

Medline

OCLC First Search

Scopus

Toxline

Web of Science

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The computing advances noted earlier have led to an abundance of web-based information resources and tools. Given the dynamic nature of these online resources, this bibliography only includes references from 2000 to the present. The reader will notice that many of the same subjects related to occupational health, clinical toxicology, and hazardous substances are still well covered in the literature. In addition, new themes have emerged such as biological agents, 'omics,' and informatics applications in toxicology. Related to these new themes is the emphasis in the literature on describing the development and design of specific databases or integrated applications. Finally, another trend reflected in the bibliography is that the development of these resources is a global phenomenon.

The remainder of the chapter is divided into four sections. Section one lists those print articles or books that highlight useful toxicology-related information resources. The selected resources range from print (books, periodicals, government documents, technical reports, etc.) and electronic materials (databases, websites, CD-ROMs, etc.) to government (agencies, laws and regulations, etc.) and professional resources (associations, conferences, listservs, etc.).

Within the past 10 years, more and more of the above types of resources have become available online. As a result, the print guides themselves have moved to a web-based format to take advantage of the interactive nature of the Internet. Section two will feature a representative sample of these online guides.

The third section covers articles that describe the development and application of specific databases or information systems. The abundance of these articles truly reflects how essential computing technology, computational biology, and informatics are to expanding the toxicology knowledge base.

Finally, the last section includes articles that explore issues surrounding the development, use, and management of toxicology information systems. Taxonomy development, data quality, interoperability, standards, and open access are among the issues that need to be addressed to ensure effective, efficient, and equitable access to the information.

PRINT GUIDES TO TOXICOLOGY-RELATED RESOURCES

These print publications describe an array of toxicology, chemical, environmental health, and occupational health resources, predominantly online. The multidisciplinary nature of toxicology has resulted in each subject area identifying those resources and tools that uniquely serve its own community's needs.

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ONLINE GUIDES TO TOXICOLOGY-RELATED RESOURCES

As previously discussed, most information resources and tools are now available online. Several university academic libraries and professional societies have adopted the role of compilers of 'subject guides' or 'links' pages to these web-based toxicology-related resources. Since these online guides may be as ephemeral as the resources they list, only a handful has been included in this second section. The websites below were selected for comprehensiveness of coverage, authority, currency, and predominance of web-based resources. In addition, only those sites that focused specifically on toxicology were included. Given the multidisciplinary nature of toxicology, a comprehensive list would also need to include occupational health, biochemistry, genetics, and other related fields.

San Diego State University, Library and Information Access. Subject Guide for Toxicology & Environmental Health
Web: http://infodome.sdsu.edu/research/guides/science/toxicology.shtml
Access date: January 20, 2007

Society of Forensic Toxicologists. Toxilinks
Web: http://www.soft-tox.org/?pn=toxilinks
Access date: January 20, 2007

Society of Toxicology. Sites of Interest
Web: http://www.toxicology.org/ai/si/sites.asp
Access date: January 20, 2007

University of Buffalo Libraries. Toxicology – In-Depth Research Guide
Web: http://ublib.buffalo.edu/libraries/asl/guides/toxicology.html

University of California at Santa Cruz. Subject Guide – Environmental toxicology
Web: http://library.ucsc.edu/science/subjects/etox/index.html
Access date: January 28, 2007

The University of Kentucky. World Wide Web Subject Catalog: Toxicology
Web: http://www.uky.edu/Libraries/guide.php?ISub_id=140
Access date: January 28, 2007

University of Minnesota Biomedical Library. Toxicology – Selected Resources
Web: http://www.biomed.lib.umn.edu/help/guides/toxicology
Access date: January 28, 2007

University of Sydney, Veterinary Education and Information Network. Toxicology and Toxinology
Web: http://vein.library.usyd.edu.au/links/toxicology.html
Access date: January 20, 2007

Wiggins G. Chemical Information Sources Wiki
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TOXICOLOGY-RELATED DATABASES AND INFORMATION SYSTEMS

The combination of computing technology, informatics, and biostatistics has forged powerful analytical tools for toxicology researchers. These tools have led to unparalleled advances in knowledge as well as opened new areas of inquiry heretofore unable to be explored. They have become essential for capturing, managing, organizing, integrating, mining, and analyzing the flow of data and textual information generated in toxicology and environmental health research.

Numerous articles delve into the opportunities and challenges of developing, managing, and utilizing these information systems. The purpose of these computer-based applications can range from managing experimental data and tracking chemical exposures to integrating multiple databanks and assessing drug safety. A recent trend is on harnessing computational power to conduct predictive toxicology. As this in silico or 'within a computer-simulated environment' method proves its validity and reliability, more of these tools will continue to be added to the researchers' array of resources. While many of these databases and information systems are intended for toxicologists, several are geared towards the general public, policy makers, and health professionals.

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ISSUES SURROUNDING TOXICOLOGY INFORMATION SYSTEMS

While previous sections have focused on specific resources, online tools, and information systems, these articles explore cross-cutting topics associated with these resources. Among some of the issues covered include:

- information seeking behavior and guidelines for effective searching
- new applications or uses for an existing information system
- integration and interoperability of systems
- data collection and quality
- standards for data and database design
- extraction of meaningful information from the data through informatics and text/data mining.

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GLOSSARY OF TERMS USED IN TOXICOLOGY, 2nd EDITION

(IUPAC Recommendations 2007)

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Glossary of terms used in Toxicology, 2nd edition

(IUPAC Recommendations 2007)

Abstract: This glossary, a revision of the IUPAC "Glossary for Chemists of Terms Used in Toxicology" [*Pure Appl. Chem.* **65**, 2003 (1993)] incorporating new and redefined terms from the "Glossary of Terms Used in Toxicokinetics" [*Pure Appl. Chem.* **76**, 1033 (2004)], contains definitions and explanatory notes, if needed, for terms frequently used in the multidisciplinary field of toxicology. The glossary is compiled primarily for those scientists and others who now find themselves working in toxicology or requiring a knowledge of the subject, especially for hazard and risk assessment. Many medical terms are included because of their frequent occurrence in the toxicological literature. There are three annexes, one containing a list of abbreviations and acronyms used in toxicology, one containing a list of abbreviations and acronyms used by international bodies and by legislation relevant to toxicology and chemical safety, and one describing the classification of carcinogenicity according to the weight of evidence available.

Keywords: toxicology; toxicokinetics; risk assessment; hazard assessment; carcinogenicity; IUPAC Chemistry and Human Health Division.

Note: Terms for which no primary source is given have been taken verbatim from the original IUPAC "Glossary for Chemists of Terms Used in Toxicology" [1] or have been newly defined by the compilers of this paper. New or redefined terms in the "Glossary of Terms Used in Toxicokinetics" are currently referenced as in that glossary [2]. Other terms that are quoted verbatim from their sources are referenced individually. For other chemical terminology, the reader is referred to the on-line version of *Compendium of Chemical Terminology* (the "Gold Book") [3].

CONTENTS

PREFACE

IUPAC aims to promote world-wide "regulation, standardization, or codification" in relevant areas of chemistry. In 1993, the importance of toxicology to chemists was recognized by the publication in *Pure and Applied Chemistry* (*PAC*) of the "Glossary for Chemists of Terms Used in Toxicology" [1]. This glossary has been widely accepted and used, but, inevitably, with the continuing development of both chemistry and toxicology, terms have changed their meanings as a result of altered usage and new terms have been coined. Further, some important terms were overlooked, notably those relating to toxicokinetics, and a supplementary glossary has already been published in *PAC* [2]. The revised and extended glossary presented here includes all new terms identified as relevant by the Working Party, together with those in toxicokinetics previously omitted. As before, the glossary is compiled primarily for chemists who now find themselves working in toxicology or requiring a knowledge of the subject. However, there are also many other scientists as well as regulators and managers who have to interpret toxicological information and need ready access to internationally accepted definitions of relevant terms in common use. In order to make this a convenient one-stop glossary, the terms included in this glossary have come from a wide range of disciplines which contribute to toxicology. For some of the entries, alternative definitions are given in order to display the significant differences in the use that occur in practice. We are grateful to all those whose names are listed below who have contributed to this glossary with constructive criticism and who have suggested modifications for its improvement. Their contributions have been invaluable. The Working Group is responsible for any remaining flaws, but we hope that the final version will be sufficiently close to achieving the original objectives to justify the very widespread support that we have received.

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ALPHABETICAL ENTRIES

abiological See *abiotic*.

abiotic abiological Not associated with living organisms.

abiotic degradation Process in which a substance is converted to simpler products by physical or chemical mechanisms: examples include *hydrolysis* and *photolysis*.

abiotic transformation Process in which a substance in the environment is modified by nonbiological mechanisms.

abortifacient Substance that causes pregnancy to end prematurely and causes an abortion.

absolute lethal concentration (LC_{100}) Lowest *concentration* of a substance in an environmental medium which kills 100% of test organisms or species under defined conditions.

Note: This value is dependent on the number of organisms used in its assessment.

absolute lethal dose (LD_{100}) Lowest amount of a substance that kills 100% of test animals under defined conditions.

Note: This value is dependent on the number of organisms used in its assessment.

absorbance, *A* Logarithm of the ratio of incident to transmitted *radiant power* through a sample (excluding the effects of sample cell walls). Depending on the base of the logarithm, decadic and Napierian absorbances are used. Symbols: A, A_{10}, A_e. This quantity is sometimes called extinction, although the term "extinction", better called *attenuance*, is reserved for the quantity which takes into account the effects of luminescence and scattering as well.
Corrected from [3]

Note: When natural logarithms are used, the Napierian absorbance is the logarithm to the base e of the incident *spectral radiant power*, essentially monochromatic, divided by the transmitted spectral radiant power, P_λ.

absorbed dose (of a substance) internal dose. Amount (of a substance) taken up by an organism or into organs or tissues of interest.
See *absorption, systemic*.

absorbed dose (of ionizing radiation), *D* Energy imparted by ionizing radiation to a specified volume of matter divided by the mass of that volume.

absorptance (in chemistry), α. Ratio of the absorbed to the incident radiant power. Also called *absorption factor*. When $\alpha \leq 1$, $\alpha \approx A_e$, where A_e is the Napierian absorbance.
[3]
See also *absorbance*.

absorption (general)
1. Process of one material (absorbate) being retained by another (absorbent).

Note: The process may be the physical solution of a gas, liquid, or solid in a liquid; attachment of molecules of a gas, vapor, liquid; or dissolved substance to a solid surface by physical forces, etc.

2. Transfer of some or all of the energy of radiation to matter which it traverses.

Note: Absorption of light at bands of characteristic wavelengths is used as an analytical method in spectrophotometry to identify the chemical nature of molecules, atoms, or ions and to measure the concentrations of these species.

Corrected from [3]

absorption (in biology) uptake Penetration of a substance into an organism and its cells by various processes, some specialized, some involving expenditure of energy (active transport), some involving a *carrier* system, and others involving passive movement down an electrochemical gradient.

Note: In mammals, *absorption* is usually through the respiratory tract, gastrointestinal tract, or skin into the circulatory system and from the circulation into organs, tissues, and cells.

[2]

absorption (of radiation) Phenomenon in which radiation transfers some or all of its energy to matter which it traverses.
[3]

absorption, systemic *Uptake* to the blood and transport via the blood of a substance to an organ or *compartment* in the body distant from the site of *absorption*.
[2]

absorption coefficient (in biology) absorption factor Ratio of the absorbed quantity (*uptake*) of a substance to the administered quantity (intake).

Note: For *exposure* by way of the respiratory tract, the absorption coefficient is the ratio of the absorbed amount to the amount of the substance (usually particles) deposited (adsorbed) in the lungs.

absorption factor See *absorptance* (in chemistry), *absorption coefficient* (in biology).

abuse (of drugs, substances, solvents, etc.) Improper use of drugs or other substances.

acaricide Substance intended to kill mites, ticks, or other Acaridae.

acceptable daily intake (ADI) Estimate by JECFA of the amount of a food additive, expressed on a body weight basis that can be ingested daily over a lifetime without appreciable health *risk*.

Note 1: For calculation of ADI, a standard body mass of 60 kg is used

Note 2: *Tolerable daily intake* (TDI) is the analogous term used for contaminants.

[2]

acceptable daily intake (ADI) **not allocated** See *no acceptable daily intake allocated*.

acceptable residue level of an antibiotic Acceptable *concentration* of a residue that has been established for an antibiotic found in human or animal foods.

acceptable risk Probability of suffering disease or injury that is considered to be sufficiently small to be 'negligible'.

Note: Calculated risk of an increase of one case in a million people per year for cancer is usually considered to be negligible.

accepted risk Probability of suffering disease or injury that is accepted by an individual.

accidental exposure Unintended contact with a substance or change in the physical environment (including, e.g., radiation) resulting from an accident.

acclimatization, biological

1. Processes, including selection and adaptation, by which a population of microorganisms develops the ability to degrade a substance, or develops a tolerance to it.
2. In animal tests, allowing an animal to adjust to its environment prior to undertaking a study.

accumulation (in biology) See *bioaccumulation*.

accuracy Quantity referring to the differences between the mean of a set of results or an individual result and the value which is accepted as the true or correct value for the quantity measured.

acid dissociation constant, K_a Equilibrium constant for the following reaction of an acid HB:

$$HB(aq) \rightleftharpoons H^+(aq) + B^-(aq)$$

$$K_a = [H^+][B^-] / [HB]c^o$$

where $c^o = 1\,\text{mol dm}^{-3}$ is the standard amount concentration and activity coefficients have been neglected.

Note 1: This constant, because activity coefficients are neglected, is valid at a specified ionic strength. The thermodynamic dissociation constant is found by suitable extrapolation of the conditional constant to zero ionic strength. Note that it is defined as a dimensionless quantity, but sometimes it is given dimensions by omitting the standard amount concentration.

Note 2: Because this constant differs for each acid and varies over many degrees of magnitude, the acidity constant is often represented by the additive inverse of its common logarithm, represented by the symbol pK_a (using the same mathematical relationship as $[H^+]$ is to pH), viz.:

$$pK_a = -\log_{10} K_a$$

In general, a larger value of K_a (or a smaller value of pK_a) indicates a stronger acid, since the extent of dissociation is larger at the same concentration.

[4]

acidosis Antonym: *alkalosis* Pathological condition in which the hydrogen(1+) (hydron) amount concentration of body fluids is above normal and hence the pH of blood falls below the reference interval.

action level

1. *Concentration* of a substance in air, soil, water, or other defined medium at which specified emergency counter-measures, such as the seizure and destruction of contaminated materials, evacuation of the local population or closing down the sources of pollution, are to be taken.
2. Concentration of a pollutant in air, soil, water, or other defined medium at which some kind of preventive action (not necessarily of an emergency nature) is to be taken.

activation (abiotic) *Conversion* of a *xenobiotic* to a more *toxic* derivative by modification not involving biological catalysis.

activation (in biology) See *bioactivation*.

active ingredient Component of a mixture responsible for the biological effects of the mixture. Compare *inert ingredient*.

active metabolite *Metabolite* causing biological and (or) toxicological effects.

After [2]

See *metabolite*.

active transport Movement of a substance across a cell membrane against an electrochemical gradient, in the direction opposite to normal diffusion and requiring the expenditure of energy.

acute Antonym: *chronic*

1. Of short duration, in relation to *exposure* or effect; the effect usually shows a rapid onset.

   Note: In regulatory *toxicology*, 'acute' refers to studies where dosing is either single or limited to one day although the total study duration may extend to two weeks to permit appearance of toxicity in susceptible organ systems.

2. In clinical medicine, sudden and severe, having a rapid onset.

After [2]

acute effect Effect of finite duration occurring rapidly (usually in the first 24 h or up to 14 d) following a single *dose* or short *exposure* to a substance or radiation.

Note: Acute effects may occur continuously following continuous dosing or repeatedly following repeated dosing.

After [2]

acute exposure Antonym: *chronic exposure*
Exposure of short duration.
[2]
See *acute*, *exposure*.

acute toxicity Antonym: *chronic toxicity*

1. *Adverse effects* of finite duration occurring within a short time (up to 14 d) after administration of a single *dose* (or *exposure* to a given *concentration*) of a test substance or after multiple doses (exposures), usually within 24 h of a starting point (which may be exposure to the *toxicant*, or loss of reserve capacity, or developmental change, etc.).
2. Ability of a substance to cause *adverse effects* within a short time of dosing or *exposure*.

[2]

acute toxicity test short-term toxicity test Antonym: *chronic toxicity test* Study in which organisms are observed during only a short part of the life span and in which there is often only a single *exposure* to the test agent at the beginning of the study.

adaptation

1. Change in an organism, in response to changing conditions of the environment (specifically chemical), which takes place without any irreversible disruptions of the given biological system and without exceeding normal (homeostatic) capacities of its response.
2. Process by which an organism stabilizes its physiological condition after an environmental change.

   Note: If this process exceeds the homeostatic range, it becomes pathological and results in symptoms of disease (*adverse effects*).

added risk Difference between the *incidence* of an *adverse effect* in a treated group (of organisms or a group of *exposed* humans) and a control group (of the same organisms or the spontaneous incidence in humans).

addiction Surrender and devotion to the regular use of a medicinal or pleasurable substance for the sake of relief, comfort, stimulation, or exhilaration which it affords; often with craving when the drug is absent.

additive effect Consequence that follows *exposure* to two or more physicochemical agents which act jointly but do not interact: The total effect is the simple sum of the effects of separate exposures to the agents under the same conditions.
[2]

adduct New chemical species AB, each molecular entity of which is formed by direct combination of two separate molecular entities A and B in such a way that there is change in connectivity, but no loss, of atoms within the moieties A and B.

Note 1: Stoichiometries other than 1:1 are also possible, for example, a bis-adduct (2:1). An 'intramolecular adduct' can be formed when A and B are groups contained within the same molecular entity.

Note 2: This is a general term that, whenever appropriate, should be used in preference to the less explicit term *complex*. It is also used specifically for products of an addition reaction.

[3]

adenocarcinoma *Malignant tumor* originating in glandular *epithelium* or forming recognizable glandular structures.

adenoma *Benign tumor* occurring in glandular *epithelium* or forming recognizable glandular structures.

adjuvant

1. In pharmacology, a substance added to a *drug* to speed or increase the action of the main component.
2. In immunology, a substance (such as aluminum hydroxide) or an organism (such as killed mycobacterium) that increases the response to an *antigen*.

administration (of a substance) Application of a known amount of a substance to an organism in a reproducible manner and by a defined route.

adrenergic Secreting adrenaline (epinephrine) and/or related substances; in particular referring to sympathetic nerve fibers.
See *sympathomimetic*.

adsorption Increase in the *concentration* of a substance at the interface of a condensed and a liquid or gaseous layer owing to the operation of surface forces.
[2]
See also *interfacial layer*.

adsorption factor Ratio of the amount of substance adsorbed at the interface of a condensed and a liquid or gaseous phase to the total amount of the substance available for *adsorption*.
[2]

adstringent See *astringent*.

advection (in environmental chemistry) Process of transport of a substance in air or water solely by mass motion.
[2]

adverse effect Change in biochemistry, physiology, growth, development morphology, behavior, or lifespan of an organism, which results in impairment of functional capacity or impairment of capacity to compensate for additional stress or increase in susceptibility to other environmental influences.
After [2]

adverse event Occurrence that causes an *adverse effect*.

Note: An adverse event in clinical studies is any untoward reaction in a human subject participating in a research project; such an adverse event, which may be a psychological reaction, must be reported to an institutional review board.

aerobe Organism that requires dioxygen for respiration and hence for growth and life.

aerobic Requiring dioxygen.

aerodynamic diameter (of a particle) Diameter of a spherical particle with relative density equal to unity that has the same settling velocity in air as the particle in question.

aerosol Mixture of small particles (solid, liquid, or a mixed variety) and a *carrier* gas (usually air).

Note 1: Owing to their size, these particles (usually less than 100 μm and greater than 0.01 μm in diameter) have a comparatively small sedimentation velocity and hence exhibit some degree of stability in the earth's gravitational field.

Note 2: An aerosol may be characterized by its chemical composition, its radioactivity, the particle size distribution, the electrical charge, and the optical properties.

[2]

aetiology See *etiology*.

after-effect of a poison Ability of a *poison* to produce a change in an organism after cessation of contact.

age sensitivity Quantitative and qualitative age dependence of an effect.

agonist Antonym: *antagonist* Substance that binds to cell *receptor*s normally responding to a naturally occurring substance and produces an effect similar to that of the natural substance.

Note 1: A partial agonist activates a receptor but does not cause as much of a physiological change as does a full agonist.

Note 2: A co-agonist works together with other co-agonists to produce a desired effect.

air pollution Presence of substances in the atmosphere resulting either from human activity or natural processes, in sufficient concentration, for a sufficient time and under circumstances such as to interfere with comfort, *health*, or welfare of persons or to harm the environment.

air pollution control system
1 Network of organizations that monitor air pollution.
2. Group of measures or processes used to minimize or prevent air pollution.

albuminuria Presence of albumin, derived from *plasma*, in the urine.

algicide algaecide Substance intended to kill algae.

aliquot (in analytical chemistry) Known amount of a homogeneous material, assumed to be taken with negligible *sampling error*.

Note 1: The term is usually applied to fluids.

Note 2: The term "aliquot" is usually used when the fractional part is an exact divisor of the whole; the term "aliquant" has been used when the fractional part is not an exact divisor of the whole (e.g., a 15-mL portion is an aliquant of 100 mL).

Note 3: When an aliquot is taken of a laboratory sample or test sample or the sample is otherwise subdivided, the samples have been called split samples.

[2]

alkalosis Antonym: *acidosis* Pathological condition in which the hydrogen(1+) (hydron) substance concentration of body fluids is below normal and hence the pH of blood rises above the reference interval.

alkylating agent Substance that introduces an alkyl substituent into a compound.

allele One of several alternate forms of a *gene* that occur at the same relative position (locus) on homologous *chromosomes* and which become separated during *meiosis* and can be recombined following fusion of *gametes*.

allergen Immunostimulant antigenic substance that may or may not cause a clinically significant effect but which is capable of producing immediate *hypersensitivity*.

allergy Symptoms or signs occurring in sensitized individuals following *exposure* to a previously encountered substance (*allergen*) which would otherwise not cause such *symptom*s or *sign*s in non-sensitized individuals. The most common forms of allergy are *rhinitis*, *urticaria*, *asthma*, and *contact dermatitis*.

allometric

1. Pertaining to a systematic relationship between growth rates of different parts of an organism and its overall growth rate.

[2]

2. Pertaining to a systematic relationship between size, shape, and metabolism in different species.

allometric growth Regular and systematic pattern of growth such that the mass or size of any organ or part of a body can be expressed in relation to the total mass or size of the entire organism according to the *allometric* equation:

$$Y = bx^{\alpha}$$

where Y = mass of the organ, x = mass of the organism, α = growth coefficient of the organ, and b is a constant.

[2]

allometric scaling

1. Adjustment of data to allow for change in proportion between an organ or organs and other body parts during the growth of an organism.
2. Adjustment of data to allow for differences and make comparisons between species having dissimilar characteristics (e.g., in size, shape, and metabolism).

After [2]

allometry (in biology) Measurement of the rate of growth of a part or parts of an organism relative to the growth of the whole organism.

[2]

allomone *Semiochemical* that is produced by an organism inducing a response in an organism of another species that is favorable to the emitter.

See *kairomone*, *synomone*.

all-or-none effect See *quantal effect*.

alopecia Baldness; absence or thinning of hair from areas of skin where it is usually present.

alveol/us (pulmonary), -i pl., -ar adj. Terminal air sac of the lung where gas exchange occurs.

ambient Surrounding (applied to environmental media such as air, water, sediment, or soil).

ambient monitoring Continuous or repeated measurement of agents in the environment to evaluate ambient *exposure* and *health risk* by comparison with appropriate reference values based on knowledge of the probable relationship between exposure and resultant *adverse* health *effects*.

ambient standard See *environmental quality standard*.

Ames test In vitro test for *mutagenicity* using mutant strains of the bacterium *Salmonella typhimurium* which cannot grow in a given histidine-deficient medium: *mutagen*s can cause reverse *mutation*s which enable the bacterium to grow on the medium. The test can be carried out in the presence of a given microsomal fraction (S-9) from rat liver (see *microsome*) to allow metabolic transformation of mutagen precursors to active derivatives.

amnesic shellfish poisoning (ASP) Serious illness that is a consequence of consumption of bivalve shellfish (mollusks) such as mussels, oysters, and clams that have ingested, by filter feeding, large quantities of microalgae containing domoic acid; acute symptoms include vomiting, diarrhea, and in some cases, confusion, loss of memory, disorientation, and even coma.

amplification (of genes) See *gene amplification*.

anabolism Antonym: *catabolism* Biochemical processes by which smaller molecules are joined to make larger molecules.

anaemia See *anemia*.

anaerobe Antonym: *aerobe*

Organism that does not require dioxygen for life.

Note: Obligate (strict) anaerobes grow only in the absence of dioxygen. Facultative anaerobes can grow either in the presence or in the absence of dioxygen.

anaerobic Antonym: *aerobic* Not requiring dioxygen.

anaesthetic See *anesthetic*.

analgesic Substance that relieves pain, without causing loss of consciousness.

analogue metabolism Process by which a normally non-biodegradable compound is biodegraded in the presence of a structurally similar compound which can induce the necessary enzymes.

analytic study (in epidemiology) Study designed to examine associations, commonly putative or hypothesized causal relationships.

anaphylactoid Of or resembling *anaphylaxis*.

anaphylaxis Life-threatening type 1 hypersensitivity allergic reaction (see *allergy*) occurring in a person or animal *exposed* to an *antigen* or *hapten* to which they have previously been sensitized.

Note: Consequences of the reaction may include angio-edema, vascular collapse, shock, and respiratory distress.

anaplasia Loss of normal cell differentiation, a feature characteristic of most *malignancies*.

anemia Condition in which there is a reduction in the number of red blood cells or amount of *hemoglobin* per unit volume of blood below the reference interval for a similar individual of the species under consideration, often causing pallor and fatigue.

anesthetic Substance that produces loss of feeling or sensation: general anesthetic produces loss of consciousness; local or regional anesthetic renders a specific area insensible to pain.

aneuploid Cell or organism with missing or extra *chromosome*s or parts of chromosomes and thus an abnormal number of chromosomes which is not an exact multiple of the haploid number.

anoxia Strictly total absence of oxygen but sometimes incorrectly used instead of *hypoxia* to mean a decreased oxygen supply in tissues.

antagonism (in toxicology) Combined effect of two or more factors that is smaller than the solitary effect of any one of those factors.

Note: In *bioassays*, the term may be used when a specified effect is produced by *exposure* to either of two factors but not by exposure to both together.

antagonist (in toxicology) Antonym: *agonist* Substance that binds to a cell *receptor* normally responding to a naturally occurring substance and prevents a response to the natural substance.

anthelmint(h)ic antihelminth helminthagogue helminthic vermifuge

1. n., Substance intended to kill or cause the expulsion of parasitic intestinal worms, such as helminths.
2. adj., Acting to expel or kill parasitic intestinal worms.

anthracosis (coal miners' pneumoconiosis) Form of *pneumoconiosis* caused by accumulation of anthracite carbon deposits in the lungs due to inhalation of smoke or coal dust.

anthropogenic

1. Caused by or influenced by human activities.
2. Describing a conversion factor used to calculate a *dose* or *concentration* affecting a human that has been derived from data obtained with another species (e.g., the rat).

[2]

anti-adrenergic See *sympatholytic*.

antibiotic Substance produced by, and obtained from, certain living cells (especially bacteria, yeasts, and molds), or an equivalent synthetic substance, which is *biostatic* or *biocidal* at low concentrations to some other form of life, especially pathogenic or noxious organisms.

antibody Protein (*immunoglobulin*) produced by the immune system in response to *exposure* to an antigenic molecule and characterized by its specific binding to a site on that molecule (antigenic determinant or *epitope*).

[3]

anticholinergic

1. adj., Preventing transmission of *parasympathetic* (acetylcholine releasing) nerve impulses.
2. n., Substance that prevents transmission of parasympathetic nerve impulses.

anticholinesterase See *cholinesterase inhibitor*.

anticoagulant Substance that prevents blood clotting (e.g., warfarin).

antidote Substance capable of specifically counteracting or reducing the effect of a potentially *toxic* substance in an organism by a relatively specific chemical or pharmacological action.

antigen Substance or a structural part (*epitope*) of a substance that causes the immune system to produce specific *antibody* or specific cells and combines

with specific binding sites (*epitopes*) on the antibody or cells.

antihistamine Substance that blocks or counteracts the action of *histamine*.

antihelminth See *anthelmint(h)ic*.

antimetabolite Substance, structurally similar to a *metabolite*, which competes with it or replaces it, and so prevents or reduces its normal utilization.

antimuscarinic

1. n., Substance inhibiting or preventing the actions of muscarine and muscarine-like agents (e.g., atropine) on the muscarinic acetylcholine *receptors*.
2. adj., Inhibiting or preventing the actions of muscarine and muscarine-like agents on the muscarinic acetylcholine receptors.

antimycotic fungicide Substance used to kill a fungus or to inhibit its growth.

antinicotinic

1. n., Substance inhibiting or preventing the actions of nicotine and nicotine-like agents (e.g., suxamethonium chloride) on the nicotinic acetylcholine *receptors*.
2. adj., Inhibiting or preventing the actions of nicotine and nicotine-like agents on the nicotinic acetylcholine receptors.

antipyretic Substance that relieves or reduces fever.

antiresistant Substance used as an additive to a *pesticide* formulation in order to reduce the resistance of insects to the pesticide (e.g., an antimetabolite that inhibits metabolic inactivation of the pesticide).

antiserum Serum containing *antibodies* to a particular *antigen* either because of immunization or after an infectious disease.

Note: Usually, the antibodies are polyclonal.

antiviral **See** *virucide*.

aphasia Loss or impairment of the power of speech or writing, or of the ability to understand written or spoken language or signs, due to a brain injury or disease.

aphicide Substance intended to kill *aphids*.

aphid Common name for a harmful plant parasite in the family Aphididae, some species of which are vectors of plant virus diseases.

aplasia Lack of development of an organ or tissue, or of the cellular products from an organ or tissue.

apopto/sis n., tic adj. Active process of programmed cell death, requiring metabolic energy, often characterized by fragmentation of *DNA*, and cell deletion without associated *inflammation*.
[2]
See *necrosis*.

arboricide Substance intended to kill trees and shrubs.

area source Widespread origin of *emissions*. Area under the concentration–time curve
See *area under the curve*.

area under the curve (AUC) Area between a curve and the abscissa (horizontal axis), i.e., the area underneath the graph of a function: often, the area under the tissue (*plasma*) *concentration* curve of a substance expressed as a function of time.
[2]

area under the moment curve (AUMC) Area between a curve and the abscissa (horizontal axis) in a plot of (*concentration* $\times$ time) vs. time.
[2]

argyria argyrosis Pathological condition characterized by gray-bluish or black pigmentation of tissues (such as skin, retina, mucous membranes, internal organs) caused by the accumulation of metallic silver, due to reduction of a silver compound which has entered the organism during (prolonged) administration or *exposure*.

arrhythmia Any variation from the normal rhythm of the heartbeat.

arseniasis Chronic arsenical poisoning.

artefact Observation, effect, or result which is inaccurate because it is produced by the methodology used in scientific investigation or by experimental error.

arteriosclerosis Hardening and thickening of the walls of the arteries.
See also *atherosclerosis*.

arthralgia Pain in a joint.

arthritis *Chronic inflammation* of a joint, usually accompanied by pain and often by changes in structure.

arthropathy arthrosis Disease of a joint.

arthrosis Joint or articulation.

asbestosis Form of *pneumoconiosis* caused by inhalation of asbestos fibers.

ascaricide Substance intended to kill roundworms (Ascaridae).

asphyxia Condition resulting from insufficient intake of oxygen: Symptoms include breathing

difficulty, impairment of senses, and, in extreme, convulsions, unconsciousness and death.

asphyxiant Substance that blocks the transport or use of oxygen by living organisms.

Note: Examples include both physical (nitrogen gas) and chemical (carbon monoxide) asphyxiants.

assay
1. n., Process of quantitative or qualitative analysis of a component of a *sample*.
2. n., Results of a quantitative or qualitative analysis of a component of a sample.
3. v., To carry out quantitative or qualitative analysis of a component of a sample.

assimilation Uptake and incorporation of substances by a living organism.

asthenia Weakness; lack or loss of strength.

asthma Chronic respiratory disease characterized by bronchoconstriction, excessive mucus secretion, and *edema* of the pulmonary alveoli, resulting in difficulty in breathing out, wheezing, and cough.

astringent
1. adj., Causing contraction, usually locally after topical application.
2. n., Substance causing cells to shrink, thus causing tissue contraction or stoppage of secretions and discharges; such substances may be applied to skin to harden and protect it.

ataxia Unsteady or irregular manner of walking or movement caused by loss or failure of muscular coordination.

Atherosclerosis Pathological condition in which there is thickening, hardening, and loss of elasticity of the walls of blood vessels, characterized by a variable combination of changes of the innermost layer consisting of local accumulation of lipids, complex carbohydrates, blood and blood components, fibrous tissue, and calcium deposits. In addition, the outer layer becomes thickened and there is fatty degeneration of the middle layer.
See also *arteriosclerosis*.

atrophy Wasting away of the body or of an organ or tissue, involving a decrease in size and (or) numbers of cells.

attenuation (in genetics) Regulation of *gene* expression in bacteria by premature termination of *transcription* of a biosynthetic *operon*.

attractant Substance that attracts animals. Some attractants fulfill natural biological functions such as mating or predation: Others may be used to attract animals for monitoring or for control.
See also *pheromone*.

attributable risk Part of a *risk* that is identified as due to *exposure* to a defined substance.
[2]

autoimmune disease Pathological condition resulting when an organism produces *antibodies* or specific cells which bind to constituents of its own tissues (auto*antigens*) and cause tissue injury: Examples of such disease may include rheumatoid *arthritis*, *myasthenia* gravis, systemic lupus erythematosus, and scleroderma.

autooxidation See *autoxidation*.

autophagosome Membrane-bound body (secondary *lysosome*) in which parts of the cell are digested.

autopsy necropsy Postmortem examination of the organs and body tissue to determine cause of death or pathological condition.

autosome Any *chromosome* other than a sex chromosome.

autoxidation Reaction with dioxygen at moderate temperatures.

autoxidation (in food chemistry) Apparently spontaneous, usually slow reaction of foodstuff components with dioxygen in an *aerobic* environment at moderate temperatures.

auxotroph Organism unable to synthesize an organic molecule which is required for its growth: When the compound is given to the organism with the other nutrients it requires, growth of the organism may occur.

auxotrophy Inability of a microorganism to synthesize a particular organic compound required for its growth.

avicide Substance intended to kill birds.

axenic animal See *germ-free animal*.

azoospermia
1. Absence of live motile spermatozoa in semen.
2. Failure to form live spermatozoa.

back-mutation Process that reverses the effect of a *mutation* which had inactivated a *gene*; thus, it restores the wild phenotype.

bacterial artificial chromosome (BAC) *DNA* vector into which large DNA fragments can be inserted and cloned in a bacterial host.

bactericide Substance intended to kill bacteria.

bagassosis Lung disease caused by the inhalation of dust from sugar-cane residues.

basal lamina, pl. -ae Triple-layered structure on which epithelium sits: It consists of an electron-dense layer (lamina densa) between two electron-transparent layers (lamina lucida). The lamina densa is composed of type IV collagen, and the lamina lucida contains the glycoprotein laminin.

base pairing Linking of the complementary pair of polynucleotide chains of nucleic acids by means of hydrogen bonds between complementary purine and pyrimidine bases, adenine with thymine or uracil, cytosine with guanine.

basement membrane Specialized layers (*basal laminae*) of extra-cellular matrix that separate epithelial tissue from underlying connective tissue: Cancer cells must break through the basement membrane in order to migrate to other parts of the body and form metastases.

Bateman function Equation expressing the build up and decay in *concentration* of a substance (usually in *plasma*) based on first-order *uptake* and *elimination* in a *one-compartment model*, having the form

$$C = [fDk_a/V(k_a - k_e)][\exp(-k_e t) - \exp(-k_a t)]$$

where C is the concentration and D the *dose* of the substance, f the fraction absorbed, and V the *volume of distribution*. k_a and k_e are the first-order *rate constants* of uptake and elimination, respectively, and t is time.
[2]

B-cell See *B lymphocyte*.

benchmark concentration (BMC) Statistically calculated lower 95% confidence limit on the *concentration* that produces a defined *response* (called the *benchmark response* or BMR, usually 5 or 10%) for an *adverse effect* compared to background, often defined as 0 or 5%.
[2]

benchmark dose (BMD) Statistically calculated lower 95% confidence limit on the *dose* that produces a defined *response* (called the *benchmark response* or BMR, usually 5 or 10%) of an *adverse effect* compared to background, often defined as 0 or 5%.
[2]

benchmark guidance value *Biological monitoring* guidance value set at the 90th percentile of available *biological monitoring* results collected from a representative *sample* of workplaces with good occupational hygiene practices.
[2]

benchmark response *Response*, expressed as an excess of background, at which a *benchmark dose* or *benchmark concentration* is set.
[2]

benefit Advantage to or improvement in condition of an individual or a population.

benign Antonym: *malignant*
1. Of a disease, producing no persisting harmful effects.
2. *Tumor* that does not invade other tissues (see *metastasis*), having lost growth control but not positional control.

Note: Such a tumor is not *carcinogenic* but may cause mechanical damage to adjacent tissues.

berylliosis See *beryllium disease*.

beryllium disease berylliosis Serious and usually permanent lung damage resulting from chronic inhalation of beryllium.

bias
1. Deviation of results or inferences from the truth, or processes leading to such deviation.
2. Any trend in the collection, analysis, interpretation, publication, or review of data which can lead to conclusions which are systematically different from the truth.

biased sample Antonym: *random sample* Any *sample* that is not a random sample.

bilirubin Orange–yellow pigment, a breakdown product of heme-containing proteins (hemoglobin, myoglobin, *cytochrome*s), which circulates in the blood *plasma* bound to albumin or as water-soluble glucuronide conjugates, and is excreted in the bile by the liver.

bioaccessibility Potential for a substance to come in contact with a living organism and then interact with it. This may lead to *absorption*.

Note: A substance trapped inside an insoluble particle is not bioaccessible, although substances on the surface of the same particle are accessible and may also be bioavailable. Bioaccessibility, like bioavailability, is a function of both chemical speciation and biological properties. Even surface-bound substances may not be accessible to organisms which require the substances to be in solution.

bioaccessible Able to come in contact with a living organism and interact with it.
See *bioaccessibility*.

bioaccumulation Progressive increase in the amount of a substance in an organism or part of an organism that occurs because the rate of intake exceeds the organism's ability to remove the substance from the body.

Note: Bioaccumulation often correlates with *lipophilicity*.

See also *bioconcentration*, *biomagnification*.

bioaccumulation potential Ability of living organisms to concentrate a substance obtained either directly from the environment or indirectly through its food.

bioactivation Metabolic *conversion* of a *xenobiotic* to a more *toxic* derivative or one which has more of an effect on living organisms.

bioassay Procedure for estimating the *concentration* or biological activity of a substance by measuring its effect on a living system compared to a standard system.

bioavailability (general) biological availability physiological availability Extent of *absorption* of a substance by a living organism compared to a standard system.

[2]

bioavailability (in toxico- or pharmacokinetics) Ratio of the *systemic exposure* from extravascular (ev) exposure to that following intravenous (iv) *exposure* as described by the equation:

$$F = A_{ev}\ D_{iv}/B_{iv}\ D_{ev}$$

where F (fraction of *dose* absorbed) is a measure of the bioavailability, A and B are the *areas under the* (plasma) *concentration–time curve* following extravascular and intravenous administration, respectively, and D_{ev} and D_{iv} are the administered extravascular and intravenous *doses*.

[2]

bioavailable Able to be absorbed by living organisms.

See *bioavailability*.

biochemical mechanism Reaction or series of reactions, usually enzyme-catalyzed, associated with a specific physiological event in a living organism.

biochemical (biological) oxygen demand (BOD) Amount *concentration* of oxygen taken up through the respiratory activity of microorganisms growing on organic compounds present when incubated at a specified temperature (usually 20 °C) for a fixed period (usually 5 days). It is regarded as a measure of that organic *pollution* of water which can be degraded biologically but includes the oxidation of inorganic material such as sulfide and iron(II). The empirical test used in the laboratory to determine BOD also measures the oxygen used to oxidize reduced forms of nitrogen unless their oxidation is prevented by an inhibitor such as allyl thiourea.

biocid/e n., -al adj. Substance intended to kill living organisms.

bioconcentration Process leading to a higher *concentration* of a substance in an organism than in environmental media to which it is *exposed*.

See *bioaccumulation*.

bioconcentration factor (BCF) Measure of the tendency for a substance in water to accumulate in organisms, especially fish.

Note 1: The equilibrium *concentration* of a substance in fish can be estimated by multiplying its concentration in the surrounding water by its *bioconcentration factor* in fish.

Note 2: This parameter is an important determinant for human intake of aquatic food by the ingestion route.

bioconjugate See *conjugate*.

bioconversion See *biotransformation*.

biodegradation Breakdown of a substance catalyzed by enzymes in vitro or in vivo. This may be characterized for purposes of *hazard* assessment as:

1. Primary. Alteration of the chemical structure of a substance resulting in loss of a specific property of that substance.
2. Environmentally acceptable. Biodegradation to such an extent as to remove undesirable properties of the compound. This often corresponds to primary biodegradation, but it depends on the circumstances under which the products are discharged into the environment.
3. Ultimate. Complete breakdown of a compound to either fully oxidized or reduced simple molecules (such as carbon dioxide/methane, nitrate/ammonium, and water). It should be noted that the products of biodegradation can be more harmful than the substance degraded.

bioelimination Removal, usually from the aqueous phase, of a test substance in the presence of living organisms by biological processes supplemented by physicochemical reactions.

bioequivalen/ce n., -t adj. Relationship between two preparations of the same *drug* in the same dosage form that have a similar bioavailability.

bioinactivation Metabolic *conversion* of a *xenobiotic* to a less *toxic* derivative.

[2]

bioinformatics Discipline encompassing the development and utilization of computational facilities to store, analyze, and interpret biological data.

biokinetics (in toxicology) Science of the movements involved in the *distribution* of substances.
[2]

biological absorption See *absorption, biological*.

biological accessibility See *bioaccessibility*.

biological acclimatization See *acclimatization, biological*.

biological assessment of exposure See *biological monitoring*.

biological availability See *bioavailability*.

biological cycle Complete circulatory process through which a substance passes in the *biosphere*. It may involve transport through the various media (air, water, soil), followed by *environmental transformation*, and carriage through various *ecosystems*.

biological effect monitoring (BEM) Continuous or repeated measurement of early biological effects of *exposure* to a substance to evaluate ambient *exposure* and *health risk* by comparison with appropriate reference values based on knowledge of the probable relationship between ambient exposure and biological effects.

biological exposure indices (BEI) Guidance values recommended by ACGIH for assessing *biological monitoring* results.
[5]

biological half life For a substance, the time required for the amount of that substance in a biological system to be reduced to one-half of its value by biological processes, when the rate of removal is approximately exponential.
[2]

biological half time, $t_{1/2}$ See *biological half life*.

biological indicator Species or group of species that is representative and typical for a specific status of an *ecosystem*, which appears frequently enough to serve for monitoring and whose population shows a sensitive response to changes (e.g., the appearance of a toxicant in an ecosystem).
[6]

biological marker See *biomarker*.

biological monitoring biological assessment of exposure

biomonitoring Continuous or repeated measurement of any naturally occurring or synthetic chemical, including potentially *toxic substances* or their *metabolites* or biochemical effects in tissues, secreta, excreta, expired air, or any combination of these in order to evaluate occupational or environmental *exposure* and *health risk* by comparison with appropriate reference values based on knowledge of the probable relationship between ambient exposure and resultant *adverse* health *effects*.

biological oxygen demand See *biochemical oxygen demand*.

biological preparation biological biopreparation
Compound derived from living organisms and their products for use in medicine or as a *pesticide*, etc.

biological specimen
1. Organ, tissue (including blood), secretion, or excretion product taken from an organism as a *sample* reflecting the state of the whole organism.
2. Organism taken as a sample reflecting the state of a population or their environment.

biological warfare Military operations using any organism (bacteria, virus, or other disease-causing organism) or *toxin* found in nature, to kill, injure, or incapacitate human beings, animals, or plants.

biomagnification ecological magnification Sequence of processes in an ecosystem by which higher *concentration*s are attained in organisms at higher trophic levels (at higher levels in the food web); at its simplest, a process leading to a higher concentration of a substance in an organism than in its food.

biomarker Indicator signaling an event or condition in a biological system or *sample* and giving a measure of *exposure*, effect, or susceptibility.

Note: Such an indicator may be a measurable chemical, biochemical, physiological, behavioral, or other alteration within an organism.

[2]

biomarker of effect effect biomarker
Biomarker that, depending upon the magnitude, can be recognized as associated with an established or possible *health* impairment or disease.
[2]

biomarker of exposure exposure biomarker
Biomarker that relates *exposure* to a *xenobiotic* to the levels of the substance or its *metabolite*, or of the product of an interaction between the substance and some *target* molecule or cell that can be measured in a *compartment* within an organism.
[2]

biomarker of susceptibility susceptibility biomarker
Biomarker of an inherent or acquired ability of an organism to respond to *exposure* to a specific substance.
[2]

biomass
1. Total amount of biotic material, usually expressed per unit surface area or volume, in a medium such as water.
2. Material produced by the growth of microorganisms, plants, or animals.

biomineralization Complete conversion of organic substances to inorganic derivatives by living organisms, especially microorganisms.

biomolecule Substance that is synthesized by and occurs naturally in living organisms.

biomonitoring See *biological monitoring*.

biopesticide Biological agent with pesticidal activity, for example, the bacterium *Bacillus thuringiensis* when used to kill insects.
After [6]

biopsy Excision of a small piece of living tissue for microscopic or biochemical examination; usually performed to establish a diagnosis.

biosphere Portion of the planet earth that supports and includes life.

biostatic Adjective applied to a substance that arrests the growth or multiplication of living organisms.

biota All living organisms as a totality.

biotransformation bioconversion *Chemical conversion* of a substance that is mediated by living organisms or *enzyme* preparations derived therefrom.

2,3-bis(sulfanyl)propan-1-ol British anti-Lewisite dimercaprol 2,3-dimercaptopropan-1-ol Metal chelator that has been used in the treatment of arsenic, antimony, gold, mercury, and lead poisoning.

blastocyst Mammalian *embryo* at the stage at which it is implanted into the wall of the uterus.
[9]

blood–brain barrier Physiological interface between brain tissues and circulating blood created by a mechanism that alters the permeability of brain capillaries, so that some substances are prevented from entering brain tissue, while other substances are allowed to enter freely.
After [2]

blood–placenta barrier Physiological interface between maternal and fetal blood circulations that filters out some substances which could harm the fetus while favoring the passage of others such as nutrients: Many fat-soluble substances such as alcohol are not filtered out, and several types of virus can also cross this barrier.

Note: The effectiveness of the interface as a barrier varies with species and different forms of placentation.

blood plasma See *plasma (in biology)*.

blood substitution See *exchange transfusion*.

blood–testis barrier Physiological interface between the blood supply and the spermatozoa of the seminiferous tubules.

Note: This interface consists of specific junctional complexes between Sertoli cells.
After [2]

B lymphocyte B cell Type of *lymphocyte* that synthesizes and secretes *antibodies* in response to the presence of a foreign substance or one identified by it as foreign. The protective effect can be mediated to a certain extent by the antibody alone (contrast *T lymphocyte*).

body burden Total amount of a substance present in an organism at a given time.

bolus
1. Single *dose* of a substance, originally a large pill.
2. Dose of a substance administered by a single rapid intravenous injection.
3. Concentrated mass of food ready to be swallowed.

botanical pesticide Substance with activity against pests, that is produced naturally within a plant and may act as a defense against predators.

botulism Acute food poisoning caused by botulinum toxin produced in food by the bacterium *Clostridium botulinum* and characterized by muscle weakness and paralysis; disturbances of vision, swallowing, and speech; and a high mortality rate.

brady- Antonym: *tachy-* Prefix meaning slow as in bradycardia or bradypnoea

bradycardia Antonym: *tachycardia* Abnormal slowness of the heartbeat.

bradypnoea Antonym: *tachypnoea* Abnormally slow breathing.

breathing zone Space within a radius of 0.5 m from a person's face.

British anti-Lewisite (BAL) See *2,3-bis(sulfanyl) propan-1-ol*.

bronchoconstriction Antonym: *bronchodilation* Narrowing of the air passages through the bronchi of the lungs.

bronchodilation Antonym: *bronchoconstriction* Expansion of the air passages through the bronchi of the lungs.

bronchospasm Intermittent violent contraction of the air passages of the lungs.

builder (in chemistry) Material that enhances or maintains the cleaning efficiency of a surfactant, in a detergent, principally by inactivating water hardness; complex phosphates (especially sodium tripolyphosphate, i.e., pentasodium triphosphate), sodium carbonate, and sodium silicate are the builders most commonly used.

byssinosis *Pneumoconiosis* caused by inhalation of dust and associated microbial contaminants and observed in cotton, flax, and hemp workers.

bystander exposure Liability of members of the general public to come in contact with substances arising from operations or processes carried out by other individuals in their vicinity.

cacosmia Imagined perception of vile odors, including coprosmia (smelling feces) and necrosmia (the smell of death).

calcification Form of mineralization in which organic tissue becomes hardened by deposition of calcium salts within its substance.

calibration Operation that, under specified conditions, in a first step establishes a relation between the quantity values with measurement *uncertainties* provided by measurement *standards* and corresponding *indications* with associated measurement uncertainties and, in a second step, uses this information to establish a relation for obtaining a measurement result from an indication.

[7]

calibration material See *reference material*.

cancer *Disease* resulting from the development of a *malignant tumor*.

carbonylhemoglobin carboxyhemoglobin Compound that is formed between carbon monoxide and *hemoglobin* in the blood of animals and humans and is incapable of transporting oxygen.

carboxyhemoglobin See *carbonylhemoglobin*. **carcinogen** n., **-ic** adj. Agent (chemical, physical, or biological) that is capable of increasing the *incidence* of malignant *neoplasms*, thus causing *cancer*.

Note: Annex 3 describes the classification systems for carcinogens.

carcinogen/esis n., -etic adj. Induction, by chemical, physical, or biological agents, of *malignant neoplasm*s and thus *cancer*.

carcinogenicity Process of induction of *malignant neoplasm*s, and thus *cancer*, by chemical, physical, or biological agents.

carcinogenicity test Long-term (*chronic*) test designed to detect any possible carcinogenic effect of a test substance.

carcinoma epithelioma *Malignant tumor* of an epithelial cell.

cardiotoxic Chemically harmful to the cells of the heart.

carrier

1. Substance in appreciable amount which, when associated with a trace of a specified substance, will carry the trace with it through a chemical or physical process.
2. Person who is heterozygous (e.g., carries only one *allele*) for a recessive genetic character leading to *disease*, and hence does not, under most circumstances, display the disease *phenotype* but can pass it on to the next generation.

[2]

3. Gas, liquid, or solid substance (often in particulate form) used to absorb, adsorb, dilute, or suspend a substance to facilitate its transfer from one medium to another.

carrier-linked prodrug carrier prodrug Compound that contains a temporary linkage between a given active substance and a transient *carrier* group, the latter producing improved physicochemical or *pharmacokinetic* properties and easily removable in vivo.

[2]

carrier protein

1. Protein to which a specific *ligand* or *hapten* is *conjugated*.
2. Unlabeled protein introduced into an assay at relatively high *concentration*s that distributes in a *fractionation* process in the same manner as labeled protein analyte, present in very low concentrations.
3. Protein added to prevent nonspecific interaction of reagents with surfaces, *sample* components, and each other.
4. Protein found in cell membranes that facilitates transport of a *ligand* across the membrane.

[2]

carrier substance Substance that binds to another substance and transfers it from one site to another.

[2]

carry-over

1. Transfer in farming and agricultural processing of a component from one system such as soil or feed to another system such as a plant, animal, or human being: Carry-over is expressed as the *concentration* of the component in the second system divided by its concentration in the first.

2. Process in analytical studies by which materials are carried into a reaction mixture in which they do not belong.
3. Persistence of a substance in soil (e.g., a *pesticide*), such that injury may occur subsequently to a new crop.
4. Persistence of a test substance in participants undergoing a cross-over clinical trial study, in which each participant randomly receives the placebo and test substance with an intervening washout period.

case cohort study Variant of the *case control study* in which the controls are drawn from the same cohort as the cases but are identified before the cases develop; some of the controls may later become cases.

case control study Study that starts with the identification of persons with the disease (or other outcome variable) of interest, and a suitable control (comparison, reference) group of persons without the *disease*. The relationship of an attribute to the disease is examined by comparing the diseased and nondiseased with regard to how frequently the attribute is present or, if quantitative, the levels of the attribute, in the two groups.

catabolism Antonym: *anabolism*

1. Reactions involving the oxidation of organic substrates to provide chemically available energy (e. g., ATP) and to generate metabolic intermediates.
2. Generally, process of breakdown of complex molecules into simpler ones, often providing biologically available energy.

catatonia Behavior marked by excessive and sometimes violent motor acivity and excitement, or by generalized inhibition or stupor, that may occur in schizophrenia, mood disorders, or organic brain syndromes.

cathartic See *laxative*.

ceiling value (CV) Airborne *concentration* of a potentially *toxic substance* that should never be exceeded in a worker's breathing zone.

cell cycle Regulated biochemical steps that cells go through involving *DNA* replication and cell division, usually depicted as a sequential cyclical series of events.

cell line Defined unique population of cells obtained by culture from a primary source through numerous generations.
See also *transformed cell line*.

cell-mediated hypersensitivity State in which an individual reacts with allergic effects caused by the reaction of *antigen*-specific *T-lymphocytes* following *exposure* to a certain substance (*allergen*) after having been *exposed* previously to the same substance or chemical group.

cell-mediated immunity Immune response mediated by *antigen*-specific *T-lymphocytes*.

cell proliferation Rapid increase in cell number.

cell strain Cells having specific properties or markers derived from a primary culture or *cell line*.

censored data *Sample* observations for which the complete distribution is not known: for example, a cohort study in which some persons cannot be followed to the predetermined end of the study ('right-censored data') or environmental assay data in which some results are less than the sample detection limit ('left-censored data').

certified reference material (CRM) *Reference material*, accompanied by documentation issued by an authoritative body and referring to valid procedures used to obtain a specified property value with *uncertainty* and *traceability*.

Example: Human serum with assigned quantity value for the concentration of cholesterol and associated measurement *uncertainty* stated in an accompanying certificate, used as *calibrator* or measurement *trueness* control material.

[7]

chain of custody Sequence of responsibility for a substance from the manufacturer to the distributor, to the user, or to the person(s) ultimately responsible for *waste* disposal. This term is also used in controlled transmission of *sample*s from collection to analysis, especially of samples of materials used for medico-legal or forensic purposes.

chelation therapy Treatment with a chelating agent to enhance the *elimination* or reduce the *toxicity* of a metal ion.

chemesthesis Sensations that arise when chemical compounds activate *receptor* mechanisms for other effectors, such as light, pain, pressure, and heat, in the eye, skin, nose, mouth, and throat; for example, the burning feeling from chili pepper, the cooling from the menthol in mouthwash, and the stinging feeling of carbonation.

chemical etiologic agent See *toxic substance*.

chemical conversion Change from one chemical species to another.

[2]

chemical etiologic agent See *toxic substance*.

chemical oxygen demand (COD) Measure of the amount of oxygen, divided by the volume of the system, required to oxidize the organic (and inorganic) matter in wastewater using a chemically oxidizing agent. In practice, it is usually expressed in milligrams O_2 per liter.

chemical safety Practical certainty that there will be no *exposure* of organisms to toxic amounts of any substance or group of substances: This implies attaining an acceptably low *risk* of exposure to potentially toxic substances.

chemical species (of an element) Specific form of an element defined as to isotopic composition, electronic or oxidation state, and (or) complex or molecular structure.
[2]

chemical warfare Military operations using the toxic properties of chemical agents to kill, injure, or incapacitate human beings, animals, or plants.

chemophobia Irrational fear of chemicals.

chemosis Chemically induced swelling around the eye caused by *edema* of the conjunctiva.

chemosterilizer Substance used to sterilize mites, insects, rodents, or other animals.

chloracne Acne-like eruption caused by *exposure* to certain chlorinated organic substances such as polychlorinated biphenyls or 2,3,7,8-tetrachlorodibenzo-*p*-dioxin [2,3,7,8-tetrachlorooxanthrene] and other polychlorinated dibenzo dioxins and furans.

cholinomimetic See *parasympathomimetic*.

cholinesterase inhibitor Substance that inhibits the action of acetylcholinesterase (EC 3.1.1.7) and related enzymes which catalyze the hydrolysis of choline esters: Such a substance causes hyperactivity in *parasympathetic* nerves.

Note: Examples include organophosphate and carbamate *pesticides*.

chromatid Either of two filaments joined at the centromere into which a *chromosome* divides as it duplicates itself during cell division.

chromatin Stainable complex of *DNA* and proteins present in the nucleus of a *eukaryotic* cell.

chromosomal aberration Abnormality of *chromosome* number or structure.

chromosome Self-replicating structure consisting of *DNA* complexed with various proteins and involved in the storage and transmission of genetic information; the physical structure that contains the *gene*s.

chronic Antonym: *acute* Long-term (in relation to *exposure* or effect).
1. In experimental toxicology, chronic refers to mammalian studies lasting considerably more than 90 days or to studies occupying a large part of the lifetime of an organism.
2. In clinical medicine, long-established or long-lasting.

[2]

chronic effect long-term effect Antonym: *acute effect* Consequence that develops slowly and (or) has a long-lasting course; may be applied to an effect which develops rapidly and is long-lasting.
[2]

chronic exposure long-term exposure Antonym: *acute exposure* Continued *exposure* or exposures occurring over an extended period of time, or a significant fraction of the test species, or of the group of individuals, or of the population's life-time.

chronic toxicity long-term toxicity Antonym: *acute toxicity*
1. Adverse effects following chronic exposure.
2. Effects that persist over a long period of time whether or not they occur immediately upon *exposure* or are delayed.

chronic toxicity test long-term toxicity test Antonym: *acute toxicity test* Study in which organisms are observed during the greater part of the life span and in which *exposure* to the test agent takes place over the whole observation time or a substantial part thereof.

chronotoxicology Study of the influence of biological rhythms on the *toxicity* of substances or of the influence of a toxicant on biological rhythms.

ciguateratoxin poisoning Serious illness caused by eating carnivorous fish such as snappers and barracuda that have become contaminated by *toxins* produced by the microalga, *Gambierdiscus toxicus*; gastrointestinal symptoms may accompany a wide variety of neurological symptoms, including *ataxia*, *vertigo*, flaccid paralysis, respiratory arrest, and reversed perception of hot and cold; the neurological symptoms may persist for many years.

circadian nychthemeral Relating to or exhibiting an approximately 24-h periodicity.

circulation of substances in the environment Movement of *xenobiotic* substances in the environment with air flow, river current, sediment flow, etc.

cirrhosis
1. Liver disease defined by histological examination and characterized by increased fibrous tissue,

abnormal morphological and physiological changes such as loss of functional liver cells, and increased resistance to blood flow through the liver (portal *hypertension*).
2. Chronic interstitial *inflammation* and *fibrosis* of an organ.

cirrhotic Describing an organ showing *cirrhosis*.

clastogen Agent causing *chromosome* breakage and (or) consequent gain, loss, or rearrangement of pieces of chromosomes.

clastogenesis Formation (or generation) of chromosomal breaks and (or) consequent gain, loss, or rearrangement of pieces of *chromosome*s.

clearance (general) $(c_o/c_i)(\Delta V/\Delta t)$ Product of the *concentration* c_o of a component in an output system and the volume flow rate of the output system divided by the concentration c_i of this component in the input system.

Note: The term 'mean volume rate' is recommended for this quantity.

[2]

clearance (in physiology and toxicology)
1. Volume of blood or *plasma* or mass of an organ effectively cleared of a substance by *elimination* (*metabolism* and *excretion*) divided by time of elimination.

   Note: Total clearance is the sum of the clearances of each eliminating organ or tissue for that component.
2. (in *pulmonary toxicology*) Volume or mass of lung cleared divided by time of *elimination*; used qualitatively to describe removal of any inhaled substance which deposits on the lining surface of the lung.
3. (in *renal* toxicology) Quantification of the removal of a substance by the kidneys by the processes of filtration and secretion; clearance is calculated by relating the rate of renal excretion to the *plasma concentration*.

[2]

cleavage (of a molecule) Splitting of a molecule into smaller molecular entities.

clinical toxicology Scientific study involving research, education, prevention, and treatment of diseases caused by substances such as drugs and toxins.

Note: Often refers specifically to the application of toxicological principles to the treatment of human poisoning.

clon/e n., **-al** adj.
1. Population of genetically identical cells or organisms having a common ancestor.
2. To produce such a population.
3. *Recombinant DNA* molecules all carrying the same inserted sequence.

clonic Pertaining to alternate muscular contraction and relaxation in rapid succession.

cloning vector Small circle of *DNA* (e.g., a plasmid) or modified bacteriophage (bacterial virus) that can carry a segment of foreign DNA into an appropriate host organism (e.g., a bacterial, yeast, or mammalian cell).

After [9]

cluster sampling
1. A method of sampling in which the population is divided into aggregates (or clusters) of items bound together in a certain manner. A *sample* of these clusters is taken at random, and all the items which constitute them are included in the sample.
2. A sampling method in which each unit selected is a group of persons (all persons in a city block, a family, etc.) rather than an individual.

coagonist See *agonist*.

cocarcinogen Chemical, physical, or biological factor that intensifies the effect of a *carcinogen*.

Codex Alimentarius Collection of internationally adopted food standards drawn up by the Codex Alimentarius Commission, the principal body implementing the joint FAO/WHO Food Standards Program.

cohort Component of the population born during a particular period and identified by period of birth so that its characteristics (such as causes of death and numbers still living) can be ascertained as it enters successive time and age periods. The term "cohort" has broadened to describe any designated group of persons followed or traced over a period of time, as in the term *cohort study* (*prospective study*).

cohort analysis Tabulation and analysis of *morbidity* or *mortality* rates in relationship to the ages of a specific group of people (cohort), identified by their birth period, and followed as they pass through different ages during part or all of their life span. In certain circumstances such as studies of migrant populations, cohort analysis may be performed according to duration of residence in a country rather than year of birth, in order to relate *health* or mortality experience to duration of *exposure*.

cohort study concurrent study follow-up study incidence study longitudinal study prospective study *Analytic study* in *epidemiology* in which subsets of a

defined population can be identified who are, have been, or in the future may be *exposed* or not exposed, or exposed in different degrees, to a factor or factors hypothesized to influence the probability of occurrence of a given disease or other outcome. The main feature of the method is observation of a large population for a prolonged period (years), with comparison of *incidence rates* of the given disease in groups that differ in *exposure* levels.

combined effect of poisons Simultaneous or successive effect of two or more *poison*s on the organism by the same route of *exposure*.

cometabolism Process by which a normally nonbiodegradable substance is biodegraded only in the presence of an additional carbon source.
See also *metabolism*.

comet assay Means of measuring *DNA* damage, particularly DNA strand breaks. A cell is embedded in agar and exposed to a DNA-damaging agent. The cell is then permeabilized with a detergent, and an electric field is applied. If the cell's genomic DNA has been broken into small fragments, these fragments move out of the cell by electrophoresis and form a streak or "tail" leading away from the cell which looks like a comet.

comparison group See *control group*.

comparative genomics Study of the relationship of *genome* structure and function across different biological species.
After [9]

comparative risk See *relative excess risk*.

compartment Conceptualized part of the body (organs, tissues, cells, or fluids) considered as an independent system for purposes of modeling and assessment of *distribution* and *clearance* of a substance.
[2]

compartmental analysis Mathematical process leading to a model of transport of a substance in terms of *compartments* and rate constants, usually taking the form $C = Ae^{-at} + Be^{-bt} \ldots$ where each exponential term represents one compartment. C is the substance *concentration*; A, B, … are proportionality constants; α, β, … are rate constants; and t is time.
[2]

compartmentalize Separate into *compartments*.

compensation pseudo-adaptation Adaptation of an organism to changing conditions of the environment (especially chemical) is accompanied by the emergence of stresses in biochemical systems which exceed the limits of normal (*homeostatic*) mechanisms. Compensation is a temporary concealed pathology which later on can be manifested in the form of explicit pathological changes (decompensation).

competent authority In the context of European Community Council Directive 79/831/EEC, the Sixth Amendment to the European Community Council Directive 67/548/EEC relating to the Classification, Packaging and Labeling of Dangerous Substances, official government organization or group receiving and evaluating notifications of new substances.

competent bacteria Culture of bacteria (or yeast) treated in such a way that their ability to take up *DNA* molecules without transduction or conjugation has been enhanced.

complementary DNA (cDNA) *DNA* generated from an expressed m*RNA* through a process known as reverse transcription.
[9]

complete mineralization Complete breakdown of a complex organic compound to carbon dioxide, water, oxides, and oxidative inorganic products such as nitrate or sulfate.

comprehensive effect of poisons Simultaneous or successive effect made on an organism by *poisons* entering from different media, air, water, or food or through the skin.

computational toxicology Application of mathematical and computer models to predict *adverse effects* and to better understand the mechanism(s) through which a given chemical causes harm.

concentration
1. Any one of a group of three quantities characterizing the composition of a mixture and defined as one of mass, amount of substance (chemical amossunt), or number divided by volume, giving, respectively, mass, amount (of substance), or number concentration.
2. Short form for amount (of substance) concentration (substance concentration in clinical chemistry).

[2]

concentration–effect curve exposure–effect curve
Graph of the relation between *exposure concentration* and the magnitude of the resultant biological change.

concentration–effect relationship exposure–effect relationship Association between *exposure concentration* and the resultant magnitude of the continuously graded change produced, either in an individual or in a population.

concentration–response curve exposure–response curve Graph of the relation between *exposure concentration* and the proportion of individuals in a population responding with a defined effect.
[2]

concentration–response relationship exposure–response relationship Association between *exposure concentration* and the *incidence* of a defined effect in an exposed population.

concord/ance n., **-ant** adj. Pairs or groups of individuals of identical *phenotype*.

Note: In twin studies, this is a condition in which both twins exhibit or fail to exhibit a trait under investigation.

concurrent study See *cohort study*.

concurrent validity Measurement and its criterion refer to the same point in time: An example would be a visual inspection of a wound for evidence of infection validated against bacteriological examination of a specimen taken at the same time.

confounding (in data analysis)
1. Situation in which the effects of two processes are not distinguishable from one another: The distortion of the apparent effect of an *exposure* on *risk* brought about by the association of other factors which can influence the outcome.
2. Relationship between the effects of two or more causal factors as observed in a set of data, such that it is not logically possible to separate the contribution which any single causal factor has made to an effect.
3. Situation in which a measure of the effect of an exposure on risk is distorted because of the association of exposure with other factor(s) which influence the outcome under study.

confounding variable confounder Changing factor that can cause or prevent the outcome of interest, is not an intermediate variable, and is associated with the factor under investigation.

congener One of two or more substances related to each other by origin, structure, or function.
[2]

congenital Trait, condition, or disorder that exists in an organism from birth.
After [9]

conjugate (in biochemistry)
1. Chemical species produced in living organisms by covalently linking two chemical moieties from different sources.

Example: A conjugate of a *xenobiotic* with some group such as glutathione, sulfate, or glucuronic acid, to make it soluble in water or *compartmentalized* within the cell.

See also *phase II reaction*.

2. Material produced by attaching two or more substances together, for example, a *conjugate* of an antibody with a fluorochrome, or an enzyme.

[2]

conjunctiva Mucous membrane that covers the eyeball and lines the under-surface of the eyelid.

conjunctivitis *Inflammation* of the *conjunctiva*.

conservative assessment of risk Assessment of *risk* that assumes the worst possible case scenario and therefore gives the highest possible value for risk: Risk management decisions based on this value will maximize safety.

construct validity Extent to which a measurement corresponds to theoretical concepts (constructs) concerning the phenomenon under study; for example, if on theoretical grounds, the phenomenon should change with age, a measurement with construct validity would reflect such a change.

contact dermatitis Inflammatory condition of the skin resulting from dermal *exposure* to an *allergen* (sensitizer) or an irritating (corrosive, defatting) substance.

contact poison
1. Chemical that injures the target organism through physical contact and skin absorption rather than through ingestion or inhalation.

[10]

2. *Pesticide (herbicide)* that causes injury to only the plant tissue to which it is applied or which is not appreciably translocated within plants.

[11]

containment Process by which possible release, discharge, or spill of a *toxic* substance during normal use or after an accident is prevented by appropriate action.

contaminant
1. Minor impurity present in a substance.
2. Extraneous material inadvertently added to a *sample* prior to or during chemical or biological analysis.
3. In some contexts, as in relation to gas cleaning equipment, used as a synonym for '*pollutant*', especially on a small scale.
4. Unintended component in food that may pose a *hazard* to the consumer.

content validity Extent to which the measurement incorporates the domain of the phenomenon under study; for example, a measurement of functional *health* status should embrace activities of daily living, occupational, family, and social functioning, etc.

contraindication Antonym: *indication* Any condition that renders some particular line of treatment improper or undesirable.

control group comparison group Selected subjects of study, identified as a rule before a study is done, which comprises humans, animals, or other species who do not have the disease, intervention, procedure, or whatever is being studied, but in all other respects are as nearly identical to the test group as possible.

control, matched Control (individual or group or case) selected to be similar to a study individual or group, or case, in specific characteristics: some commonly used matching variables are age, sex, race, and socioeconomic status.

convection (as applied to air and water motion) Predominantly vertical motion of air or of water, induced by the expansion of the air or of water heated by the earth's surface, or by human activity, and its resulting buoyancy.
[2]

conversion See *chemical conversion*, *biotransformation*.

core grade Quality rating, based on standard evaluation criteria established by the U.S. Office of Pesticide Programs regulatory agencies, given to toxicological studies after submission by registrants.

corrosive
1. adj., Causing a surface-destructive effect on contact; in *toxicology*, this normally means causing visible destruction of the skin, eyes, or the lining of the respiratory tract or the gastrointestinal tract.
2. n., Substance that causes a surface-destructive effect on contact.

count mean diameter Mean of the diameters of all particles in a population.
See also *mass mean diameter*.

count median diameter Calculated diameter in a population of particles in a gas or liquid phase above which there are as many particles with larger diameters as there are particles below it with smaller diameters.
[2]
See also *mass median diameter*.

crackles See *crepitations*.

crepitations crackles râles Abnormal respiratory sounds heard on auscultation of the chest, produced by passage of air through passages which contain secretion or exudate or which are constricted by spasm or a thickening of their walls.
See also *rhonchi*.

Note: Auscultation is the process of listening for sounds within the body by ear unassisted or using a stethoscope.

criteri/on (pl. -a) Validated set of data used as a basis for judgment.

criterion validity Extent to which the measurement correlates with an external criterion of the phenomenon under study.

critical concentration (for a cell or an organ) *Concentration* of a substance at and above which adverse functional changes, reversible or irreversible, occur in a cell or an organ.
[2]

critical dose *Dose* of a substance at and above which adverse functional changes, reversible or irreversible, occur in a cell or an organ.
[2]

critical effect For *deterministic effects*, the first *adverse effect* that appears when the *threshold* (*critical*) *concentration* or dose is reached in the *critical organ*: Adverse effects with no defined threshold concentration are regarded as critical.
[2]

critical end-point *Toxic* effect used by the USEPA as the basis for a *reference dose*.

critical group Part of a *target* population most in need of protection because it is most *susceptible* to a given *toxicant*.

critical organ (in toxicology) Organ that first attains the *critical concentration* of a substance and exhibits the *critical effect* under specified circumstances of *exposure* and for a given population.
After [2]

critical organ concentration (of a substance) Mean *concentration* of a substance in the *critical organ* at the time the substance reaches its *critical concentration* in the most sensitive type of cell in the organ.
[2]

critical period (of development) Stage of development of an organism (e.g., organogenesis in the fetus) that is of particular importance in the life cycle if the normal full development of some anatomical, physiological, metabolic, or psychological structure or function is to be attained.

critical study pivotal study Investigation yielding the *no-observed-adverse-effect-level* that is used by the USEPA as the basis of the *reference dose*.

cross-product ratio See *odds ratio*.

cross-sectional study (of disease *prevalence* and associations) disease frequency survey prevalence study Study that examines the relationship between diseases (or other *health*-related characteristics) and other variables of interest as they exist in a defined population at one particular time.

Note: Disease *prevalence* rather than *incidence* is normally recorded in a cross-sectional study and the temporal sequence of cause and effect cannot necessarily be determined.

cumulative death rate Proportion of a defined group that dies within the specified time period (e.g., month, year).

Note: It may refer to all deaths or to deaths from a specific cause or *specific* causes.

cumulative effect Overall change that occurs after repeated *doses* of a substance or radiation.
[2]

cumulative incidence incidence proportion Number or proportion of individuals in a group who experience the onset of a *health*-related event during a specified time interval.

Note: This interval is generally the same for all members of the group, but, as in lifetime *incidence*, it may vary from person to person without reference to age.

cumulative incidence rate Proportion of the *cumulative incidence* to the total population.
[2]

cumulative incidence ratio Value obtained by dividing the *cumulative incidence rate* in the *exposed* population by the cumulative incidence rate in the unexposed population.

cumulative median lethal dose Estimate of the total administered amount of a substance that is associated with the death of half a population of animals when the substance is administered repeatedly in doses which are generally fractions of the *median lethal dose*.

cumulative risk

1. Probability of a common harmful effect associated with concurrent *exposure* by all relevant pathways and routes of exposure to a group of substances that share a common chemical mechanism of toxicity.
2. Total probability of a harmful effect over time.

cutaneous dermal Pertaining to the skin.

cyanogenic Describing any compound able to produce cyanide.

Note: An example is amygdalin, found in peach and apricot stones.

cyanosis Bluish coloration, especially of the skin and mucous membranes and fingernail beds, caused by abnormally large amounts of reduced *hemoglobin* in the blood vessels as a result of deficient oxygenation.

cyanotoxin *Toxin* produced by Cyanobacteria, sometimes called blue–green algae.

Note: Examples are microcystin and cylindrospermin.

cyclooxygenase specific inhibitors Substances, such as aspirin and ibuprofen, that block the activity of cyclooxygenase (COX), an *enzyme* that is responsible for the formation of prostanoids (including prostaglandins, prostacyclin, and thromboxane); inhibition of COX can provide relief from *inflammation* and pain.

cytochromes *Conjugated* proteins containing heme as the *prosthetic group* and associated with electron transport and with redox processes.
[2]

cytochrome P420 Inactive derivative of cytochrome P450 found in microsomal (see *microsome*) preparations.

cytochrome P448 Obsolete term for *cytochrome P450* I, A1, and A2, one of the major families of the cytochromes P450 hemoproteins.

Note: During the monooxygenation of certain substances, often a *detoxification* process, these iso-enzymes may produce intermediates which can initiate *mutations*, *cancer*, *immunotoxic* reactions, and *adverse effects*.

cytochrome P450 (CYP) Member of a superfamily of heme-containing monooxygenases involved in *xenobiotic metabolism*, cholesterol biosynthesis, and steroidogenesis, in eukaryotic organisms found mainly in the *endoplasmic reticulum* and inner mitochondrial membrane of cells. "P450" refers to the observation that a solution of this enzyme exposed to carbon monoxide strongly absorbs light at a wavelength of 450 nm compared with the unexposed solution (a difference spectrum caused by a thiolate in the axial position of the heme opposite to the carbon monoxide ligand).
After [2]

cytogenetics Branch of genetics that correlates the structure and number of *chromosome*s as seen in isolated cells with variation in *genotype* and *phenotype*.

cytokine Any of a group of soluble proteins that are released by a cell causing a change in function or development of the same cell (autocrine), an adjacent cell (paracrine), or a distant cell (endocrine). Cytokines are involved in reproduction, growth, and development; normal homeostatic regulation; response to injury and repair; blood clotting; and host resistance (immunity and tolerance).

cytoplasm Fundamental substance or matrix of the cell (within the *plasma* membrane) which surrounds the nucleus, *endoplasmic reticulum*, *mitochondria*, and other *organelles*.

cytotoxic Causing damage to cell structure or function.

death rate Estimate of the proportion of a population that dies during a specified period. The numerator is the number of persons dying during the period; the denominator is the size of the population, usually estimated as the mid-year population. The death rate in a population is generally calculated by the formula: 10^n (number of deaths during a specified period)/(number of persons at *risk* of dying during the period) where n is usually either 3 or 5 giving rates per 1000 or per 100 000 people in the population studied.

Note 1: This rate is an estimate of the person-time death rate, the death rate per 10^n person-years: usually $n = 3$. If the rate is low, it is also a good estimate of the *cumulative death rate*.

Note 2: This term is sometimes described as the crude death rate.

decipol Unit of perceived air quality: air on mountains or the sea has a decipol = 0.01; city air with moderate air pollution has a decipol = 0.05–0.03; acceptable indoor air quality has decipol = 1.4 (for 80 % satisfaction).

decompensation Explicit pathophysiological changes following compensation for *adverse effects*.

decontamination Process of rendering harmless (by neutralization, *elimination*, removal, etc.) a potentially *toxic* substance in the natural environment, laboratory areas, the workplace, other indoor areas, clothes, food, water, sewage, etc.

defoliant Substance used for removal of leaves by its *toxic* action on living plants.

dehydrogenase *Enzyme* that catalyzes oxidation of compounds by removing hydrogen.

delayed effect latent effect Consequence occurring after a *latent period* following the end of *exposure* to a *toxic* substance or other harmful environmental factor.

***de minimis* risk** See *risk de minimis*.

denaturation

1. Addition of methanol, acetone, or other suitable chemical(s) to alcohol to make it unfit for drinking.
2. Change in molecular structure of proteins so that they cannot function normally, often caused by splitting of hydrogen bonds following *exposure* to reactive substances or heat.

denitrification Reduction of nitrates to nitrites, nitrogen oxides, or dinitrogen (N_2) catalyzed by facultative *aerobic* soil bacteria under *anaerobic* conditions.

dental fluorosis Tooth enamel malformations due to excessive fluoride *exposure* during dental development.

deoxyribonucleic acid (DNA) Constituent of *chromosome*s that stores the hereditary information of an organism in the form of a sequence of purine and pyrimidine bases: this information relates to the synthesis of proteins, and hence it is a determinant of all physical and functional activities of the cell, and consequently of the whole organism.

deoxyribonucleic acid (DNA) **cloning** Replication of *DNA* sequences ligated into a suitable *vector* in an appropriate host organism.
See *deoxyribonucleic acid*.
[9]

deoxyribonucleic acid (DNA) **repair** Restoration of the molecular structure of *DNA* after it has been damaged by a chemical or physical agent: This may involve direct DNA damage reversal, base excision repair, nucleotide excision repair, mismatch repair, or double-strand break repair.

deoxyribonucleic acid (DNA) **sequencing**
Determining the order of base pairs in a *DNA* molecule.
See *deoxyribonucleic acid*.
After [9]

dependence

1. A psychic craving for a *drug* or other substance that may or may not be accompanied by a physical dependency.
2. Reliance on a drug or other substance to maintain *health*.

depilatory Substance causing loss of hair.

deposition
1. Process by which a substance arrives at a particular organ or tissue site, for example, the deposition of particles on the ciliated epithelium of the bronchial airways.
2. Process by which a substance sediments out of the atmosphere or water and settles in a certain place.

dermal cutaneous Pertaining to the skin.

dermal irritation Skin reaction resulting from a single or multiple *exposure* to a physical or chemical entity at the same site, characterized by the presence of *inflammation*; it may result in cell death.

dermatitis *Inflammation* of the skin: contact dermatitis is due to local *exposure* and may be caused by irritation, allergy, or infection.

descriptive epidemiology Study of the occurrence of disease or other *health*-related characteristics in populations, including general observations concerning the relationship of disease to basic characteristics such as age, sex, race, occupation, and social class; it may also be concerned with geographic location. The major characteristics in descriptive epidemiology can be classified under the headings: individuals, time, and place.

desensitization Suppression of sensitivity of an organism to an allergen to which the organism has been *exposed* previously.

desiccant
1. Drying agent.
2. In agriculture, a substance used for drying up plants and facilitating their mechanical harvesting.

desorption Decrease in the amount of adsorbed substance; opposite of *adsorption*.

desquamation Shedding of an outer layer of skin in scales or shreds.

deterministic Term applied to *health* effects, the severity of which varies with the dose and for which a *threshold* is believed to exist.

deterministic effect deterministic process Phenomenon committed to a particular outcome determined by fundamental physical principles.
See also *stochastic effect*.
[2]

detoxification detoxication
1. Process, or processes, of chemical modification that make a *toxic* molecule less toxic.
2. Treatment of patients suffering from poisoning in such a way as to promote physiological processes which reduce the probability or severity of *adverse effects*.

detriment Estimated measure of the expected harm or loss associated with an *adverse event*, usually in a manner chosen to facilitate meaningful addition over different events. It is generally the integrated product of arbitrary values of *risk* and *hazard* and is often expressed in terms such as costs in U.S. dollars, loss in expected years of life or loss in productivity, and is needed for numerical exercises such as cost–benefit analysis.

developmental toxicity *Adverse effect*s on the developing organism (including structural abnormality, altered growth, or functional deficiency or death) resulting from *exposure* through conception, gestation (including organogenesis), and postnatally up to the time of sexual maturation.

diaphoresis Profuse perspiration.

diaphoretic sudorific Substance that causes sweating.

diarrheal shellfish poisoning (DSP)**, diarrhetic shellfish poisoning** (DSP) Serious illness that is a consequence of consumption of bivalve shellfish (mollusks) such as mussels, oysters, and clams that have ingested, by filter feeding, large quantities of microalgae containing a group of high-molecular-weight polyethers such as okadaic acid, dinophysis toxins, pectenotoxins, and yessotoxin; *gastroenteritis* develops shortly after ingestion and generally lasts 1–2 days.

diffusion Spontaneous differential movement of components in a system.

Note: In molecular terms, the driving force for diffusion is random thermal motion. In thermodynamic terms, the driving force is a gradient of chemical potential.

[2]

diffusion coefficient, D Proportionality constant D, relating the *flux* (flux density) of amount of entities B, $J_{n,\mathrm{B}}$, to their *concentration* gradient

$$J_n = -D \operatorname{grad} c_{\mathrm{B}}$$

After [2]

dimercaprol 2,3-dimercaptopropan-1-ol See *2,3-bis (sulfanyl)propan-1-ol*.

diploid *Chromosome* state in which the chromosomes are present in homologous pairs.

Note: Normal human somatic (nonreproductive) cells are diploid (they have 46 chromosomes), whereas reproductive cells, with 23 chromosomes, are haploid.

discharge See *emission*.

discharge standard discharge release limit effluent standard emission standard Maximum amount of a *pollutant* released from a given source to a specified medium which is acceptable under specified circumstances.

discontinuous effect See *intermittent effect*.

discordance (genetic) Antonym: *concordance*
Any difference in a character between individuals due to genetic differences such as may occur in dizygotic twins, or between matched pairs in a *case cohort study*.

disease Literally, dis-ease, lack of ease; pathological condition that presents a group of symptoms peculiar to it and which establishes the condition as an abnormal entity different from other normal or pathological body states.

discontinuous effect See *intermittent effect*.

dispersion (in environmental chemistry) Dilution of a *pollutant* by spreading in the atmosphere or water due to diffusion or turbulent action.

disposition
1. Natural tendency shown by an individual or group of individuals, including any tendency to acquisition of specific diseases, often due to hereditary factors.
2. Total of the processes of *absorption* of a chemical into the circulatory systems, *distribution* throughout the body, *biotransformation*, and *excretion*.

[2]

dissipation Reduction in the amount of a *pesticide* or other compound that has been applied to plants, soil, etc. (used when it is not clear whether this is by mineralization degradation, binding, or leaching).

distributed source See *area source*.

distribution
1. Apportionment of a solute between two phases. The terms "partition" or "extraction" may also be used in this sense where appropriate.

[2]
2. Dispersal of a substance and its derivatives throughout the natural environment or throughout an organism.

[2]
3. Final location(s) of a substance within an organism after dispersal.

distribution constant See *partition ratio.*

distribution volume Theoretical volume of a body *compartment* throughout which a substance is calculated to be distributed.

[2]

2,3-disulfanyl-1-propanol See *2,3-bis(sulfanyl)propan-1-ol.*

diuresis Excretion of urine, especially in excess.

diuretic micturitic Agent that increases urine production.

DNA See *deoxyribonucleic acid*.

DNA adduct See *adduct.*

DNA amplification See *gene amplification, deoxyribonucleic acid.*

DNA cloning See *deoxyribonucleic acid cloning.*

DNA repair See *deoxyribonucleic acid repair.*

DNA sequencing See *deoxyribonucleic acid sequencing.*

dominant *Allele* that expresses its phenotypic effect when present in either the homozygous or the heterozygous state.
After [9]

dominant half life *Half life* of a fraction of a substance in a specific organ or *compartment* if it defines approximately the overall *clearance* rate for that substance at a specific time point.

[2]

dominant lethal mutation Genetic change occurring in a germ cell that does not cause dysfunction of the gamete but which is lethal to the fertilized egg or developing embryo which develops from it.

Note: Induction of a dominant lethal event after *exposure* to a chemical substance (dominant lethal test) indicates that the substance has affected germinal tissue of the test species.

dosage *Dose* divided by product of mass of organism and time of dose.

Note: Often expressed as mg (kg body weight)$^{-1}$ day^{-1} and may be used as a synonym for dose.

[2]

dose (of a substance) Total amount of a substance administered to, taken up, or absorbed by an organism, organ, or tissue.

[2]

dose (of radiation) Energy or amount of photons absorbed by an irradiated object during a specified *exposure* time divided by area or volume.

[2]

dose–effect Relation between *dose* and the magnitude of a measured biological change.
[2]

dose–effect curve Graph of the relation between *dose* and the magnitude of the biological change produced measured in appropriate units.

dose–effect relationship Association between *dose* and the resulting magnitude of a continuously graded change, either in an individual or in a population.
[2]

dose–response curve Graph of the relation between *dose* and the proportion of individuals in a population responding with a defined biological effect.
[2]

dose–response relationship Association between *dose* and the *incidence* of a defined biological effect in an *exposed* population usually expressed as percentage.
[2]

Draize test Evaluation of materials for their potential to cause dermal or ocular irritation and corrosion following local *exposure*; generally using the rabbit model (almost exclusively the New Zealand White) although other animal species have been used.

drug medicine pharmaceutical Any substance that when absorbed into a living organism may modify one or more of its functions.

Note: The term is generally accepted for a substance taken for a therapeutic purpose, but is also commonly used for abused substances.

duplicate portion sampling method (diet/food) duplicate diet study Study in which test persons consume their ordinary diet but, for each meal, they prepare for subsequent analysis a duplicate portion of all food as prepared, served, and consumed.

duplicate samples Two *sample*s taken under the same or comparable conditions.
See *replicate* sampling.

dysarthria Imperfect articulation of speech due to neuromuscular damage.

dysfunction Abnormal, impaired, or incomplete functioning of an organism, organ, tissue, or cell.

dysplasia Abnormal development of an organ or tissue identified by morphological examination.

dyspnea Difficult or labored breathing: shortness of breath.

ecogenetics Study of the influence of hereditary factors on the effects of *xenobiotics* on individual organisms.

ecology Branch of biology that studies the interactions between living organisms and all factors (including other organisms) in their environment: such interactions encompass environmental factors that determine the distributions of living organisms.

ecosystem Grouping of organisms (microorganisms, plants, animals) interacting together, with, and through their physical and chemical environments, to form a functional entity within a defined environment.

ecotoxicologically relevant concentration (ERC) environmentally relevant concentration (ERC) *Concentration* of a *pesticide* (active ingredient, formulations, and relevant metabolites) that is likely to affect a determinable ecological characteristic of an exposed system.
After [9]

ecotoxicology Study of the *toxic* effects of chemical and physical agents on all living organisms, especially on populations and communities within defined *ecosystems*; it includes transfer pathways of these agents and their interactions with the environment.

ectohormone See *pheromone*.

ectoparasiticide Substance intended to kill parasites living on the exterior of the host.

eczema Acute or chronic skin *inflammation* with *erythema*, papules, vesicles, pustules, scales, crusts, or scabs, alone or in combination, of varied *etiology*.

edema oedema Presence of abnormally large amounts of fluid in intercellular spaces of body tissues.

effect biomarker See *biomarker of effect*.

effective concentration (EC) *Concentration* of a substance that causes a defined magnitude of *response* in a given system.

Note: EC_{50} is the median concentration that causes 50 % of maximal response.

effective dose (ED) *Dose* of a substance that causes a defined magnitude of *response* in a given system.

Note: ED_{50} is the median dose that causes 50% of maximal response.

effluent Fluid, solid, or gas discharged from a given source into the external environment.

element (in molecular biology) Sequence in the promoter region of a *gene* that regulates expression of that *gene* through interaction with a trans-acting factor.

elimination (in toxicology) Disappearance of a substance from an organism or a part thereof, by processes of *metabolism*, *secretion*, or *excretion*.
[2]
See also *clearance*.

elimination half life or half time Period taken for the *plasma concentration* of a substance to decrease by half.

Note: May also be applied to other body compartments such as blood, specific organs, or tissues.

elimination rate Differential with respect to time of the *concentration* or amount of a substance in the body, or a part thereof, resulting from *elimination*.
[2]

eliminator (of a poison) Substance that contributes to the *elimination* of a poison from an organism.

embryo
1. Stage in the developing mammal at which the characteristic organs and organ systems are being formed: for humans, this involves the stages of development from the second to the eighth week postconception (inclusive).
2. In birds, the stage of development from the fertilization of the ovum up to hatching.
3. In plants, the stage of development within the seed.

embryonic period Period from fertilization to the end of major organogenesis.
[8]

embryotoxicity
1. Production by a substance of *toxic* effects in progeny in the first period of pregnancy between conception and the fetal stage.
2. Any *toxic* effect on the conceptus as a result of prenatal *exposure* during the embryonic stages of development: These effects may include malformations and variations, malfunctions, altered growth, prenatal death, and altered postnatal function.

embryotropic effect Change in the *embryo* and the regulation of its development.

emesis Vomiting.

emission discharge effluent release Release of a substance from a source, including discharges to the wider environment.

emission and exposure control Technical and administrative procedures and specifications applied for the monitoring, reduction, or *elimination* of *emissions* from a source or *exposure* to a target.

emission standard Quantitative limit on the *emission* or discharge of a substance from a source, usually expressed in terms of a time-weighted average *concentration* or a *ceiling value*.

endemic Present in a community or among a group of people; said of a disease prevailing continually in a region.

endocon Portion of a conjugated metabolite that is derived from a natural product (such as a sugar, amino acid, or other organic acid) of the metabolizing organism.
See also *exocon*, *phase II reaction*.
After [6]

endocrine Pertaining to *hormones* or to the glands that secrete hormones directly into the bloodstream.

endocrine disrupter endocrine modifier Exogenous chemical that alters function(s) of the endocrine system and consequently causes *adverse* health *effects* in an intact organism, its progeny, or (sub)populations.
[8]

endocrine modifier See *endocrine disrupter*.

endocytosis *Uptake* of material into a cell by invagination of the *plasma* membrane and its internalization in a membrane-bounded vesicle.
[2]
See also *phagocytosis, pinocytosis*.

endogenous Antonym: *exogenous* Produced within or caused by factors within an organism.
[2]

endoplasmic reticulum Intracellular complex of membranes in which proteins and lipids, as well as molecules for export, are synthesized and in which the *biotransformation* reactions of the monooxygenase enzyme systems occur.

Note: May be isolated as *microsomes* following cell fractionation procedures.

endothelial Pertaining to the layer of flat cells lining the inner surface of blood and lymphatic vessels, and the surface lining of serous and synovial membranes.

endothelium Layer of flattened epithelial cells lining the heart, blood vessels, and lymphatic vessels.
[2]

endotoxin *Toxin* that forms an integral part of the cell wall of certain bacteria and is released only upon breakdown of the bacterial cell; endotoxins do not form toxoids.

enteritis Intestinal *inflammation*.

enterohepatic circulation Cyclical process involving intestinal re*absorption* of a substance that has been excreted through the bile, followed by transfer back to the liver, making it available for biliary *excretion* again.

environment Aggregate, at a given moment, of all external conditions and influences to which a system under study is subjected.

environmental damage *Adverse effect*s to the natural environment.

environmental exposure level (EEL) Level (*concentration* or amount or a time integral of either) of a substance to which an organism or other component of the environment is *exposed* in its natural surroundings.

environmental fate Destiny of a chemical or biological *pollutant* after release into the natural environment.

environmental health Human welfare and its influence by the environment, including technical and administrative measures for improving the human environment from a *health* point of view.

environmental health impact assessment Estimate of the *adverse effects* to *health* or *risk*s likely to follow from a proposed or expected environmental change or development.

environmental health criteria documents Critical publications of IPCS containing reviews of methodologies and existing knowledge—expressed, if possible, in quantitative terms—of selected substances (or groups of substances) on identifiable, immediate, and long-term effects on human *health* and welfare.

environmental hygiene environmental sanitation Practical control measures used to improve the basic environmental conditions affecting human *health*, for example, clean water supply, human and animal *waste* disposal, protection of food from biological contamination, and housing conditions, all of which are concerned with the quality of the human environment.

environmental impact assessment (EIA) Appraisal of the possible environmental consequences of a past, ongoing, or planned action, resulting in the production of an environmental impact statement or 'finding of no significant impact (FONSI)'.

environmental impact statement (EIS) Report resulting from an *environmental impact assessment*.

environmental medicine Specialty devoted to the prevention and management of environmentally induced injury, illness, and disability, and the promotion of the health of individuals, families, and communities by ensuring a healthy environment.

environmental monitoring Continuous or repeated measurement of agents in the environment to evaluate environmental *exposure* and possible damage by comparison with appropriate reference values based on knowledge of the probable relationship between ambient exposure and resultant *adverse effect*s.

environmental protection

1. Actions taken to prevent or minimize *adverse effect*s to the natural environment.
2. Complex of measures including monitoring of environmental *pollution*, development and practice of environmental protection principles (legal, technical, and hygienic), including *risk assessment*, *risk management*, and *risk communication*.

environmental quality objective (EQO) Overall state to be aimed for in a particular aspect of the natural environment, for example, 'water in an estuary such that shellfish populations survive in good *health*'.

Note: Unlike an environmental quality standard, the EQO is usually expressed in qualitative and not quantitative terms.

environmental quality standard (EQS) ambient standard Amount *concentration* or mass concentration of a substance that should not be exceeded in an environmental system, often expressed as a *time-weighted average* measurement over a defined period.

environmental risk assessment Estimate of the probability that harm will result from a defined *exposure* to a substance in an environmental medium. The estimate is valid only for a given species and set of conditions.

environmental sanitation See *environmental hygiene.*

environmental tobacco smoke (ETS) See *sidestream smoke*.

environmental transformation Chemical transformation of substances resulting from interactions in the environment.

environmentally relevant concentration See *ecotoxicologically relevant concentration*.

enzootic Present in a community or among a group of animals; said of a disease prevailing continually in a region.

enzyme Biological catalyst: a protein, nucleic acid, or a conjugate of a protein with another compound (co-enzyme).

enzyme induction Process whereby an enzyme is synthesized in response to a specific substance or to other agents such as heat or a metal species.
[2]

epidemiology Study of the distribution and determinants of *health*-related states or events in specified populations and the application of this study to control of health problems.

epigastric Pertaining to the upper-middle region of the abdomen.

epigene/sis n., -tic adj. Phenotypic change in an organism brought about by alteration in the expression of genetic information without any change in the genomic sequence itself.

Note: Common examples include changes in nucleotide base methylation and changes in histone acetylation. Changes of this type may become heritable.

epigenetic See *epigene/sis, -tic*.

epileptiform Occurring in severe or sudden spasms, as in convulsion or epilepsy.

epithelioma Any tumor derived from *epithelium*.

epithelium Sheet of one or more layers of cells covering the internal and external surfaces of the body and hollow organs.
[2]

epitope Any part of a molecule that acts as an antigenic determinant: A macromolecule can contain many different epitopes, each capable of stimulating production of a different specific *antibody*.

equilibrium State of a system in which the defining variables (temperature, pressure, chemical potential) have constant values in time.
[2]

equivalent diameter (of a particle) Diameter of a spherical particle of the same density as a particle under investigation that, relative to a given phenomenon or property, would behave in the same way as the particle under investigation.

erythema Redness of the skin produced by congestion of the capillaries.

eschar Slough or dry scab on an area of skin that has been burnt.

estimated daily intake (EDI) Prediction of the daily *intake* of a residue of a potentially harmful agent based on the most realistic estimation of the residue levels in food and the best available food consumption data for a specific population: Residue levels are estimated taking into account known uses of the agent, the range of contaminated commodities, the proportion of a commodity treated, and the quantity of home-grown or imported commodities.

Note: The EDI is expressed in mg residue per person.

estimated environmental concentration (EEC) Predicted *concentration* of a substance, typically a *pesticide*, within an environmental *compartment* based on estimates of quantities released, discharge patterns, and inherent disposition of the substance (fate and distribution) as well as the nature of the specific receiving *ecosystems*.
See also *expected environmental concentration*.
After [9]

estimated exposure concentration (EEC) Measured or calculated amount or mass *concentration* of a substance to which an organism is likely to be *exposed*, considering *exposure* by all sources and routes.

estimated exposure dose (EED) Measured or calculated *dose* of a substance to which an organism is likely to be *exposed*, considering *exposure* by all sources and routes.

estimated maximum daily intake (EMDI) Prediction of the maximum daily intake of a residue of a potentially harmful agent based on assumptions of average food consumption per person and maximum residues in the edible portion of a commodity, corrected for the reduction or increase in residues resulting from preparation, cooking, or commercial processing.

Note: The EMDI is expressed in mg residue per person.

etiology aetiology
1. Science dealing with the cause or origin of *disease*.
2. In individuals, the cause or origin of disease.

eukaryote Antonym: *prokaryote* Cell or organism with the genetic material packed in a membrane-surrounded structurally discrete nucleus and with well-developed cell organelles.

Note: The term includes all organisms except archaebacteria, eubacteria, and cyanobacteria (until recently classified as cyanophyta or blue–green algae).

European Inventory of Existing Chemical Substances (EINECS) List of all substances supplied either singly or as components in preparations to persons in a Member State of the European Community on any occasion between 1 January 1971 and 18 September 1981.

eutrophic Describes a body of water with a high *concentration* of nutrient salts and a high or excessive rate of biological production.

eutrophication Adverse change in the chemical and biological status of a body of water following depletion of the oxygen content caused by decay of organic matter resulting from high primary production as a result of enhanced input of nutrients.

excess lifetime risk Additional or excess *risk* incurred over the lifetime of an individual by *exposure* to a *toxic* substance.

excess rate See *rate difference*.

exchange transfusion Method of active artificial *elimination* of *toxicity* consisting in complete replacement of blood of the patient by donor blood.

excipient Any largely inert substance added to a *drug* to give suitable consistency or form to the drug.

excitotoxicity Pathological process by which neurons are damaged and killed by the overactivation of *receptors* for the excitatory neurotransmitter glutamate, such as the *N*-methyl-d-aspartic acid (NMDA) receptor and α-amino-3-hydroxy-5-methyl-4-isoxazole propionic acid (AMPA) receptor.

Note: Excitotoxins like NMDA and kainic acid bind to glutamate t receptors, and can cause excitotoxicity by allowing high levels of calcium ions to enter cells, activating enzymes such as phospholipases, endonucleases, and proteases such as calpain which damage cell structures including the cytoskeleton, membranes, and *DNA*.

excretion Discharge or *elimination* of an absorbed or *endogenous* substance, or of a *waste* product, and (or) its *metabolites*, through some tissue of the body and its appearance in urine, feces, or other products normally leaving the body.

Note: Excretion does not include the passing of a substance through the intestines without *absorption*.

[2]
See also *clearance, elimination*.

excretion rate Amount of substance and (or) its *metabolite*s that is excreted divided by time of excretion.

[2]

exocon Portion of a conjugated metabolite that is derived from the parent molecule.

[6]

exogenous Antonym: *endogenous* Resulting from causes or derived from materials external to an organism.

exogenous substance See *xenobiotic*.

exon Coding section of a *gene* that is separated from other coding sequences of the same gene by intervening noncoding sequences.
See *intron*.

exothelium Layer of flattened epithelial cells external to an organ or tissue.

expected environmental concentration (EEC) expected exposure concentration (EEC) Calculated *concentrations* of a substance, typically a *pesticide*, in various environmental compartments based on calculations using maximum-*exposure* scenarios.

Note: EEC models assume a maximum number of applications per growing season at the maximum rate of application according to the application methods stated on the product label.

After [10]

expected exposure concentration (EEC) See *expected environmental concentration*.

experimental model ecosystem See *microcosm*.

explant Living tissue removed from its normal environment and transferred to an artificial medium for growth.

exponential decay Variation of a quantity according to the law

$$A = A_0 e^{-\lambda t}$$

where A and A_0 are the values of the quantity being considered at time t and zero, respectively, and λ is an appropriate constant.

[2]

exposed Antonyms: non-exposed, unexposed
Subject to a factor that is under study in the environment, for instance, an environmental *hazard*.

exposed group (sometimes abbreviated to **exposed**) (in epidemiology) People (or other organisms) who have been *exposed* to a supposed cause of a disease or *health* state of interest, or possess a

characteristic that is a determinant of the health outcome of interest.

exposure

1. *Concentration*, amount, or intensity of a particular physical or chemical agent or environmental agent that reaches the *target population*, organism, organ, tissue, or cell, usually expressed in numerical terms of concentration, duration, and frequency (for chemical agents and microorganisms) or intensity (for physical agents).
2. Process by which a substance becomes available for *absorption* by the target population, organism, organ, tissue, or cell, by any route.
3. For X- or gamma radiation in air, the sum of the electrical charges of all the ions of one sign produced when all electrons liberated by photons in a suitably small element of volume of air completely stopped, divided by the mass of the air in the volume element.

[2]

exposure assessment Process of measuring or estimating *concentration* (or intensity), duration, and frequency of *exposure*s to an agent present in the environment or, if estimating hypothetical exposures, that might arise from the release of a substance, or radionuclide, into the environment.

exposure biomarker See *biomarker of exposure*.

exposure control See *emission and exposure control*.

exposure–effect curve See *concentration–effect curve*.

exposure limit General term defining an administrative substance *concentration* or intensity of *exposure* that should not be exceeded.

exposure ratio In a *case control study*, value obtained by dividing the rate at which persons in the case group are *exposed* to a *risk* factor (or to a protective factor) by the *rate* at which persons in the control group are exposed to the risk factor (or to the protective factor) of interest.

exposure–response relationship See *concentration–response relationship*, *dose–response relationship*.

exposure surface Surface on a *target* where a substance (e.g., a *pesticide*) is present. With mammals, examples of outer *exposure* surfaces include the exterior of an eyeball, the skin surface, and a conceptual surface over the nose and open mouth. Examples of inner exposure surfaces include the gastrointestinal tract, the respiratory tract, and the urinary tract lining.

[12]

exposure test Determination of the level, *concentration*, or *uptake* of a potentially *toxic* compound and (or) its *metabolite*(s) in biological *sample*s from an organism (blood, urine, hair, etc.) and the interpretation of the results to estimate the absorbed *dose* or degree of environmental *pollution*; or the measuring of biochemical effects, usually not direct *adverse effect*s of the substance, and relating them to the quantity of substance absorbed, or to its concentration in the environment.

expressed sequence tag (EST) Partial or full complementary *DNA* sequence that can serve as a marker for a region of the *genome* which encodes an expressed product.

[9]

expression (in genetics) Conversion of the genetic information encoded in *DNA* into a final gene product (either a protein or any of the different types of RNA).

Note: Because changes in *RNA* synthesis are often estimated by measuring mRNA levels, the term 'gene expression' is often misleadingly used as synonymous with transcription. The term 'gene expression' includes transcription, processing, and splicing of mRNA, as well as translation, and post-translational modification of the protein product.

external validity Generalizability of the results of a particular study, beyond the limits of the population actually studied.

extracellular space Volume within a tissue, outside cells, and excluding vascular and lymphatic space.

[2]

extracellular volume Volume of fluid outside the cells but within the outer surface of an organism.

[2]

extraction ratio Amount of substance extracted from a source divided by the total contained within the source.

[2]

extra risk Probability that an agent produces an observed *response*, as distinguished from the probability that the response is caused by a spontaneous event unrelated to the agent.

extraneous residue limit (ERL) Refers to a *pesticide* residue or contaminant arising from environmental sources (including former agricultural uses) other than the use of a pesticide or contaminant substance directly or indirectly on the commodity. It is the maximum *concentration* of a pesticide residue or contaminant that is recommended by the *Codex Alimentarius Commission* to be legally permitted or recognized as acceptable in or on food, agricultural commodity, or animal feed.

Note: The mass content is expressed in milligrams of pesticide residue or contaminant per kilogram of commodity.

extrapolation Calculation, based on quantitative observations in *exposed* test species or in vitro test systems, of predicted *dose–effect* and *dose–response relationships* for a substance in humans and other biota including interspecies extrapolations and extrapolation to susceptible groups of individuals.

Note: The term may also be used for qualitative information applied to species or conditions that are different from the ones in which the original investigations were carried out.

extrapyramidal movement disorders Involuntary movement disorders mediated by signaling through neurons outside the pyramidal (corticospinal) tract, often describing side effects of psychiatric medications.

fecundity

1. Ability to produce offspring frequently and in large numbers.
2. In demography, the physiological ability to reproduce.
3. Ability to produce offspring within a given period of time.

[8]

feromone ectohormone pheromone Substance used in olfactory communication between organisms of the same species eliciting a change in sexual or social behavior.

fertility Ability to conceive and to produce offspring: For litter-bearing species, the number of offspring per litter is used as a measure of fertility.

Note: Reduced fertility is sometimes referred to as subfertility.

fertility toxicant Produces abnormalities of male or female reproductive functions or impairs reproductive capacity.

fertilizer Substance applied to soil or hydroponic systems for improving the root nutrition of plants with the aim of increasing crop yields and (or) controlling production.

fetal period See *fetus*.

fetotoxicity *Toxicity* to the *fetus*.

fetus (often incorrectly foetus) Young mammal within the uterus of the mother from the visible completion of characteristic organogenesis until birth.

Note: In humans, this period is usually defined as from the third month after fertilization until birth (prior to this, the young mammal is referred to as an embryo).

fibrosis Abnormal formation of fibrous tissue.

fiducial limit Form of confidence limit given as a stated probability, for example, $P = 0.95$.

Note: In toxicology, the terms 'fiducial limits' and 'confidence limits' are generally considered to be synonymous.

finding of no significant impact (FONSI) Statement prepared and issued to the public when the results of an environmental impact assessment identify no harmful effects of concern.

See *environmental impact assessment*.

first-order chemical reaction first-order reaction

1. Chemical reaction where the initial rate is directly proportional to the *concentration* of one of the reactants.

[2]

2. Any process in which a variable decreases with time at a constant fractional amount.

[2]

first-pass effect *Biotransformation* and, in some cases, *elimination* of a substance in the liver after *absorption* from the intestine and before it reaches the *systemic* circulation.

[2]

first-pass metabolism See *first-pass effect*.

fixed dose procedure Acute *toxicity* test in which a substance is tested initially at a small number (3 or 4) predefined *dose*s to identify which produces evident toxicity without lethality: The test may be repeated at one or more higher or lower defined discriminating doses to satisfy the criteria.

fluoridosis See *fluorosis*.

fluorosis fluoridosis

*Adverse effect*s of fluoride, as in dental or skeletal fluorosis.

flux (of a quantity) Flow rate of an entity through a cross-section perpendicular to the flow divided by the cross-sectional area.

foci (singular focus) in neoplasia Small groups of cells distinguishable, in appearance or histochemically, from the surrounding tissue: indicative of an early stage of a lesion that may lead to the formation of a neoplastic nodule.

foetus See *fetus*.

follow-up study See *cohort study*.

food additive Any substance, not normally consumed as a food by itself and not normally used as a typical ingredient of a given food, whether or not it has nutritive value, that is added intentionally to food for a technological (including organoleptic) purpose in the manufacture, processing, preparation, treatment, packing, packaging, transport, or holding of the food. Addition results, or may be reasonably expected to result (directly or indirectly), in the substance or its byproducts becoming a component of, or otherwise affecting, the characteristics of the food to which it is added.

Note: The term does not include 'contaminants' or substances added to food for maintaining or improving nutritional qualities.

food allergy *Hypersensitivity* reaction to substances in the diet to which an individual has previously been sensitized.

food chain Sequence of transfer of matter and energy in the form of food from organism to organism in ascending or descending *trophic levels*.

food intolerance Physiologically based reproducible, unpleasant (adverse) reaction to a specific food or food ingredient that is not immunologically based.

food web Network of *food chains*.

forced diuresis Method of stimulating diuresis based on performing hydrational therapy, sometimes with parallel introduction of diuretics, with the aim of achieving increased clearance of a *toxic* substance in urine.

foreign substance See *xenobiotic*.

founder effect Changes in allelic frequencies that occur when a small group is separated from a large population and establishes a colony in a new location.
[9]

fractionation Process of classification of an analyte or a group of analytes from a *sample* according to physical (e.g., size, solubility) or chemical (e.g., bonding, reactivity) properties.
[2]

frame-shift mutation Point *mutation* involving either the deletion or insertion of one or two nucleotides in a *gene*: By the frame shift mutation, the normal reading frame used when decoding nucleotide triplets in the gene is altered.

fumigant Substance that is vaporized in order to kill or repel pests.

functional genomics Development and implementation of technologies to characterize the mechanisms through which *gene*s and their products function and interact with each other and with the environment.
[9]

fungicide Substance intended to kill fungi.

fungus preparation Substance obtained from fungi that has an insecticidal effect reflecting the pathogenicity of the fungi for insects.

gamete Reproductive cell (either sperm or egg) containing a haploid set of *chromosome*s.

gametocide Substance intended to kill *gametes*.

gastroenteritis *Inflammation* of the stomach and intestine.

gastrointestinal Pertaining to or communicating with the stomach and intestine.

gavage Administration of materials directly into the stomach by esophageal intubation.

gene Length of *DNA* or *RNA* (in viruses) that encodes a functional product, which may be a polypeptide or a ribonucleic acid.

Note: A gene is the fundamental unit of heredity.
After [9]

gene amplification Occurrence of extra copies of a *gene*; with respect to a plasmid, an increase in the number of plasmid copies per cell, which may be induced by a specific treatment.

Note: Spontaneous gene amplification frequently occurs in tumor cells.

gene expression Transcriptional activation of a *gene* so that its functional product is produced.

gene therapy Introduction of genetic material into an individual, or the modification of the individual's genetic material, in order to achieve a therapeutic or prophylactic objective.
After [9]

genetic epidemiology Study of the correlations between phenotypic trends and genetic variation across population groups and the application of the results of such a study to control of health problems.

gene map Map showing the positions in the *genome* of *gene*s or other genetic markers, either relative to each other or as a physical map of absolute distances.

generally regarded as safe (GRAS) Phrase used to describe the USFDA philosophy that justifies approval of food additives that may not meet the usual test criteria for *safety* but have been used

extensively and have not demonstrated that they cause any harm to consumers.

genetically modified organism (GMO) Bacterium, plant, or animal whose *DNA* has been deliberately altered.

genetic polymorphism Existence of inter-individual differences in *DNA* sequences coding for one specific *gene*, giving rise to different functional and (or) morphological traits.
After [2]

genetic susceptibility Predisposition to a particular *disease* or sensitivity to a substance due to the presence of a specific allele or combination of *alleles* in an individual's *genome*.
After [9]

genetic toxicology Study of chemically or physically induced changes to the structure of *DNA*, including *epigenetic* phenomena or *mutations* that may or may not be heritable.

genome Complete set of chromosomal and extrachromosomal *genes* of an organism, a cell, an organelle, or a virus, i.e., the complete *DNA* component of an organism (or the complete *RNA* component of an RNA virus).

Note: This includes both the DNA present in the chromosomes and that in subcellular organelles (e.g., mitochondria or chloroplasts).

[2]

genomics

1. Science of using *DNA*- and *RNA*-based technologies to demonstrate alterations in *gene* expression.
2. (in toxicology) Method providing information on the consequences for gene expression of interactions of the organism with environmental stress, *xenobiotics*, etc.

[2]

genotoxic Capable of causing a change to the structure of the *genome*.

genotype Genetic constitution of an organism as revealed by genetic or molecular analysis; the complete set of *gene*s possessed by a particular organism, cell, organelle, or virus.

germ-free animal axenic animal Animal grown under sterile conditions in the period of postnatal development: Such animals are usually obtained by cesarean operation and kept in special sterile boxes in which there are no viable microorganisms (sterile air, food, and water are supplied).

germ-line cell Cell with a haploid *chromosome* content.

Note: In animals, the germ-line cells are the sperm or egg (synonym *gamete*); in plants, the pollen cell or the ovum.

After [9]

germinal aplasia Complete failure of gonad development.

germ warfare See *biological warfare*.

glomerular Pertaining to a tuft or cluster, as of a plexus of capillary blood vessels or nerve fibers, especially referring to the capillaries of the glomerular of the kidney.

glomerulus Tuft or a cluster, as of a plexus of capillary blood vessels or nerve fibers (e.g., capillaries of the filtration apparatus of the kidney).

glomerular filtration Formation of an ultrafiltrate of the blood occurring in the *glomerulus* of the kidney.
[2]

glomerular filtration rate Volume of ultrafiltrate formed in the kidney tubules from the blood passing through the glomerular capillaries divided by time of filtration.
[2]

glue-sniffing Inhalation of solvent vapor from plastic cements or other adhesives in order to become intoxicated.
See also *solvent abuse*.

glycobiology See *glycomics*.

glycome Description of the complete set of carbohydrates and their functions in a living organism.

glycomics glycobiology Global study of the structure and function of carbohydrates, especially oligosaccharides (short chains of sugars) in a living organism.

gnotobiont See *gnotobiote*.

gnotobiota Specifically and entirely known microfauna and microflora of a specially reared laboratory animal.

gnotobiot/e n., **-ic** adj. gnotobiont Specially reared laboratory animal whose microflora and microfauna are specifically known in their entirety.

goiter Noncancerous enlargement of the thyroid gland, visible as a swelling at the front of the neck, that is often associated with iodine deficiency.

goitrogen Any substance (such as thiouracil) that induces the formation of a goiter.

gonadotropic Pertaining to effects on sex glands and on the systems that regulate them.

good agricultural practice (GAP) in the use of pesticides Nationally authorized safe uses of *pesticides* under actual conditions necessary for effective and reliable pest control.

Note: It encompasses a range of levels of pesticide applications up to the highest authorized use, applied in a manner that leaves a residue which is the smallest amount practicable. Authorized safe uses include nationally registered or recommended uses, that take into account public and occupational *health* and environmental safety considerations. Actual conditions include any stage in the production, storage, transport, distribution, and processing of food commodities and animal feed.

good laboratory practice (GLP) principles Fundamental rules incorporated in OECD guidelines and national regulations concerned with the process of effective organization and the conditions under which laboratory studies are properly planned, performed, monitored, recorded, and reported.

good manufacturing practice (GMP) principles Fundamental rules incorporated in national regulations concerned with the process of effective organization of production and ensuring standards of defined quality at all stages of production, distribution, and marketing.

Note: Minimization of *waste* and its proper disposal are part of this process.

graded effect Antonyms: *all-or-none effect*, *quantal effect*, *stochastic effect* Consequence that can be measured on a graded scale of intensity or severity and its magnitude related directly to the *dose* or *concentration* of the substance producing it.

graminicide *Pesticide (herbicide)* used for the control of weedy grasses (*Gramineae*).
[6]

granuloma Granular growth or *tumor*, usually of lymphoid and epithelial cells.

ground treatment of plants Dusting or spraying of plants with *pesticides* by hand, by special machines, or by apparatus fixed to tractors or driven by them.

guideline for exposure limits Scientifically judged quantitative value (a *concentration* or number) of an environmental constituent that ensures aesthetically pleasing air, water, or food and from which no *adverse effect* is expected concerning noncarcinogenic endpoints, or that gives an acceptably low estimate of lifetime *cancer risk* from those substances which are proven human *carcinogens* or carcinogens with at least limited evidence of human *carcinogenicity*.

guideline value Quantitative measure (a *concentration* or a number) of a constituent of an environmental medium that ensures aesthetically pleasing air, water, or food and does not result in a significant *risk* to the user.

guides to air quality Sets of atmospheric *concentration*s and *exposure* times that are associated with specific effects of varying degrees of *pollution* on humans, animals, vegetation, and the environment in general.

guides to environmental quality Sets of *concentration*s, numbers and *exposure* times that are associated with the specific effects of factors in environmental media on humans, animals, vegetation, and the environment in general.

guinea-pig maximization test Magnusson and Kligman test Widely used skin test for screening possible contact *allergens*: considered to be a useful method to identify likely moderate and strong *sensitizers* in humans.

haem See *heme*.

half life, $t_{1/2}$ half time Time required for the *concentration* of a reactant in a given reaction to reach a value that is the arithmetic mean of its initial and final (equilibrium) values. For a reactant that is entirely consumed, it is the time taken for the reactant concentration to fall to one-half of its initial value.

Note: The half life of a reaction has meaning only in special cases:

1. For a first-order reaction, the half life of the reactant may be called the half life of the reaction.
2 For a reaction involving more than one reactant, with the *concentration*s of the reactants in their stoichiometric ratios, the half life of each reactant is the same, and may be called the half life of the reaction. If the concentrations of reactants are not in their stoichiometric ratios, there are different half lives for different reactants, and one cannot speak of the half life of the reaction.

See also *biological half life*, *elimination half life*.
[2]

half time, $t_{1/2}$ See *half life*.

haploid monoploid State in which a cell contains only one set of *chromosome*s.

haplotype
1. Contraction of the phrase "haploid genotype", the genetic constitution of an individual with respect to one member of a pair of allelic *genes*: Haplotype can refer to only one locus or to an entire genome (a *genome*-wide haplotype would comprise half of a diploid genome, including one allele from each allelic gene pair).
2. Set of *single nucleotide polymorphisms* found to be statistically associated on a single chromatid.

hapten Low-molecular-mass *species* which is not itself antigenic unless complexed with a carrier, such as a protein. Once bound, it presents an *epitope* that can cause the *sensitization* of *lymphocytes*.
After [1]

harm adverse effect Damage or *adverse effect* to a population, species, individual organism, organ, tissue, or cell.

harmful occupational factor Component of the work environment, the effect of which on a worker under certain conditions leads to ill *health* or reduction of working ability.

harmful substance noxious substance Substance that, following contact with an organism, can cause ill *health* or *adverse effect*s either at the time of *exposure* or later in the life of the present and future generations.

hazard Set of inherent properties of a substance, mixture of substances, or a process involving substances that, under production, usage, or disposal conditions, make it capable of causing *adverse effect*s to organisms or the environment, depending on the degree of *exposure*; in other words, it is a source of danger.
See also *risk.*

hazard assessment Determination of factors controlling the likely effects of a *hazard* such as the *dose–effect* and *dose–response relationships*, variations in *target* susceptibility, and mechanism of *toxicity*.

hazard communication standard U.S. OSHA standard requiring all employers to inform employees of the *hazard* of substances in the workplace and the steps necessary to avoid harm.

hazard evaluation Establishment of a qualitative or quantitative relationship between *hazard* and benefit, involving the complex process of determining the significance of the identified hazard and balancing this against identifiable benefit.

Note: This may subsequently be developed into a *risk* evaluation.

hazard identification Determination of substances of concern, their *adverse effect*s, *target* populations, and conditions of *exposure*, taking into account *toxicity* data and knowledge of effects on human *health*, other organisms, and their environment.

hazard index (HI) Sum of the *hazard* quotients for substances that affect the same target organ or organ system.

Note: Ideally, hazard quotients should be combined for pollutants that cause *adverse effects* by the same mechanism. Aggregate exposures below a hazard index of 1.0 were unlikely to result in adverse health effects over a lifetime of *exposure*. A hazard index greater than 1.0 does not necessarily suggest a likelihood of adverse effects. The hazard index cannot be translated to a probability that adverse effects will occur, and is not likely to be proportional to risk.

hazard quotient (HQ) Ratio of *toxicant exposure* (estimated or measured) to a reference value regarded as corresponding to a threshold of *toxicity*.

Note: If the *hazard* quotient exceeds unity, the toxicant may produce an *adverse effect*, but normally this will require a hazard quotient of several times unity; a hazard quotient of less than 1.0 indicates that no adverse effects are likely over a lifetime of exposure.

hazardous production factor hazard at work hazardous occupational factor Production factor the effect of which on a worker under certain conditions results in injury or some impairment of *health*.

health
1. State of complete physical, mental, and social well-being, and not merely the absence of *disease* or infirmity.
2. State of dynamic balance in which an individual's or a group's capacity to cope with the circumstances of living is at an optimal level.
3. State characterized by anatomical, physiological, and psychological integrity; ability to perform personally valued family, work, and community roles; ability to deal with physical, biological, psychological, and social stress; a feeling of well-being; and freedom from the *risk* of disease and untimely death.
4. In ecology, a sustainable steady state in which humans and other living organisms can coexist indefinitely.

health advisory level (HAL) In the United States, nonregulatory health-based reference level of chemical traces (usually in ppm, i.e., mg L^{-1}) in drinking water at which there are no adverse health *risks* when ingested over various periods of time.

Note: Such levels are established for 1 day, 10 days, long-term and life-time *exposure* periods. They allow for a wide margin of safety.

health-based exposure limit Maximum *concentration* or intensity of *exposure* that can be tolerated without significant effect (based on only scientific and not economic evidence concerning exposure levels and associated *health* effects).

health hazard Any factor or *exposure* that may adversely affect *health*.

health surveillance Periodic medico-physiological examinations of *exposed* workers with the objective of protecting *health* and preventing occupationally related disease.

healthy worker effect Epidemiological phenomenon observed initially in studies of occupational *diseases*: Workers usually exhibit lower overall disease and death rates than the general population, due to the fact that the old, severely ill, and disabled are ordinarily excluded from employment. Death rates in the general population may be inappropriate for comparison, if this effect is not taken into account.

heat shock proteins stress proteins Group of proteins whose synthesis is increased by increased transcription when cells are exposed to elevated temperatures.

Note: Production of high levels of heat shock proteins can also be triggered by *exposure* to different kinds of environmental stress conditions, for example, infection, *inflammation*, exposure of the cell to chemicals (such as ethanol, arsenicals, or certain metal species), ultraviolet light, starvation, hypoxia (oxygen deprivation), nitrogen deficiency (in plants), or water deprivation. Hence, the alternative name, stress proteins. Their upregulation is sometimes described more generally as part of the stress response.

heavy metal toxic metal Erroneous terms used commonly in the toxicological literature but having no generally agreed meaning, sometimes even applied to nonmetals, and therefore a source of confusion and to be avoided. The term 'metal' is adequate without the qualifying adjective but may be misleading since it implies a solid material when toxicological concern is mostly for the ionic form or another chemical species.

helminthagogue See *anthelmint(h)ic*.

helminthic See *anthelmint(h)ic*.

hematemesis Vomiting of blood.

hematoma Localized accumulation of blood, usually clotted, in an organ, space, or tissue, due to a failure of the wall of a blood vessel.

hematotoxicity Adverse changes in blood caused by *exposure* to chemicals.

hematuria Presence of blood in the urine.

heme haem Complex consisting of an iron ion coordinated to a *porphyrin* acting as a tetradentate ligand, and to one or two axial ligands.
After [3]

hemochromatosis Hereditary disorder affecting iron metabolism in which excessive amounts of iron accumulate in the body tissues.

Note: The disorder is characterized by diabetes mellitus, liver dysfunction, and a bronze pigmentation of the skin.

hemodialysis Use of an artificial kidney to remove *toxic* compounds from the blood by passing it through a tube of semipermeable membrane.

Note: The tube is bathed in a dialyzing solution to restore the normal chemical composition of the blood while permitting diffusion of toxic substances from the blood.

hemoglobin *Heme*-containing protein in red blood cells with an important function in transporting oxygen from the lungs to body tissues.

hemoglobinuria Presence of free *hemoglobin* in the urine.

hemolysin Substance that damages the membrane of erythrocytes causing the release of *hemoglobin*.

hemolysis Release of *hemoglobin* from erythrocytes, and its appearance in the *plasma*.

hemoperfusion Passing blood through a column of charcoal or adsorbent resin for the removal of *drug*s or *toxins*.

hemosiderin Insoluble iron(III) hydroxide-based pigment deposited in cells in conditions of iron overload.

Henderson–Hasselbalch equation Equation of the form:

$$pH = pKa - \lg([HA]/[A^-])$$

for the calculation of the pH of solutions where the ratio $[HA]/[A^-]$ is known and HA and A^- are the

hydronated and dehydronated forms of an acid, respectively.
Corrected from [3]

hepatic Pertaining to the liver.

hepatotoxic Poisonous to liver cells.

Henry's law constant At constant temperature and pressure, the ratio of the partial pressure of a gas above a liquid to its solubility in the liquid and therefore a measure of its partition between the gas phase and the solute phase.

Note 1: The solubility may be expressed in any convenient units, such as amount fraction, molality, or amount (substance) concentration. The exact definition used should always be given.

Note 2: Rigorously, the Henry's law constant is the limiting value at zero partial pressure.

[13]

herbicide Substance intended to kill plants.

heterozygote Organism that has different allelic forms of a specified *gene* on each of a pair of homologous *chromosomes* or describing the *genome* of that organism.
After [9]

Hill plot Graphical method for analyzing binding of a molecule A to a macromolecule P with n binding sites. A Hill plot of $\lg[\theta/(1-\theta)]$ vs. $\lg[A]$ has a slope of 1 if binding is noncooperative and >1 for cooperative binding, where $\theta = [A]_{bound}/n[P]_{total}$ is the fraction of sites occupied.
[2]

histamine 2-(1H-imidazol-4-yl)ethan-1-amine, an amine derived from histidine by decarboxylation and released from cells in the *immune system* as part of an allergic reaction: It is a powerful stimulant of gastric secretion, constrictor of bronchial smooth muscle, and vasodilator.

histogenic origin Germ cell layer of the *embryo* from which a given adult tissue develops.

histology Study (usually microscopic) of the anatomy of tissues and their cellular and subcellular structure.

histopathology Microscopic pathological study of the anatomy and cell structure of tissues in disease to reveal abnormal or adverse structural changes.

hit-and-run effect Toxicity that follows a single *exposure* to a substance.

homeostasis Normal, internal stability in an organism maintained by coordinated responses of the organ systems that automatically compensate for environmental changes.

homology (in biology)
1. Similarity of anatomical structures in different species because of shared ancestry
2. Similarity of *DNA* or *RNA* nucleotide sequences, or of protein amino-acid sequences, supporting the hypothesis that they share a common ancestor.

Note: Homology among DNA or RNA nucleotide sequences, or among protein amino-acid sequences, is often concluded on the basis of sequence similarity. In general, if there are almost identical sequences, it is likely that they are homologous. However, it is possible that highly similar sequences were not derived from a common ancestor, i.e., they are similar but not homologous.

homozygote Organism that has the same allelic form of a specified *gene* on each of a pair of homologous chromosomes or describing the genome of that organism.
After [9]

horme/sis n., **-tic** adj. Benefit at low dose of a substance that is harmful at a higher dose.

hormone Substance formed in one organ or part of the body and carried in the blood to another organ or part where it selectively alters functional activity.

human ecology Interrelationship between humans and the entire environment – physical, biological, socioeconomic, and cultural, including the interrelationships between individual humans or groups of humans and other human groups or groups of other species.

human equivalent dose Human *dose* of an agent that is believed to induce the same magnitude of a *toxic* effect that the known animal dose has induced.

human exposure threshold (of toxicological concern) Generic value of *exposure* to a substance, or a group of substances falling within a defined structural class, below which there is expected to be no appreciable risk to human health.

hydrolysis Chemical reaction of a substance with water, usually resulting in the formation of one or more derivatives.

hydrophilic/ adj., **-ity** n. lipophobic Antonym: *hydrophobic* Describing the character of a substance, material, molecular entity, or group of atoms which has an affinity for water.

hydrophobic/ adj., **-ity** n. lipophilic Antonym: *hydrophilic* Describing the character of a substance, material, molecular entity, or group of atoms which is insoluble or confers insolubility in water, or resistance to wetting or hydration.

hygiene Science of *health* and its preservation.

hyper- Antonym: *hypo-* Prefix meaning above or excessive: when used with the suffix '-emia' refers to blood and with the suffix '-uria' refers to urine, for example, 'hyperbilirubinemia'.

hyperemia Excessive amount of blood in any part of the body.

hyperalimentation Ingestion or administration of nutrients in excess of optimal amounts.

hyperbilirubinemia Excessive *concentration* of bilirubin in the blood.

hypercalcemia Excessive *concentration* of calcium in the blood.

hyperglycemia Excessive *concentration* of glucose in the blood.

hyperkalemia Excessive *concentration* of potassium in the blood.

hypernatremia Excessive *concentration* of sodium in the blood.

hyperparathyroidism Abnormally increased parathyroid gland activity that affects, and is affected by, *plasma* calcium *concentration*.

hyperplasia Abnormal multiplication or increase in the number of normal cells in a tissue or organ.

hyper-reactivity Term used to describe the responses of (effects on) an individual to (of) an agent when they are qualitatively those expected, but quantitatively increased.

hyper-reflexia Exaggeration of reflexes.

hypersensitivity State in which an individual reacts with *allergic* effects following *exposure* to a certain substance (*allergen*) after having been *exposed* previously to the same substance.

Note: Most common chemical-induced allergies are type I (IgE-mediated) and type IV (cell-mediated) hypersensitivity.

hypersusceptibility Excessive reaction following *exposure* to a given amount or *concentration* of a substance as compared with the large majority of other *exposed* subjects.

hypertension Persistently high blood pressure in the arteries or in a circuit, for example, pulmonary hypertension or hepatic portal hypertension.

hypertrophy Excessive growth in bulk of a tissue or organ through increase in size but not in number of the constituent cells.

hypervitaminosis Condition resulting from the ingestion of an excess of one or more vitamins.

hypo- Prefix meaning under, deficient: when used with the suffix '-emia' refers to blood and with the suffix '-uria' refers to urine, for example, 'hypocalcemia'.

hypocalcemia Abnormally low calcium *concentration* in the blood.

hypokalemia Abnormally low potassium *concentration* in the blood.

hypomagnesemia Abnormally low magnesium *concentration* in the blood.

hyponatremia Abnormally low sodium *concentration* in the blood.

hypovolemic Pertaining to an abnormally decreased volume of circulating fluid (*plasma*) in the body.

hypoxemia Deficient oxygenation of the blood.

hypoxia

1. Abnormally low dioxygen content or tension.
2. Deficiency of dioxygen in the inspired air, in blood, or in tissues, short of anoxia.

hypoxic Dioxygen-deficient.

iatrogenic Any adverse condition resulting from medical treatment.

icterus Excess of bile pigment in the blood and consequent deposition and retention of bile pigment in the skin and the sclera.

idiopathic environmental intolerance See *multiple chemical sensitivity*.

idiosyncrasy Genetically based unusually high sensitivity of an organism to the effect of certain substances.

immediately-dangerous-to-life-or-health-concentration (IDLHC) According to the U.S. NIOSH, the maximum *exposure concentration* from which one could escape within 30 min without any escape-impairing symptoms or any irreversible *health* effects.

immission Environmental *concentration* of a *pollutant* resulting from a combination of *emission*s and dispersals (often synonymous with *exposure*).

immune complex Product of an *antigen–antibody* reaction that may also contain components of the complement system.

immune response Selective reaction of the body to substances that are foreign to it, or that the *immune*

system identifies as foreign, shown by the production of antibodies and *antibody*-bearing cells or by a cell-mediated *hypersensitivity* reaction.

immune system Integrated network of organs, glands, and tissues that has evolved to protect the body from foreign substances, including bacteria, viruses, and other infection-causing parasites and pathogens.

Note: The immune system may produce hypersensitivity reactions which, in the extreme, can be fatal. If the immune system misidentifies normal body components as foreign, this leads to autoimmune disorders, such as lupus, in which the body destroys its own constituents.

immunoassay Ligand-binding assay that uses a specific antigen or antibody, capable of binding to the analyte, to identify and quantify substances. The antibody can be linked to a radioisotope (radioimmunoassay, RIA) or to an enzyme which catalyzes an easily monitored reaction (enzyme-linked immunosorbent assay, ELISA), or to a highly fluorescent compound by which the location of an antigen can be visualized (immunofluorescence).
[3]

immunochemistry Study of biochemical and molecular aspects of immunology, especially the nature of *antibodies*, *antigens*, and their interactions.

immunogen See *antigen*.

immunoglobulin Family of closely related glycoproteins capable of acting as antibodies and present in *plasma* and tissue fluids; immunoglobulin E (IgE) is the source of *antibody* in type I *hypersensitivity* (*allergic*) reactions.

immunoglobulin E-mediated hypersensitivity State in which an individual reacts with allergic effects caused fundamentally by the reaction of *antigen*-specific *immunoglobulin* E following *exposure* to a certain substance (*allergen*) after having been *exposed* previously to the same substance.

immunomodulation Modification of the functioning of the *immune system* by the action of a substance that increases or reduces the ability to produce *antibodies*.

immunopotentiation Enhancement of the capacity of the *immune system* to produce an effective response.

immunosuppression Reduction in the functional capacity of the *immune response*; may be due to:
1. Inhibition of the normal response of the *immune system* to an *antigen*.
2. Prevention, by chemical or biological means, of the production of an *antibody* to an antigen by inhibition of the processes of transcription, translation, or formation of tertiary structure.

immunosurveillance Mechanisms by which the *immune system* is able to recognize and destroy *malignant* cells before the formation of an overt *tumor*.

immunotoxic Harmful to the *immune system*.

impermeable Of a membrane, not allowing a given substance to pass through. When applied to non-biological membranes with no qualification, the term normally refers to water.

implantation Attachment of the fertilized ovum (blastocyst) to the endometrium and its subsequent embedding in the compact layer, occurring 6 or 7 days after fertilization of the ovum.
[8]

in silico Phrase applied to data generated and analyzed using computer modeling and information technology.

in vitro Antonym: *in vivo* In glass, referring to a study in the laboratory usually involving isolated organ, tissue, cell, or biochemical systems.

in vivo Antonym: *in vitro* In the living body, referring to a study performed on a living organism.

incidence Number of occurrences of illness commencing, or of persons falling ill, during a given period in a specific population: usually expressed as a rate.

Note: When expressed as a rate, it is the number of ill persons divided by the average number of persons in the specified population during a defined period, or alternatively divided by the estimated number of persons at the mid-point of that period.
[2]

incidence rate (epidemiology) Measure of the frequency at which new events occur in a population.

Note: This is the value obtained by dividing the number of new events that occur in a defined period by the population at *risk* of experiencing the event during this period, sometimes expressed as person-time.

incremental unit risk estimate For an air pollutant, this is the additional lifetime *cancer risk* occurring in a hypothetical population in which all individuals are *exposed* continuously from birth throughout their lifetimes to a *concentration* of 1 microgram per cubic meter ($\mu g\ m^{-3}$) of the pollutant in the air they breathe.

indication Quantity value provided by a measuring instrument or a measuring system.
[7]

indirect exposure
1. *Exposure* to a substance in a medium or vehicle other than the one originally receiving the substance.
2. Exposure of people to a substance by contact with a person directly *exposed*.

individual monitor See *personal sampler*.

individual protective device (IPD) personal protective device (PPD) personal protective equipment (PPE) Device for individual use for protection of the whole body, eyes, respiratory pathways, or skin of workers against hazardous and harmful production factors.

individual risk Probability that an individual person will experience an *adverse effect*.

inducer Substance that causes *induction*.

induction Increase in the rate of synthesis of an *enzyme* in response to the action of an *inducer* or environmental conditions.

Note: Often the inducer is the substrate of the induced enzyme or a structurally similar substance (gratuitous inducer) that is not metabolized.

induction period latent period Time from the onset of *exposure* to the appearance of signs of *disease*.

industrial hygiene See *occupational hygiene*.

inert chemical Substance that is not generally reactive.

inert ingredient Any intentionally added ingredient of a mixture that does not contribute to the desired biological effect: This definition does not include impurities and does not imply that the inert ingredient has no biological effects. Related term: *active ingredient*

infertility (in human medicine) Inability to become pregnant within 1 year of unprotected intercourse.
[8]

inflammation Reaction of the body to injury or to infectious, allergic, or chemical irritation; characterized by redness, swelling, heat, and pain resulting from dilation of the blood vessels accompanied by loss of *plasma* and leucocytes (white blood cells) into the tissues.

infusion (in physiology) Therapeutic introduction of a fluid other than blood, as a (usually saline) solution, into a vein.
[2]

ingestion
1. Process of taking food and drink into the body by mouth.
2. Process of taking in particles by a phagocytic cell.

inhalation Act of drawing in of air, vapor, or gas and any suspended *particulates* into the lung.

inherently biodegradable Class of compounds for which there is unequivocal evidence of *biodegradation* (primary or ultimate) in any test of biodegradability.

inhibitory concentration (IC) *Concentration* of a substance that causes a defined inhibition of a given system.

Note: IC_{50} is the median concentration that causes 50 % inhibition.

inhibitory dose (ID) Dose of a substance that causes a defined inhibition of a given system.

Note: ID_{50} is the median dose that causes 50 % inhibition.

initiator
1. Agent that induces a change in a *chromosome* or *gene* that leads to the induction of *tumors* after a second agent, called a *promoter*, is administered to the tissue.
2. Substance that starts a chain reaction

Note: An initiator is consumed in a chain reaction, in contrast to a catalyst.

insecticide Substance intended to kill insects.

intake Amount of a substance that is taken into the body, regardless of whether or not it is absorbed: The total daily intake is the sum of the daily intake by an individual from food, drinking-water, and inhaled air.

integral indicator of toxic effect Parameter (such as body weight or temperature) characterizing the overall changes in the general state of the organism *exposed* to a *toxic* substance.

interactome Large-scale protein–protein interaction map.

interfacial layer Inhomogeneous space region intermediate between two bulk phases in contact, and where properties are significantly different from, but related to, the properties of the bulk phases.
[2]

intermittent effect discontinuous effect Biological change that comes and goes at intervals.

internal dose See *absorbed dose*.

internal validity Selection and comparison of index and comparison groups in such a manner that, apart from *sampling error*, the observed differences between these groups with respect to dependent variables under study may be attributed only to the hypothesized effect under investigation.

interpolation Estimation of a value between two known data points.

interpretation (of data or findings) Evaluation of the observations from an investigation or study in order to determine their significance for human *health*, for the environment or for both.

interspecies dose conversion Process of extrapolating from the doses of one animal species to another, for example, from rodent dose to human equivalent.

interstitial fluid Aqueous solution filling the narrow spaces between cells.
[2]

interstitial pneumonia Chronic form of pneumonia involving increase of the interstitial tissue and decrease of the functional lung tissue.

intervention study Epidemiological investigation designed to test a hypothesized cause–effect relationship by intentional change of a supposed causal factor in a population.

intestinal reabsorption Absorption further down the intestinal tract of a substance or substances that have been absorbed before and subsequently excreted into the intestinal tract, usually through the bile.

intoxication
1. Poisoning: pathological process with clinical signs and symptoms caused by a substance of *exogenous* or *endogenous* origin.
2. Drunkenness following consumption of beverages containing ethanol or other compounds affecting the central nervous system.

intrinsic activity Maximal stimulatory effect induced by a compound in relation to that of a given reference compound.
[2]

intrinsic clearance Volume of *plasma* or blood from which a substance is completely removed in a period of time under unstressed conditions.
[2]

intrinsic factor (in biochemistry) Specific protein required for the absorption of vitamin B_{12} and secreted by cells in the gastric glands of the stomach.
[2]

intron Noncoding sequence within *gene*s that separates the exons (coding regions).

Note: Introns are spliced out of the m*RNA* molecule created from a *gene* after transcription and prior to translation.

After [9]

ionizing radiation Any radiation consisting of directly or indirectly ionizing particles or a mixture of both or photons with energy higher than the energy of photons of ultraviolet light or a mixture of both such particles and photons.

irreversible alteration Change from normal structure or function that persists or progresses after cessation of *exposure* of the organism.

irritant
1. n., Substance that causes *inflammation* following immediate, prolonged, or repeated contact with skin, mucous membrane, or other biological material.

   Note: A substance capable of causing inflammation on first contact is called a primary irritant.
2. adj., Causing inflammation following immediate, prolonged, or repeated contact with skin, mucous membrane, or other tissues.

ischemia Local deficiency of blood supply and hence oxygen to an organ or tissue owing to constriction of the blood vessels or to obstruction.

isotonic Denoting a liquid exerting the same osmotic pressure or chemical potential of water (*water potential*) as another liquid with which it is being compared.

itai-itai disease Illness (renal osteomalacia) observed in the Toyama prefecture of Japan, resulting from the ingestion of cadmium-contaminated rice.

Note: Damage occurred to the *renal* and skeletoarticular systems, the latter being very painful ('itai' means 'ouch' in Japanese and refers to the intense pain caused by the condition).

jaundice Pathological condition characterized by deposition of bile pigment in the skin and mucous membranes, including the conjunctivae, resulting in yellow appearance of the patient or animal.

joint effect Simultaneous or successive effect of factors of diverse types (chemical, physical, biological) on an organism.

kairomone *Semiochemical* that is produced by one organism inducing a response in an organism of another species that is unfavorable to the emitter. Related terms: *allomone, synomone*

kinetics (in chemistry) Branch of chemistry concerned with measuring and studying rates of chemical reactions.
[2]

ketone bodies Acetoacetate, beta-hydroxybutyrate, and acetone, produced from acetyl-CoA, mainly in the mitochondria of liver cells when carbohydrates are so scarce that energy must be obtained from breaking down fatty acids; beta-hydroxybutyrate is not itself a ketone, but is called a ketone body because, like the other compounds, it is produced from ketones.

ketosis Pathological increase in the production of *ketone bodies*, for example, following blockage or failure of carbohydrate metabolism.

kinetics (in toxicology) See *toxicokinetics*.

knock-down Technique used to decrease the expression of a particular *gene* in a cell or living organism in order to define its function.

knock-in Technique used to express an *exogenous gene* or to overexpress an *endogenous* gene in a living organism in order to define its function.

Note: In mammalian toxicology, this technique is most readily applied to the mouse.

knock-out (in biology) Technique used to inactivate a particular *gene* in a living organism in order to define its function.

Note: In mammalian toxicology, this technique is most readily applied to the mouse.
After [9]

lachrymation See *lacrimation*.

lacrimation Secretion and discharge of tears.

lachrymator See *lacrimator*.

lacrimator Substance that irritates the eyes and causes the production of tears or increases the flow of tears.

larvicide Substance intended to kill larvae.

laryngospasm Reflex spasmodic closure of the sphincter of the *larynx*, particularly the glottic sphincter.

larynx Main organ of voice production, the part of the respiratory tract between the *pharynx* and the trachea.

lassitude Weakness; exhaustion.

latency See *latent period*.

latent effect See *delayed effect*.

latent period
1. Delay between *exposure* to a harmful substance and the manifestations of a *disease* or other *adverse effect*s.
2. Period from disease initiation to disease detection.

[2]

lavage Irrigation or washing out of a hollow organ or cavity such as the stomach, intestines, or lungs.

laxative cathartic purgative Substance that causes evacuation of the intestinal contents.

lead colic (painters' colic) Chronic intestinal pains and constipation caused by lead poisoning.

lesion
1. Area of pathologically altered tissue.
2. Injury or wound.
3. Infected patch of skin.

lethal Deadly; fatal; causing death.

lethal concentration (LC) *Concentration* of a substance in an environmental medium that causes death following a certain period of *exposure*.

lethal dose (LD) Amount of a substance or physical agent (e.g., radiation) that causes death when taken into the body.

lethal synthesis Metabolic formation of a highly *toxic* compound often leading to death of affected cells.

leukemia Progressive, *malignant* disease of the blood-forming organs, characterized by distorted proliferation and development of leucocytes and their precursors in the bone marrow and blood.

leukopenia Reduced *concentration* of leukocytes in the blood.

lgP_{ow} lgK_{ow} Logarithm to the base 10 of the partition coefficient of a substance between octan-1-ol and water.

Note: This is used as an empirical measure for lipophilicity in calculating *bioaccumulation*, fish *toxicity*, membrane *adsorption*, and penetration, etc.

library (in DNA bioinformatics) Collection of *DNA* sequences in a searchable electronic form.

library (in molecular biology) Collection of genomic or complementary *DNA* sequences that have been cloned in a *vector* and grown in an appropriate host organism (e.g., bacteria, yeast).
After [9]

life-long exposure Subjection to a potentially *toxic* substance during the whole lifetime.

ligand Ion, molecule, or molecular group that binds to another chemical entity to form a larger complex.

limacide Substance intended to kill mollusks including the gastropod mollusk, *Limax*.

limit recommended See *recommended exposure limit*.

limit test Acute *toxicity* test in which, if no ill-effects occur at a preselected maximum dose, no further testing at greater *exposure* levels is required.

limit value (LV) Limit *concentration* at or below which Member States of the European Community must set their *environmental quality standard* and *emission standard* for a particular substance according to Community Directives.

limited evidence According to the USEPA's Guidelines for Carcinogen *Risk* Assessment [17], 'limited evidence' is a collection of facts and accepted scientific inferences that suggests that an agent may be causing an effect, but this suggestion is not strong enough to be considered established fact.

linearized multistage model Sequence of steps in which (a) a *multistage model* is fitted to *tumor incidence* data; (b) the maximum linear term consistent with the data is calculated; (c) the low-*dose* slope of the *dose–response* function is equated to the coefficient of the maximum linear term; and (d) the resulting slope is then equated to the upper bound of *potency*.

lipophilic/ adj., **-ity** n. hydrophobic/ adj., -ty n. Antonyms: *hydrophilic/ -ity, lipophobic/ -ity* Having an affinity for fat and high lipid solubility.

Note: This is a physicochemical property which describes a partitioning equilibrium of solute molecules between water and an immiscible organic solvent, favoring the latter, and which correlates with *bioaccumulation*.

lipophobic/ adj., **-ity** n. hydrophilic/ adj., -ity n. Antonyms: *hydrophobic/* adj. *ity n., lipophilic/* adj. *ity n*. Having a low affinity for fat and a high affinity for water.

liposome

1. Artificially formed lipid droplet, small enough to form a relatively stable suspension in aqueous media, useful in membrane transport studies and in *drug* delivery.
2. Lipid droplet in the *endoplasmic reticulum* of a fatty liver.

After [1]

local effect Change occurring at the site of contact between an organism and a *toxicant*.

logit In competitive binding assays, the *logit*-log *dose* relationship, in which the *response* is defined by:

$$R = \text{logit}\,(y) = \lg\,[y/(1-y)]$$

where $y = b/b_0$ with b = fraction of tracer bound and b_0 = value of b with no unlabeled ligand in the system.

Note: Logit-transformed assay data frequently yield straight-line dose–response data, amenable to statistical analysis. More generally in toxicology, the transformation is applied to dose–response data where b_0 denotes the maximum response in the absence of a toxic substance.

[2]

log-normal distribution *Distribution* function $F(y)$, in which the logarithm of a quantity is normally distributed, i.e.,

$$F(y) = f\text{gauss}(\ln y)$$

where $f\text{gauss}(x)$ is a Gaussian (or normal) *distribution*.

[3]

log-normal transformation Transformation of data with a logarithmic function that results in a normal *distribution*.

[2]

long-term effect See *chronic effect*.

long-term exposure See *chronic exposure*.

long-term toxicity See *chronic toxicity*.

lowest-effective dose (LED) Lowest *dose* of a chemical inducing a specified effect in a specified fraction of *exposed* individuals.

[2]

lowest lethal concentration found See *minimum lethal concentration*.

lowest-observed-adverse-effect level (LOAEL) Lowest *concentration* or amount of a substance (*dose*), found by experiment or observation, that causes an *adverse effect* on morphology, functional capacity, growth, development, or life span of a *target* organism distinguishable from normal (control) organisms of the same species and strain under defined conditions of *exposure*.

lowest-observed-effect level (LOEL) Lowest *concentration* or amount of a substance (*dose*), found by experiment or observation, that causes any alteration in morphology, functional capacity, growth, development, or life span of *target* organisms distinguishable from normal (control) organisms of the same species and strain under the same defined conditions of *exposure*.

lymphocyte Animal cell that interacts with a foreign substance or organism, or one which it identifies as foreign, and initiates an immune response against the substance or organism.

Note: There are two main groups of lymphocytes, B lymphocytes and T lymphocytes.

lymphoma General term comprising *tumors* and conditions allied to tumors arising from some or all of the cells of lymphoid tissue.

lysimeter Laboratory column of selected representative soil or a protected monolith of undisturbed field soil with which it is possible to *sample* and monitor the movement of water and other substances.

lysosome Membrane-bound cytoplasmic organelle containing hydrolytic enzymes.

Note: Release of these enzymes from lysosomes damaged by xenobiotics can cause autolysis of the cell.

macrophage Large (10–20 μm diameter) amoeboid and phagocytic cell found in many tissues, especially in areas of *inflammation*, derived from blood monocytes and playing an important role in host defense mechanisms.

macroscopic (gross) pathology Study of changes associated with disease that are visible to the naked eye without the need for a microscope.

Mad Hatter syndrome See *mercurialism*.

Magnusson and Kligman test See *guinea-pig maximization test*.

mainstream smoke (tobacco smoking) Smoke that is inhaled by the smoker.

malaise Vague feeling of bodily discomfort.

malignancy Population of cells showing both uncontrolled growth and a tendency to invade and destroy other tissues.

Note: A malignancy is life-threatening.

malignant Antonym: *benign*

1. Tending to become progressively worse and to result in death if not treated.
2. In *cancer*, cells showing both uncontrolled growth and a tendency to invade and destroy other tissues.

mania Emotional disorder (mental illness) characterized by an expansive and elated state (euphoria), rapid speech, flight of ideas, decreased need for sleep, distractibility, grandiosity, poor judgment, and increased motor activity.

margin of exposure (MOE) Ratio of the *no-observed-adverse-effect level* (NOAEL) to the theoretical or *estimated exposure dose* (EED) or *concentration* (EEC).

margin of safety (MOS) See *margin of exposure*.

mass mean diameter Diameter of a spherical particle with a mass equal to the mean mass of all the particles in a population.

mass median diameter Diameter of a spherical particle with the median mass of all the particles in a population.

material safety data sheet (MSDS) Compilation of information required under the U.S. OSHA *Hazard* Communication Standard on the identity of hazardous substances, *health* and physical *hazard*s, *exposure* limits, and precautions.

maximum allowable (admissible, acceptable) concentration (MAC) Regulatory value defining the *concentration* that if inhaled daily (in the case of work people for 8 h with a working week of 40 h; in the case of the general population, 24 h) does not, in the present state of knowledge, appear capable of causing appreciable harm, however long delayed during the working life or during subsequent life or in subsequent generations.

maximum average daily concentration of an atmospheric pollutant peak daily average concentration of an air pollutant Highest of the average daily *concentration*s recorded at a definite point of measurement during a certain period of observation.

maximum contaminant level (MCL) Under the Safe Drinking Water Act (USA), primary MCL is a regulatory *concentration* for drinking water which takes into account both *adverse effect*s (including sensitive populations) and technological feasibility (including natural background levels): Secondary MCL is a regulatory concentration based on 'welfare', such as taste and staining, rather than *health*, but also takes into account technical feasibility.

Note: MCL Goals (MCLG) under the Safe Drinking Water Act do not consider feasibility and are zero for all human and animal *carcinogens*.

maximum exposure limit (MEL) Occupational *exposure* limit legally defined in the United Kingdom under COSHH as the maximum *concentration* of an airborne substance, averaged over a reference period, to which employees may be *exposed* by inhalation under any circumstances, and set on the advice of the HSC Advisory Committee on *Toxic* Substances.

maximum permissible concentration (MPC) See *maximum allowable concentration*.

maximum permissible daily dose Maximum daily dose of substance whose penetration into a human body during a lifetime will not cause diseases or *health hazard*s that can be detected by current investigation methods and will not adversely affect future generations.

maximum permissible level (MPL) Level, usually a combination of time and *concentration*, beyond which any *exposure* of humans to a chemical or physical agent in their immediate environment is unsafe.

maximum residue limit (MRL) for pesticide residues Maximum contents of a *pesticide* residue (expressed as mg kg^{-1} fresh weight) recommended by the *Codex Alimentarius Commission* to be legally permitted in or on food commodities and animal feeds.

Note: MRLs are based on data obtained following *good agricultural practice* and foods derived from commodities that comply with the respective MRLs are intended to be toxicologically acceptable.

maximum residue limit (MRL) for veterinary drugs Maximum contents of a *drug* residue (expressed as mg kg^{-1} or μg kg^{-1} fresh weight) recommended by the *Codex Alimentarius Commission* to be legally permitted or recognized as acceptable in or on food commodities and animal feeds.

Note: The MRL is based on the type and amount of residue considered to be without any toxicological *hazard* for human *health* as expressed by the acceptable daily intake (ADI) or on the basis of a temporary ADI that uses an additional uncertainty factor. It also takes into account other relevant public health *risks* as well as food technological aspects.

maximum tolerable concentration (MTC) Highest *concentration* of a substance in an environmental medium that does not cause death of test organisms or species (denoted by LC_0).

maximum tolerable dose (MTD) Highest amount of a substance that, when introduced into the body, does not kill test animals (denoted by LD_0).

maximum tolerable exposure level (MTEL) Maximum amount (*dose*) or *concentration* of a substance to which an organism can be *exposed* without leading to an *adverse effect* after prolonged *exposure* time.

maximum tolerated dose (MTD) High *dose* used in *chronic toxicity* testing that is expected on the basis of an adequate *subchronic* study to produce limited *toxicity* when administered for the duration of the test period.

Note 1: It should not induce
(a) overt toxicity, for example appreciable death of cells or organ dysfunction, or
(b) toxic manifestations that are predicted materially to reduce the life span of the animals except as the result of neoplastic development, or
(c) 10% or greater retardation of body weight gain as compared with control animals.

Note 2: In some studies, toxicity that could interfere with a carcinogenic effect is specifically excluded from consideration.

maximum velocity, V_{max} maximum rate In *Michaelis–Menten kinetics*, the maximum rate of *conversion* of a substrate when its *concentration* is not rate-limiting. [2]

mean life mean time Average lifetime of a molecular, atomic, or nuclear system in a specified state.

Note: For an exponentially decaying system, it is the average time for the number of molecules, atoms, or nuclei in a specified state to decrease by a factor of e, the base of natural logarithms.

mean residence time (in pharmacokinetics) (MRT) Average time a *drug* molecule remains in the body or an organ after rapid intravenous injection.

Note 1: Like clearance, its value is independent of dose.

Note 2: After an intravenous bolus:

$$t_r = A_m/A$$

where *t*r is the MRT, A is the area under the plasma concentration–time curve, and A_m is the area under the moment curve.

Note 3: For a drug with one-compartment distribution characteristics, MRT equals the reciprocal of the elimination rate constant.

After [2]

measurement uncertainty See *uncertainty*.

median effective concentration (EC_{50}) Statistically derived median *concentration* of a substance in an environmental medium expected to produce a certain effect in 50% of test organisms in a given population under a defined set of conditions.

Note: EC_n refers to the median concentration that is effective in *n*% of the test population.

median effective dose (ED_{50}) Statistically derived median *dose* of a chemical or physical agent (radiation)

expected to produce a certain effect in 50% of test organisms in a given population or to produce a half-maximal effect in a biological system under a defined set of conditions.

Note: ED_n refers to the median dose that is effective in $_n$ % of the test population.

median lethal concentration (LC_{50}) Statistically derived median *concentration* of a substance in an environmental medium expected to kill 50% of organisms in a given population under a defined set of conditions.

median lethal dose (LD_{50}) Statistically derived median *dose* of a chemical or physical agent (radiation) expected to kill 50% of organisms in a given population under a defined set of conditions.

median lethal time (TL_{50}) Statistically derived median time interval during which 50% of a given population may be expected to die following *acute* administration of a chemical or physical agent (radiation) at a given *concentration* under a defined set of conditions.

median narcotic concentration (NC_{50}) Statistically derived median *concentration* of a substance in an environmental medium expected to cause *narcotic* conditions in 50% of a given population under a defined set of conditions.

median narcotic dose (ND_{50}) Statistically derived dose of a substance expected to cause *narcotic* conditions in 50% of test animals under a defined set of conditions.

medicine

1. Science and practice of diagnosing, treating, or preventing disease and other damage to the body or mind.
2. Any drug or therapy used to treat disease or injury.

Note: Any substance may be used as a drug or a remedy; the end effect will depend on the dose.

meiosis Process of 'reductive' cell division, occurring in the production of *gametes*, by means of which each daughter nucleus receives half the number of *chromosome*s characteristic of the somatic cells of the species.

See also *miosis*.

mercurialism Mad Hatter syndrome

Chronic poisoning caused by *exposure* to mercury, often by breathing its vapor but also by skin absorption and, less commonly, by ingestion.

Note: Central nervous system damage usually predominates.

mesocosm See *microcosm*.

mesothelioma Malignant *tumor* of the mesothelium of the pleura, pericardium, or peritoneum, that may be caused by *exposure* to asbestos fibers and some other fibers.

metabolic activation bioactivation *Biotransformation* of a substance to a more biologically active derivative.

[2]

metabolic enzymes Proteins that catalyze chemical transformations of body constituents and, in more common usage, of *xenobiotics*.

[2]

metabolic half life metabolic half time

Time required for one-half of the quantity of a substance in the body to be metabolized.

Note: This definition assumes that the final quantity in the body is zero. See *half life*.

metabolic model Analysis and theoretical reconstruction of the way in which the body deals with a specific substance, showing the proportion of the intake that is absorbed, the proportion that is stored and in what tissues, the rate of breakdown in the body and the subsequent fate of the metabolic products, and the rate at which it is eliminated (see *elimination*) by different organs as unchanged substance or *metabolites*.

metabolic transformation *Biotransformation* of a substance that takes place within a living organism.

metabolism

1. Sum total of all physical and chemical processes that take place within an organism from uptake to elimination.
2. In a narrower sense, the physical and chemical changes that take place in a substance within an organism, including *biotransformation* to *metabolites*.

metabolite Intermediate or product resulting from *metabolism*.

metabolomics See *metabonomics*.

metabonomics metabolomics Evaluation of cells, tissues, or biological fluids for changes in *metabolite* levels that follow *exposure* to a given substance, in order to determine the metabolic processes involved, to evaluate the disruption in intermediary metabolic processes that results from *exposure* to that substance, or to determine the part of the genome that is responsible for the changes.

Note: Although 'metabolomics' and 'metabonomics' are frequently used as synonyms, there is a growing consensus that there is a difference

in that 'metabolomics' places a greater emphasis on comprehensive metabolic profiling, while 'metabonomics' is used to describe multiple (but not necessarily comprehensive) metabolic changes caused by a biological perturbation.

After [2]

metaplasia Abnormal transformation of an adult, fully differentiated tissue of one kind into a differentiated tissue of another kind.

metastasis

1. Movement of bacteria or body cells, especially *cancer* cells, from one part of the body to another, resulting in change in location of a disease or of its symptoms from one part of the body to another.
2. Growth of pathogenic microorganisms or of abnormal cells distant from the site of their origin in the body.

methaemoglobin See *methemoglobin*.

methemoglobin methaemoglobin Derivative of *hemoglobin* that is formed when the iron(II) in the *heme* porphyrin is oxidized to iron(III); this derivative cannot transport dioxygen.

methemoglobinaemia methaemoglobinaemia Presence of methaemoglobin in the blood in greater than normal proportion.

methemoglobin-forming substance methaemoglobinforming substance Substance capable of oxidizing directly or indirectly the iron(II) in *hemoglobin* to iron(III) to form methemoglobin.

Michaelis constant, K_M Substance *concentration* of *substrate* at which the rate of reaction is equal to one-half of the limiting rate (maximum rate).

Note: Also called the *Michaelis concentration*. The Michaelis constant (Michaelis concentration) may be used only when *Michaelis–Menten kinetics* is obeyed.

[2]

Michaelis–Menten kinetics Description of the dependence of an initial rate of reaction upon the *concentration* of a substrate S that is present in large excess over the concentration of an *enzyme* or other catalyst (or reagent) E with the appearance of saturation behavior following the Michaelis–Menten equation:

$$\nu = V[\mathrm{S}]_o/(K_M + [\mathrm{S}])$$

where $\underline{\upsilon}$ is the observed initial rate, V is its limiting value at substrate saturation (i.e., $[\mathrm{S}] >> K_M$), and K_M the substrate concentration when $\underline{\upsilon} = V/2$. The definition is experimental, i.e., it applies to any reaction that follows an equation of this general form. The symbols V_{max} or $\underline{\upsilon}_{max}$ are sometimes used for V.

Note 1: The parameters V and K_M (the '*Michaelis constant*') of the equation can be evaluated from the slope and intercept of a linear plot of $1/\upsilon$ vs. $1/[\mathrm{S}]$ ('Lineweaver–Burk plot') or from slope and intercept of a linear plot of υ vs. $v/[\mathrm{S}]$ ('Eadie–Hofstee plot').

Note 2: A Michaelis–Menten equation is also applicable to the condition where E is present in large excess, in which case the total *concentration* $[\mathrm{E}]_o$ appears in the equation instead of $[\mathrm{S}]_o$.

Note 3: The term has sometimes been used to describe reactions that proceed according to the scheme:

$$E + S \underset{k_{-1}}{\overset{k_1}{\rightleftarrows}} ES \xrightarrow{k_{cat}} \text{Products}$$

in which case $K_M = (k_{-1} + k_{cat})/k_1$ (Briggs–Haldane conditions). It has more usually been applied only to the special case in which $k_{-1} >> k_{cat}$ and $K_M = k_{-1}/k_1 = K_S$, the dissociation constant of the complex. In this case, K_M is a true dissociation constant (Michaelis–Menten conditions).
See also *rate-controlling step*.

[3]

Michaelis–Menten mechanism Simplest mechanism that explains *Michaelis–Menten kinetics*.

Note 1: According to the mechanism, a substrate S first combines with a molecule of enzyme E, and this process is followed by a step in which the *enzyme*-substrate complex ES breaks down (sometimes with the participation of the solvent) into enzyme and reaction products:

$$E + S \underset{k_{-1}}{\overset{k_1}{\rightleftarrows}} ES$$

$$ES \xrightarrow{k_2} E + \text{Products}$$

If, as is usual, the substrate S is present in great excess of the enzyme it can be shown that steady-state conditions apply, and that the rate equation is:

$$\nu = \frac{k_2 [E]_o [S]_o}{(k_{-1} + k_1)/k_1 + [S]_o}$$

where $[\mathrm{E}]_o$, $[\mathrm{S}]_o$ are the total *concentrations* of enzyme and substrate. This equation is of the required general form of the Michaelis–Menten equation.

Note 2: Other, more complicated, mechanisms lead to the *Michaelis–Menten equation*, adherence to which therefore does not require that the Michaelis–Menten mechanism applies.

[2]

microalbuminuria Chronic presence of albumin in slight excess in urine.

microarray Grid of nucleic acid molecules of known sequence linked to a solid substrate, which can be probed with a sample containing either m*RNA* or *complementary DNA* from a cell or tissue to reveal changes in *gene* expression relative to a control sample.

Note: Microarray technology, which is also known as 'DNA gene chip' technology, allows the expression of many thousands of *genes* to be assessed in a single experiment.

After [8]

microcosm experimental model ecosystem Artificial test system that simulates major characteristics of the natural environment for the purposes of ecotoxicological assessment.

Note: Such a system would commonly have a terrestrial phase, with substrate, plants, and herbivores, and an aquatic phase, with vertebrates, invertebrates, and plankton. The term '*mesocosm*' implies a more complex and larger system than the term '*microcosm*', but the distinction is not clearly defined.

micromercurialism Early or subclinical effects of *exposure* to elemental mercury detected at the low *exposure* levels.

micronucleus test Test for *mutagenicity* in which animals are treated with a test agent after which time the frequency of micronucleated cells is determined; if a test group shows significantly increased levels of micronucleated cells compared to a control group, the chemical is considered capable of inducing chromosomal damage.

microproteinemia Chronic presence of microprotein (alpha-1 and beta-2 microglobulin) in blood, indicating proximal renal tubule damage.

microsome Artefactual spherical particle, not present in the living cell, derived from pieces of the *endoplasmic reticulum* present in homogenates of tissues or cells.

Note: Microsomes sediment from such homogenates (usually the *S*9 fraction) when centrifuged at 100 000 g for 60 min: The microsomal fraction obtained in this way is often used as a source of *monooxygenase enzymes*.

micturitic See *diuretic*.

midstream sampling Taking an *aliquot* of a flowing liquid, such as urine, avoiding initial and terminal flow periods which are likely to be unrepresentative.

[2]

Minamata disease Neurological *disease* caused by methylmercury, first seen in subjects ingesting contaminated fish from Minamata Bay in Japan.

mineralization Complete conversion of organic substances to inorganic derivatives, often visible as microscopic deposits which may be associated with damage to soft tissue (e.g., in the kidney).

minimal risk level (MRL) Estimate of the daily human *exposure* to a hazardous substance that is likely to be without appreciable risk of adverse noncancer *health* effects over a specified duration of exposure: This substance-specific estimate is used by ATSDR health assessors to identify contaminants and potential health effects that may be of concern at hazardous waste sites.

minimum lethal concentration (LC_{min}) Lowest *concentration* of a *toxic* substance in an environmental medium that kills individual organisms or test species under a defined set of conditions.

minimum lethal dose (LD_{min}) Lowest amount of a substance that, when introduced into the body, may cause death to individual species of test animals under a defined set of conditions.

miosis meiosis (obsolete) myosis Abnormal contraction of the pupil of the eye to less than 2 mm.

miscible Liquid substances capable of mixing without separation into two phases; refers to liquid mixtures.

miticide Substance intended to kill mites.

mitochondri/on sing., **/a** pl. Eukaryote cytoplasmic organelle that is bounded by an outer membrane and an inner membrane; the inner membrane has folds called cristae that are the center of ATP synthesis in oxidative phosphorylation in the animal cell and supplement ATP synthesis by the chloroplasts in photosynthetic cells.

Note: The mitochondrial matrix within the inner membrane contains ribosomes, many oxidative *enzymes*, and a circular *DNA* molecule that carries the genetic information for a number of these enzymes.

mitogen Substance that induces *lymphocyte* transformation or, more generally, *mitosis* and cell proliferation.

mitosis Process by which a cell *nucleus* divides into two daughter nuclei, each having the same genetic complement as the parent cell: Nuclear division is usually followed by cell division.

mixed-function oxidase (MFO) See *monooxygenase*.

modifying factor (MF) See *safety factor, uncertainty factor*.

molluskicide limacide molluscicide Substance intended to kill mollusks.

monitoring Continuous or repeated observation, measurement, and evaluation of *health* and (or) environmental or technical data for defined purposes, according to prearranged schedules in space and time, using comparable methods for sensing and data collection.

Note: Evaluation requires comparison with appropriate reference values based on knowledge of the probable relationship between ambient *exposure* and *adverse effects*.

monoclonal Pertaining to a specific protein from a single clone of cells, all molecules of this protein being the same.

monoclonal antibody *Antibody* produced by cloned cells derived from a single *lymphocyte*.

monooxygenase mixed-function oxidase *Enzyme* that catalyzes reactions between an organic compound and molecular oxygen in which one atom of the oxygen molecule is incorporated into the organic compound and one atom is reduced to water; involved in the *metabolism* of many natural and foreign compounds giving both unreactive products and products of different or increased *toxicity* from that of the parent compound.

Note: Such enzymes are the main catalysts of phase 1 reactions in the metabolism of *xenobiotics* by the *endoplasmic reticulum* or by preparations of *microsomes*.

Monte Carlo simulation Analysis of a sequence of events using random numbers to generate possible outcomes in an iterative process.

After [2]

morbidity Any departure, subjective or objective, from a state of physiological or psychological well-being: In this sense, 'sickness', 'illness', and 'morbid condition' are similarly defined and synonymous.

morbidity rate Term (to be avoided) used loosely to refer to *incidence* or *prevalence* rates of *disease*.

morbidity survey Method for the estimation of the *prevalence* and (or) *incidence* of a *disease* or diseases in a population.

mordant Substance that fixes a dyestuff in or on a material by combining with the dye to form an insoluble compound, used to fix or intensify stains in a tissue or cell preparation.

mortality Death as studied in a given population or subpopulation.

Note: The term 'mortality' is often used incorrectly instead of 'mortality rate'.

mortality rate See *death rate*.

mortality study Investigation dealing with death rates or proportion of deaths attributed to specific causes as a measure of response.

mucociliary transport Process of removal of particles from the bronchi of the lungs in a mucus stream moved by cilia, thus contributing to *uptake* from the gastrointestinal tract.

[2]

Mulliken population analysis Partitioning scheme based on the use of density and overlap matrices, at one time used for allocating the electrons of a molecular entity in some fractional manner among its various parts (atoms, bonds, orbitals).

[2]

multicompartment model Product of a *compartmental analysis* requiring more than two *compartments*.

[2]

multifactorial disease Illness with pathogenesis dependent on complex interplay of genetic and (or) environmental factors.

After [9]

multigeneration study

1. *Toxicity* test in which two to three generations of the test organism are *exposed* to the substance being assessed.
2. Toxicity test in which only one generation is exposed and effects on subsequent generations are assessed.

multiple chemical sensitivity (MCS) idiopathic environmental intolerance Intolerance condition attributed to extreme sensitivity to various environmental chemicals, found in air, food, water, building materials, or fabrics.

Note: This syndrome is characterized by the patient's belief that his or her symptoms are caused by very low-level *exposure* to environmental chemicals. The term 'chemical' is used to refer broadly to many natural and

man-made chemical agents, some of which have several chemical constituents. Several theories have been advanced to explain the cause of multiple chemical sensitivity, including allergy, toxic effects, and neurobiologic sensitization. There is insufficient scientific evidence to confirm a relationship between any of these possible causes and symptoms.

multiple (or multiphasic) screening Procedure that has evolved by combining single screening tests, and is the logical corollary of mass screening.

Note 1: Where much time and effort have been spent by a population in attending for a single test such as mass radiography, it is natural to consider the economy of offering other tests at the same time.

Note 2: Multiple (or multiphasic) screening implies the administration of a number of tests, in combination, to large groups of people.

multipotent Of a cell, capable of giving rise to several different kinds of structure or types of cell. [2]

multistage cluster sampling Cluster sampling with more than two stages, each sampling being made on aggregates (or clusters) in which the clusters already obtained by the preceding sampling have been divided.

multistage model *Dose–response* model for *cancer* death estimation of the form

$$P = 1 - \exp[-(q_o + q_1 d_1 + q_2 d_2 + \ldots + q_k d_k)]$$

where P is the probability of cancer death from a continuous *dose* rate, d_i, of group (or stage) $i = 0, 1, 2\ldots$, the q's are constants, and k is the number of dose groups (or, if less than the number of dose groups, k is the number of biological stages believed to be required in the *carcinogen*esis process). With the *multistage model*, it is assumed that cancer is initiated by cell *mutations* in a finite series of steps. [2]

multistage sampling Type of sampling in which the *sample* is selected by stages, the sampling units at each stage being subsampled from the larger units chosen at the previous stage.

multivariate statistics Set of statistical tools to analyze data matrices using regression and (or) pattern recognition techniques. [2]

murine Of or belonging to the family of rats and mice (Muridae).

mutagen Agent that can induce heritable changes (*mutation*s) of the *genotype* in a cell as a consequence of alterations in or loss of genetic material.

mutagenesis Induction (or generation) of heritable changes (*mutation*s) of the *genotype* in a cell as a consequence of alterations or loss of *genes* or *chromosome*s (or parts thereof).

mutagenicity Ability of a physical, chemical, or biological agent to induce (or generate) heritable changes (*mutation*s) in the *genotype* in a cell as a consequence of alterations or loss of *genes* or *chromosome*s (or parts thereof).

mutation Any relatively stable heritable change in genetic material that may be a chemical transformation of an individual *gene* (*gene* or point *mutation*), altering its function, or a rearrangement, gain, or loss of part of a *chromosome*, that may be microscopically visible (chromosomal mutation).

Note: Mutation can be either germinal, and inherited by subsequent generations, or somatic and passed through cell lineage by cell division.

myalgia Pain or tenderness in a muscle or group of muscles.

myasthenia Muscular weakness.

mycotoxin *Toxin* produced by a fungus.

Note: Examples are aflatoxins, tricothecenes, ochratoxin, and patulin.

mydriasis Extreme dilation of the pupil of the eye, either as a result of normal physiological response or in response to a chemical *exposure*.

myelosuppression Reduction of bone marrow activity leading to a lower *concentration* of platelets, red cells, and white cells in the blood.

nanoparticle Microscopic particle whose size is measured in nanometers, often restricted to so-called nanosized particles (NSPs; <100 nm in aerodynamic diameter), also called *ultrafine particles*.

nanotoxicology Scientific discipline involving the study of the actual or potential danger presented by the harmful effects of nanoparticles on living organisms and *ecosystems*, of the relationship of such harmful effects to *exposure*, and of the mechanisms of action, diagnosis, prevention, and treatment of intoxications.

narcotic

1. Nonspecific usage – an agent that produces insensibility or stupor.

2. Specific usage – an opioid, any natural or synthetic *drug* that has morphine-like actions.

natriuretic Substance increasing the rate of excretion of sodium ion in the urine.

natural occurrence Presence of a substance in nature, as distinct from presence resulting from inputs from human activities.

Note: The contamination of the natural environment by some man-made compounds may be so widespread that it is practically impossible to get access to biota with a truly natural level; only 'normal' levels can be measured, those which are usually prevalent in places where there is no obvious local contamination.

necropsy See *autopsy*.

necro/sis n., /**tic** adj. Sum of morphological changes resulting from cell death by lysis and (or) enzymatic degradation, usually accompanied by *inflammation* and affecting groups of cells in a tissue.

Note: Not to be confused with *apoptosis*.
[2]

negligible risk
1. Probability of *adverse effects* occurring that can reasonably be described as trivial.
2. Probability of adverse effects occurring that is so low that it cannot be reduced appreciably by increased regulation or investment of resources.

nematicide nematocide Substance intended to kill nematodes.

neonat/e n., /**al** adj. Infant during the first 4 weeks of postnatal life.

Note: For statistical purposes, some scientists have defined the period as the first 7 days of postnatal life. The precise definition varies from species to species.

neoplas/ia, -m New and abnormal formation of tissue as a *tumor* or growth by cell proliferation that is faster than normal and continues after the initial stimulus that initiated the proliferation has ceased.

nephritis *Inflammation* of the kidney, leading to kidney failure, usually accompanied by *proteinuria*, *hematuria*, *edema*, and *hypertension*.

nephropathy renopathy Any *disease* or abnormality of the kidney.

nephrosis *Disease* of the kidneys marked by degeneration of renal tubular epithelium.

nephrotoxic Chemically harmful to the cells of the kidney.

neural Pertaining to a nerve or to the nerves.

neurologic shellfish poisoning (NSP) Serious illness that is a consequence of consumption of toxic bivalve shellfish (mollusks) such as mussels, oysters, and clams that have ingested, by filter feeding, large quantities of microalgae containing brevetoxin: Symptoms include *gastroenteritis*; rectal burning; *paresthesias* of the face, trunk, and limbs; *myalgias*; *ataxia*; *vertigo*; and reversal of hot/cold sensation. See also *amnesic shellfish poisoning*, *diarrheal shellfish poisoning*.

neuron(e) Nerve cell, the morphological and functional unit of the central and peripheral nervous systems.

neuropathy Any *disease* of the central or peripheral nervous system.

neurotoxic/ adj., /**ity** n. Able to produce chemically an *adverse effect* on the nervous system: such effects may be subdivided into two types.
1. Central nervous system effects (including transient effects on mood or performance and presenile dementia such as Alzheimer's disease).
2. Peripheral nervous system effects (such as the inhibitory effects of organophosphorus compounds on synaptic transmission).

nitrification Sequential oxidation of ammonium salts to nitrite and nitrate by microorganisms.

nitrosative stress *Adverse effects* occurring when the generation of reactive nitrogen species in a system exceeds the system's ability to neutralize and eliminate them; nitrosative stress may lead to nitrosylation reactions that can alter protein structure, thus inhibiting normal function.

no-acceptable-daily-intake-allocated This expression is applicable to a substance for which the available information is not sufficient to establish its safety, or when the specifications for identity and purity are not adequate, or when the available data show that the substance is hazardous and should not be used.

Note: The basis for the use of the expression should be determined before action is taken; in the first two cases above, not being able to allocate an ADI does not mean that the substance is unsafe.

***n*-octanol-water partition coefficient** Obsolete for *octan-1-ol-water partition coefficient*. See *octan-1-ol-water partition coefficient*.

nodule Small node or boss that is solid and can be detected by touch.

no-effect dose (NED) subthreshold dose Amount of a substance that has no effect on the organism.

Note: It is lower than the *threshold* of harmful effect and is estimated while establishing the threshold of harmful effect.

no-effect level (NEL) Maximum dose (of a substance) that produces no detectable changes under defined conditions of *exposure*.

Note: This term tends to be substituted by *no-observed-adverse-effect level* (NOAEL) or *no observed-effect level* (NOEL).

non-bioenvironmental transformation Change in the chemical or physical nature of a substance occurring as a result of physicochemical conditions and independent of any biological system.

nonionizing radiation Electromagnetic radiation of low energy that is not capable of causing ionization.

nonoccupational exposure Environmental *exposure* outside the workplace to substances that are otherwise associated with particular work environments and (or) activities and processes that occur there.

nonstochastic See *deterministic*.

non-target organism Organism affected by a *pesticide* although not the intended object of its use.

no-observed-adverse-effect level (NOAEL) Greatest *concentration* or amount of a substance, found by experiment or observation, which causes no detectable adverse alteration of morphology, functional capacity, growth, development, or life span of the *target* organism under defined conditions of *exposure*.

no-observed-effect level (NOEL) Greatest *concentration* or amount of a substance, found by experiment or observation, that causes no alterations of morphology, functional capacity, growth, development, or life span of *target* organisms distinguishable from those observed in normal (control) organisms of the same species and strain under the same defined conditions of *exposure*.

no-response level (NRL) Maximum *dose* of a substance at which no specified response is observed in a defined population and under defined conditions of *exposure*.

nosocomial Associated with a hospital or infirmary, especially used of *diseases* that may result from treatment in such an institution.

noxious substance See *harmful substance*.

nucle/us (in cell biology) sing., **/i** pl. Compartment in the interphase eukaryotic cell bounded by a double membrane and containing the genomic *DNA*, with the associated functions of transcription and processing.

nuisance threshold Lowest *concentration* of an air pollutant that can be considered objectionable.

nutritional table method Procedure for evaluating the dietary intake of a large number of people.

Note 1: The accuracy of the method depends on the accuracy with which records of the food consumption can be established and the accuracy of the nutritional tables specifying the *concentration* of various nutrients, vitamins, essential, and non-essential substances including pesticide residues.

Note 2: For each record of quantity of food consumed during a certain time period, the daily intake of the substance in question is calculated by multiplying the substance concentration in the food item (as obtained from the nutritional table) by the quantity of food consumed and dividing by the time of observation.

nychthemeral circadian Relating to or exhibiting a nychthemeron or 24-h period.

nystagmus Involuntary, rapid, rhythmic movement (horizontal, vertical, rotary, mixed) of the eyeball, usually caused by a disorder of the labyrinth of the inner ear or a malfunction of the central nervous system.

objective environment Actual physical, chemical, and social environment as described by objective measurements, such as noise levels in decibels and *concentration*s of air *pollutants*.

occupational environment Surrounding conditions at a workplace.

occupational exposure Experience of substances, intensities of radiation, etc., or other conditions while at work.

occupational exposure limit (OEL) Regulatory level of *exposure* to substances, intensities of radiation, etc., or other conditions, specified appropriately in relevant government legislation or related codes of practice.

occupational exposure standard (OES)

1. Level of *exposure* to substances, intensities of radiation, etc., or other conditions considered to represent specified good practice and a realistic criterion for the control of exposure by appropriate plant design, engineering controls, and, if necessary, the addition and use of personal protective clothing.

2. In UK, *health*-based exposure limit defined under COSHH Regulations as the *concentration* of any airborne substance, averaged over a reference period, at which, according to current knowledge, there is no evidence that it is likely to be injurious to employees, if they are *exposed* by inhalation, day after day, to that concentration, and set on the advice of the HSE Advisory Committee on *Toxic* Substances.

occupational hygiene Identification, assessment, and control of physicochemical and biological factors in the workplace that may affect the *health* or well-being of those at work and in the surrounding community.

occupational medicine Specialty devoted to the prevention and management of occupational injury, illness, and disability, and the promotion of the *health* of workers, their families, and their communities.

occupational safety and health See *occupational hygiene*.

octan-1-ol–water partition coefficient, P_{ow}, K_{ow} Ratio of the solubility of a chemical in octan-1-ol divided by its solubility in water.

Note: Measure of *lipophilicity*, used in the assessment of both the uptake and physiological distribution of organic chemicals and prediction of their environmental fate.

ocular Pertaining to the eye.

odds Ratio of the probability of occurrence of an event to that of non-occurrence, or the ratio of the probability that something is so, to the probability that it is not so.

odds ratio (OR) θ cross-product ratio relative odds Quotient obtained by dividing one set of odds by another. The terms 'odds' or 'odds ratio' are defined differently according to the situation under discussion. Consider the following notation for the distribution of a binary *exposure* and a disease in a population or a *sample*.

	Exposed	Nonexposed
Disease	*a*	*b*
No disease	*c*	*d*

The odds ratio (cross-product ratio) is *ad/bc*.

Note 1: The *exposure*-odds ratio for a set of case control data is the ratio of the odds in favor of exposure among the cases (*a/b*) to the odds in favor of exposure among noncases (*c/d*), which is equal to *ad*/(*bc*). With incident cases, unbiased subject selection, and a 'rare' disease (say, under 2% cumulative *incidence* rate over the study period), *ad/bc* is an approximate estimate of the *risk* ratio. With incident cases, unbiased subject selection, and density sampling of controls, *ad/bc* is an estimate of the ratio of the person-time incidence rates (force of morbidity) in the *exposed* and unexposed. No rarity assumption is required for this.

Note 2: The disease-odds (rate-odds) ratio for a cohort or cross-section is the ratio of the odds in favor of disease among the exposed population (*a/c*) to the odds in favor of disease among the unexposed (*b/d*), which is equal to *ad/bc* and hence is equal to the exposure odds ratio for the cohort or cross-section.

Note 3: The *prevalence*-odds ratio refers to an odds ratio derived cross-sectionally, as, for example, an odds ratio derived from studies of prevalent (rather than incident) cases.

Note 4: The *risk*-odds ratio is the ratio of the odds in favor of getting disease, if exposed, to the odds in favor of getting disease if not *exposed*. The odds ratio derived from a cohort study is an estimate of this.

odor threshold odour threshold odor detection threshold In principle, the lowest *concentration* of an odorant in the air that can be detected by a human being.

Note: In practice, a panel of 'sniffers' is often used, and the *threshold* taken as the concentration at which 50% of the panel can detect the odorant (although some workers have also used 100% thresholds). The odor concentration at the detection threshold may be defined as one odor unit.

oedema See *edema*.

olf Unit used to measure scent emission of people and objects; one olf is defined as the scent emission of an 'average person', a sitting adult who takes an average of 0.7 baths per day and whose skin has a total area of $1.8\,m^2$; the scent emission of an object or person is measured by specially trained personnel comparing it to normed scents.

Note: The olf should not be confused with the of unit of scent immission (as opposed to emission), the *decipol*, which also takes into account the ventilation system's air volume flow.

olfactometer Apparatus for testing the power of the sense of smell.

oligozoospermia Sperm *concentration* less than a reference value.
[8]

oliguria Excretion of a diminished amount of urine in relation to fluid intake.

-omics, -omes Neologism referring to the fields of study in biology ending in the suffix -omics, such as *genomics* or *proteomics*: The related neologism -omes are the objects of study of the field such as the *genome* or *proteome*, respectively.

oncogene *Gene* that can cause neoplastic (see *neoplasia*) transformation of a cell; oncogenes are slightly changed equivalents of normal genes known as proto-oncogenes.

oncogenesis Production or causation of *tumors*.

oncogenic Capable of producing *tumors* in animals, either *benign* (noncancerous) or *malignant* (cancerous).
[9]

one-compartment model Kinetic model, where the whole body is thought of as a single *compartment* in which the substance distributes rapidly, achieving an *equilibrium* between blood and tissue immediately.
[2]

one-hit model *Dose–response* model of the form

$$P = 1 - e^{-bd}$$

where P is the probability of *cancer* death from a continuous *dose* rate, d, and b is a constant.

onycholysis Loosening or detachment of the nail from the nail bed following some destructive process.

oogenesis Process of formation of the ovum (plural ova), the female *gamete*.

operon Complete unit of *gene* expression and regulation, including structural genes, regulator gene(s), and control elements in *DNA* recognized by regulator gene product(s).

ophthalmic Pertaining to the eye.

organ dose Amount of a substance or physical agent (radiation) absorbed by an organ.

organelle Microstructure or separated compartment within a cell that has a specialized function, for example, ribosome, peroxisome, lysosome, Golgi apparatus, mitochondrion, nucleolus, nucleus.

organic carbon partition coefficient, K_{oc} Measure of the tendency for organic substances to be adsorbed by soil or sediment, expressed as:

$$K_{oc} = \frac{(\text{mass adsorbed substance})/(\text{mass organic carbon})}{(\text{mass concentration of absorbed substance})}$$

The K_{oc} is substance-specific and is largely independent of soil properties.

organoleptic
1. Relating to perception by a sensory organ.
2. Involving the use of sensory organs, e.g., organoleptic tests.

osteo- Prefix meaning pertaining to bone.

osteodystrophy Abnormal development of bone.

osteogenesis Formation or development of bone.

osteomalacia Condition marked by softening of the bones (due to impaired mineralization, with excess accumulation of osteoid), with pain, tenderness, muscular weakness, anorexia, and loss of weight, resulting from deficiency of vitamin D and calcium.

osteoporosis Significant decrease in bone mass with increased porosity and increased tendency to fracture.

ovicide Substance intended to kill eggs.

oxidative stress *Adverse effects* occurring when the generation of *reactive oxygen species* (ROS) in a system exceeds the system's ability to neutralize and eliminate them; excess ROS can damage a cell's lipids, protein, or *DNA*.

palpitation
1. Unduly rapid or throbbing heartbeat that is noted by a patient; it may be regular or irregular.
2. Undue awareness by a patient of a heartbeat that is otherwise normal.

paralysis Loss or impairment of motor function.

paralytic shellfish poisoning (PSP) Serious illness that is a consequence of consumption of toxic bivalve shellfish (mollusks) such as mussels, oysters, and clams that have ingested, by filter feeding, large quantities of microalgae containing saxitoxin or its derivatives.

Note: Initially there is tingling, numbness, and burning of the tongue and lips, which spreads to the face, neck, arms, fingertips, legs, and toes; this is followed by weakness of the upper and lower limbs, loss of motor coordination, and, in severe cases, paralysis.

para-occupational exposure
1. *Exposure* of a worker's family to substances carried from the workplace to the home.
2. Exposure of visitors to substances in the workplace.

parasympathetic Of, relating to, or affecting the parasympathetic nervous system which stimulates digestive secretions, slows the heart, constricts the pupils of the eyes, and dilates blood vessels. See *sympathetic nervous system*.

parasympatholytic Producing effects resembling those caused by interruption of the parasympathetic nerve; also called anticholinergic.

parasympathomimetic cholinomimetic Producing effects resembling those caused by stimulation of the parasympathetic nervous system.

parenteral dosage Method of introducing substances into an organism avoiding the gastrointestinal tract (subcutaneously, intravenously, intramuscularly, etc.).

paresis Slight or incomplete paralysis.

paresthesia paraesthesia Abnormal or unexplained tingling, pricking, or burning sensation on the skin.

particulate matter (in atmospheric chemistry)
1. General term used to describe airborne solid or liquid particles of all sizes.

   Note: The term *aerosol* is recommended to describe airborne particulate matter.
2. Particles in air, usually of a defined size and specified as PM_n where n is the maximum *aerodynamic diameter* (usually expressed in μm) of at least 50 % of the particles.

[2]

partition coefficient *Concentration* of a substance in one phase divided by the concentration of the substance in the other phase when the heterogeneous system of two phases is in *equilibrium*.

Note 1: The ratio of concentrations (or, strictly speaking, activities) of the same molecular species in the two phases is constant at constant temperature.

Note 2: The *octan-1-ol–water partition coefficient* is often used as a measure of the *bioconcentration* factor for modeling purposes.

[2]

Note 3: This term is in common usage in toxicology but is not recommended by IUPAC for use in chemistry and should not be used as a synonym for partition constant, partition ratio, or distribution ratio.

partition ratio, K_D Ratio of the *concentration* of a substance in a single definite form, A, in the extract to its *concentration* in the same form in the other phase at equilibrium, for example, for an aqueous/organic system:

$$K_D(A) = [A]^{org}/[A]^{aq}$$

[2]

passive sampler Device for taking samples of environmental media following diffusional contact with a suitable collecting material.
See *personal sampler*.

passive smoking Inhalation of sidestream smoke by people who do not smoke themselves.
See also *sidestream smoke*.

patch test Test for allergic sensitivity in which a suspected *allergen* is applied to the skin on a small surgical pad.

Note: Patch tests may be used to detect *exposure* to *pesticides*.

peak daily average concentration of an air pollutant See *maximum average daily concentration of an atmospheric pollutant*.

penetration (in cell biology)
1. Action of entering or passing through a cell membrane.
2. Ability or power to enter or pass through a cell membrane.

perceived environment perceived risk
See *subjective environment*.

percutaneous Through the skin following application on the skin.

perfusion (in physiology)
1. Act of pouring over or through, especially the passage of a fluid through the vessels of a specific organ.
2. Liquid poured over or through an organ or tissue.

[2]

perinatal Relating to the period shortly before and after birth, usually from the 20th to the 29th week of gestation to 1 to 4 weeks after birth.

peritoneal dialysis Method of artificial *detoxication* in which a *toxic* substance from the body is transferred into liquid that is instilled into the peritoneum.

Note: Effectively, this represents the employment of the peritoneum surrounding the abdominal cavity as a dialyzing membrane for the

purpose of removing *waste* products or toxins accumulated as a result of *renal* failure.

permeability Ability or power to enter or pass through a cell membrane.

permeability coefficient, *P* Quantity defining the permeability of molecules across a cell membrane and expressed as

$$P = \frac{KD}{\Delta x}$$

where K is the partition coefficient, D is the diffusion coefficient, and Δx is the thickness of the cell membrane.

Note: SI units m s^{-1}; frequently used units cm s^{-1}, with units cm^2 s^{-1} for D, cm for Δx.

permeable Of a membrane, allowing a given substance to pass through.

Note: When applied to nonbiological membranes with no qualification, the term normally refers to water.

permeation Action of entering or passing through a cell membrane.

permissible exposure limit (PEL) Recommendation by U.S. OSHA for a *time-weighted average concentration* that must not be exceeded during any 8-h work shift of a 40-h working week.

peroxisome *Organelle*, similar to a *lysosome*, characterized by its content of catalase (EC 1.11.1.6), peroxidase (EC 1.11.1.7), and other oxidative *enzymes*.

persistence Attribute of a substance that describes the length of time that the substance remains in a particular environment before it is physically removed or chemically or biologically transformed.

persistent inorganic pollutant (PIP) Inorganic substance that is stable in the environment, is liable to long-range transport, may bioaccumulate in human and animal tissue, and may have significant impacts on human health and the environment.

Note 1: Examples are arsenides, fluorides, cadmium salts, and lead salts.

Note 2: Some inorganic chemicals, like crocidolite asbestos, are persistent in almost all circumstances, but others, like metal sulfides, are persistent only in unreactive environments; sulfides can generate hydrogen sulfide in a reducing environment or sulfates and sulphuric acid in oxidizing environments. As with organic substances, persistence is often a function of environmental properties.

persistent organic pollutant (POP) Organic chemical that is stable in the environment, is liable to long-range transport, may bioaccumulate in human and animal tissue, and may have significant impacts on human health and the environment.

Examples: dioxin, PCBs, DDT, tributyltin oxide (TBTO).

Note: The Stockholm Convention on Persistent Organic Pollutants was adopted at a Conference of Plenipotentiaries held from 22 to 23 May 2001 in Stockholm, Sweden; by signing this convention, governments have agreed to take measures to eliminate or reduce the release of POPs into the environment.

personal monitoring Type of environmental monitoring in which an individual's *exposure* to a substance is measured and evaluated.

Note: This is normally carried out using a personal *sampler*.

personal protective device (PPD) individual protective device (IPD) personal protective equipment (PPE) Equipment (clothing, gloves, hard hat, respirator, etc.) worn by an individual to prevent *exposure* to a potentially *toxic* substance.

personal sampler individual sampler Compact, portable instrument for individual air sampling, measuring, or both, the content of a harmful substance in the respiration zone of a working person.
See also *passive sampler*.

pest Organism that may harm public *health*, attacks food and other materials essential to mankind, or otherwise affects human beings adversely.

pesticide A substance intended to kill pests.

Note: In common usage, any substance used for controlling, preventing, or destroying animal, microbiological, or plant pests.

pesticide residue Any substance or mixture of substances found in humans or animals or in food and water following use of a pesticide: the term includes any specified derivatives, such as degradation and conversion products, metabolites, reaction products, and impurities considered to be of toxicological significance.

phagocytosis Process by which particulate material is endocytosed by a cell.
[2]
See also *endocytosis, pinocytosis*.

pharmaceutical Medicinal *drug*.

pharmacodynamics Process of interaction of pharmacologically active substances with *target* sites in living systems, and the biochemical and physiological consequences leading to therapeutic or *adverse effect*s.
[2]

pharmacogenetics Study of the influence of genetic factors on the effects of *drug*s on individual organisms.
[2]

pharmacogenomics Methods and science permitting identification of the *gene*s which influence individual variation in the efficacy or toxicity of therapeutic agents, and the application of this information in clinical practice.
[2]

pharmacokinetics
1. Process of the *uptake* of *drug*s by the body, the *biotransformation* they undergo, the *distribution* of the *drug*s and their metabolites in the tissues, and the *elimination* of the drugs and their metabolites from the body.
2. Study of such processes.

[2]

pharmacology Science of the use and effects of *drug*s: may be subdivided into *pharmacokinetics* and *pharmacodynamics* defined above.
[2]

pharynx Throat, the part of the digestive tract between the esophagus below and the mouth and nasal cavities above and in front.

phase I reaction of *biotransformation* Enzymic modification of a substance by oxidation, reduction, hydrolysis, hydration, dehydrochlorination, or other reactions catalyzed by *enzymes* of the cytosol, of the *endoplasmic reticulum* (microsomal enzymes), or of other cell *organelles*.
See also *cytochrome P450*.

phase II reaction of *biotransformation* Binding of a substance, or its *metabolites* from a phase I reaction, with *endogenous* molecules (*conjugation*), making more water-soluble derivatives that may be excreted in the urine or bile.

Note: Phase II reactions include glucuronidation, sulfation, acetylation, amino acid (e.g., glycine), and glutathione conjugation.

phase III reaction of *biotransformation* Further *metabolism of conjugated metabolites* produced by *phase II reactions*.
[2]

phenome Complete phenotypic description of an organism (by analogy with *genome*).

phenotype Observable structural and functional characteristics of an organism determined by its *genotype* and modulated by its environment.

pheromone See *feromone*.

photo-irritation *Inflammation* of the skin caused by *exposure* to light, especially that due to *metabolites* formed in the skin by *photolysis*.

photolysis Cleavage of one or more covalent bonds in a molecular entity resulting from absorption of light, or a photochemical process in which such cleavage is an essential part.

Note: Term often used incorrectly to describe irradiation of a sample, although in the combination *flash photolysis* this usage is accepted.

[3]

photooxidation Oxidation reactions induced by light. Common processes are:
1. Loss of one or more electrons from a chemical species as a result of photoexcitation of that species.
2. Reaction of a substance with oxygen under the influence of ultraviolet, visible, or infrared light. When oxygen remains in the product, this latter process is also called photooxygenation. Reactions in which neither the substrate nor the oxygen are electronically excited (i.e., photosensitized oxidations) are sometimes called photoinitiated oxidations.

[3]

photophobia Abnormal visual intolerance of light.

photosensitization of skin Allergic reaction (see *allergy*) due to a metabolite formed by the influence of light.

phototoxicity *Adverse effect*s produced by *exposure* to light energy, especially those produced in the skin.

physical map (in genetics) Map showing how much *DNA*, measured in base pairs, separates two genes.

Note: Not to be confused with a genetic map which shows the position of genes in relation to each other, based on the frequency of crossing overs.

physiological availability See *bioavailability*.

physiological pharmacokinetic model See *physiologically based pharmacokinetic modeling*.

physiologically based pharmacokinetic modeling (PBPK) toxicologically based pharmacokinetic modeling Mathematical modeling of kinetic behavior

of a substance, based on measured physiological parameters.
[2]

pinocytosis Type of *endocytosis* in which soluble materials are taken up by the cell and incorporated into vesicles for digestion.
[2]

piscicide Substance intended to kill fish.

pivotal study See *critical study*.

placentation
1. Formation of a placenta in the uterus.
2. Type or structure of a placenta.
3. In botany, arrangement of placentas within the plant ovary.

plasma (in biology)
1. Fluid component of blood in which the blood cells and platelets are suspended.
2. Fluid component of semen produced by the accessory glands, the seminal vesicles, the prostate, and the bulbo-urethral glands.
3. Cell substance outside the nucleus (i.e., the cytoplasm).

plasma half life See *elimination half life*.

plasmapheresis Removal of blood from the body and centrifuging it to obtain *plasma* and packed red blood cells: The blood cells are resuspended in a physiologically compatible solution (usually type-specific fresh frozen plasma or albumin) and returned to the donor or injected into a patient who requires blood cells rather than whole blood.

plasmid Autonomous self-replicating extra-chromosomal circular *DNA* molecule present in bacteria and yeast.

Note 1: Plasmids replicate autonomously each time a bacterium divides and are transmitted to the daughter cells.

Note 2: DNA segments are commonly cloned using plasmid *vectors*.

After [9]

pleura Lining of the lung.

ploidy Term indicating the number of sets of *chromosome*s present in an organism.

plumbism saturnism Chronic poisoning caused by absorption of lead or lead salts.

pneumoconiosis Usually fibrosis of the lungs that develops owing to (prolonged) inhalation of inorganic or organic dusts.

Note: Cause-specific types of pneumoconiosis are:
1. anthracosis: from coal dust
2. asbestosis: from asbestos dust
3. byssinosis: from cotton dust
4. siderosis: from iron dust
5. silicosis: from silica dust
6. stannosis: from tin dust

pneumonitis *Inflammation* of the lung.

point mutation Change in a single base pair in *DNA*.

point source Single *emission* source in a defined location.

poison (in toxicology) Substance that, taken into or formed within the organism, impairs the *health* of the organism and may kill it.

poison-bearing Containing a *poison*.

poisoning intoxication Morbid condition produced by a *poison*.

pollutant Any undesirable solid, liquid, or gaseous matter in a solid, liquid, or gaseous environmental medium.

Note 1: 'Undesirability' is often *concentration*-dependent, low concentrations of most substances being tolerable or even essential in many cases.

Note 2: A primary pollutant is one emitted into the atmosphere, water, sediments, or soil from an identifiable source.

Note 3: A secondary pollutant is a pollutant formed by chemical reaction in the atmosphere, water, sediments, or soil.

pollution Introduction of *pollutants* into a solid, liquid, or gaseous environmental medium, the presence of pollutants in a solid, liquid, or gaseous environmental medium, or any undesirable modification of the composition of a solid, liquid, or gaseous environmental medium.

polyclonal antibody *Antibody* produced by a number of different cell types.

polydipsia Chronic excessive thirst.

polymerase chain reaction (PCR) Technique by which specific *DNA* segments are amplified selectively using cycles of annealing, chain extension, and thermal dissociation.
After [9]

polymorphism in metabolism polymorphia (in metabolism) Interindividual variations in *metabolism* of endogenous and *exogenous* compounds due to genetic influences, leading to enhanced side effects or *toxicity* of *drug*s (e.g., poor vs. fast metabolizers) or to different clinical effects (metabolism of steroid hormones).

polyuria Excessive production and discharge of urine.

population (in statistics) Totality of related items under consideration.

Note 1: A clearly defined part of a population is called a subpopulation. The term 'population segment' is sometimes used as a synonym for subpopulation.

Note 2: In the case of a random variable, the probability distribution is considered as defining the population of that variable.

population (in epidemiology) Assemblage of individuals with defined characteristics.

population at risk Persons who can and may develop an adverse *health* effect and who are potentially *exposed* to a substance under study. People already having chronic disease are excluded from the population at *risk* in studies of the *incidence* of the *adverse effect*.

[2]

population critical concentration (PCC) *Concentration* of a substance in the critical organ at which a specified percentage of the *exposed* population has reached the individual critical organ concentration.

Note: The percentage is indicated by PCC-10 for 10%, PCC-50 for 50%, etc. (similar to the use of the term LD_{50}).

population effect Absolute number or *incidence* rate of cases occurring in a group of people.

population risk See *societal risk*.

porphin(e) See *porphyrin*.

porphyria Disturbance of porphyrin *metabolism* characterized by increased formation, accumulation, and excretion of porphyrins and their precursors.

porphyrin porphin(e) Natural pigment containing a fundamental skeleton of four pyrrole nuclei united through the α-positions by four methine groups to form a macrocyclic structure.

posology Pharmacological study of the choice of appropriate *dose* of a drug in relation to the physiological factors, such as age, that may influence its effect.

post-translational modification Processes by which proteins are biochemically modified within a cell following their synthesis on the ribosomes.

potency (in toxicology) Expression of relative *toxicity* of an agent as compared to a given or implied standard or reference.

potentiation Dependent action in which a substance or physical agent at a *concentration* or *dose* that does not itself have an *adverse effect* enhances the harm done by another substance or physical agent.

See also *synergism*.

practical certainty (of safety) Numerically specified low *risk* of *exposure* to a potentially *toxic* substance (e.g., 1 in 1000) or socially acceptable low risk of *adverse effect*s from such an exposure applied to decision making in regard to chemical safety.

precautionary principle Approach to risk management that can be applied in circumstances of scientific uncertainty, reflecting a perceived need to take action in the face of a potentially serious risk without waiting for definitive results of scientific research.

Note: The 1992 Rio Declaration on Environment and Development says: 'In order to protect the environment, the precautionary approach shall be widely applied by states according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.'

precision (in metrology) Closeness of agreement between *indications* obtained by replicate measurements on the same or similar objects under specified conditions.

Note: Measurement precision is usually expressed numerically by measures of imprecision, such as standard deviation, variance, or coefficient of variation under the specified conditions of measurement.

[7]

precordial Pertaining to the region over the heart and lower thorax.

precursor Substance from which another, usually more biologically active, substance is formed.

predicted environmental concentration (PEC) predicted exposure concentration (PEC)

See *estimated environmental concentration*.

predicted exposure concentration (PEC) See *estimated environmental concentration*.

predicted no-effect concentration (PNEC) Concentration that is expected to cause no adverse effect to any naturally occurring population in an environment at risk from *exposure* to a given substance.

predictive validity Reliability of a measurement expressed in terms of its ability to predict the criterion: An example would be an academic aptitude

test that was validated against subsequent academic performance.

predictive value Percentage of positive results that are true positives or of negative results that are true negatives.

premature ovarian failure Follicular depletion by the age of 35 years.
[8]

preneoplastic Before the formation of a *tumor*.

prevalence Number of instances of existing cases of a given disease or other condition in a given population at a designated time; sometimes used to mean *prevalence rate*.

Note: When used without qualification, refers usually to the situation at a specified time (point prevalence).

prevalence rate (ratio) Total number of individuals who have an attribute or disease at a particular time (or during a particular period) divided by the population at *risk* of having the attribute or disease at this point in time or midway through the period.

primary pollutant See *pollutant*.

prior informed consent (PIC) Concept in law and medicine that states that before one is subjected to a risk, especially a risk of bodily harm, one is entitled to be fully informed well in advance of the nature of that *risk* in order to make an informed decision about whether to accept it or not.

primary protection standard Accepted maximum level of a *pollutant* (or its indicator) in the *target* organism, or some part thereof, or an accepted maximum intake of a pollutant or nuisance into the target under specified circumstances.

probability sample See *random sample*.

probit Probability unit obtained by adding 5 to the normal deviates of a standardized normal distribution of results from a dose–response study.

Note 1: Addition of 5 removes the complication of handling negative values.

Note 2: A plot of probit against the logarithm of *dose* or *concentration* gives a linear plot if the response follows a logarithmic normal distribution. Estimates of the LD_{50} and ED_{50} (or LC_{50} and EC_{50}) can be obtained from this plot.

procarcinogen Substance that has to be metabolized before it becomes a *carcinogen*.
[2]

prodrug Precursor converted to an active form of a *drug* within the body.
[2]

progression (in oncology) Increase in the size of a *tumor* or spread of *cancer* in the body.

prokaryote Unicellular organism, characterized by the absence of a membrane-enclosed nucleus.

Note: Prokaryotes include bacteria, blue–green algae, and mycoplasmas.

promoter (in molecular genetics) Sequence of nucleotides in a *DNA* molecule to which *RNA* polymerase binds so as to start transcription.

promoter (in oncology) Agent that induces *cancer* when administered to an animal or human being who has been *exposed* to a cancer *initiator*.

promotor Erroneous spelling of *promoter* (in molecular genetics), found in some literature.

pro-pesticide Substance applied in a form that is not active as a *pesticide* and which becomes active once it enters an organism and undergoes chemical modification.

prophage Latent state of a phage *genome* in a lysogenic bacterium.

proportional mortality rate (ratio) Proportion of observed deaths from a specified condition in a defined population divided by the proportion of deaths expected from this condition in a standard population, expressed either on an age-specific basis or after age adjustment.

prospective cohort study See *cohort study*.

prosthetic group Nonprotein entity essential for an *enzyme's* activity and tightly bound to the enzyme molecule in its active form.
[2]

proteinuria Excretion of excessive amounts of protein (derived from blood *plasma* or kidney tubules) in the urine.

proteome Description of the complete set of proteins encoded by the *genome*.
[2]

proteomics Global analysis of *gene* expression using a variety of techniques to identify and characterize proteins.

Note: It can be used to study changes caused by *exposure* to chemicals and to determine if changes in m*RNA* expression correlate with changes in protein expression: the analysis may also show changes in post-translational

modification, which cannot be distinguished by mRNA analysis alone.
[2]

provisional tolerable weekly intake (PTWI) See *tolerable weekly intake*.

pseudo-acceptable daily intake (PADI) Intake for a substance derived by applying a thousandfold uncertainty factor to the lowest low-effect level for noncarcinogenic endpoints.

pseudoadaptation Apparent adaptation of an organism to changing conditions of the environment (especially chemical) associated with stresses in biochemical systems that exceed the limits of normal (homeostatic) mechanisms.

Note: Essentially, there is a temporary concealed pathology that later on can be manifested in the form of explicit pathological changes sometimes referred to as 'decompensation'.

psychosis Any major mental disorder characterized by derangement of the personality and loss of contact with reality.

psychotropic Exerting an effect upon the mind and capable of modifying mental activity.

public health impact assessment Applying *risk* assessment to a specific target population of known size, giving as the end product a quantitative statement about the number of people likely to be affected in a particular population.

pulmonary Pertaining to the lung(s).
[2]

purgative See *laxative*.

pyrexia Condition in which the temperature of a human being or mammal is above normal.

pyrogen Any substance that produces fever.

quality assurance All those planned and systematic actions necessary to provide adequate confidence that a product or service will satisfy given requirements for quality.

quality control

1. Operational techniques and activities that are used to fulfill requirements for quality.
2. In toxicology, procedures incorporated in experimental protocols to reduce the possibility of error, especially human error.

Note: This is a requirement of *good laboratory practice*.

quantal Describing a condition that can be expressed only as 'occurring' or 'not occurring', such as death.
[2]

quantal effect all-or-none effect Antonym: *graded effect* Condition that can be expressed only as 'occurring' or 'not occurring', such as death or occurrence of a *tumor*.

quantitative structure–activity relationship (QSAR) Quantitative structure–biological activity model derived using *regression analysis* and containing as parameters physicochemical constants, indicator variables, or theoretically calculated values.

Note: The term is extended by some authors to include chemical reactivity, i.e., activity and reactivity are regarded as synonyms. This extension is discouraged.
[2]

quantitative structure–metabolism relationship (QSMR) Quantitative association between the physicochemical and (or) the structural properties of a substance and its metabolic behavior.
[2]

radiant power Power emitted, transferred, or received as radiation.

radiation toxicology Scientific study involving research, education, prevention, and treatment of diseases caused by ionizing or nonionizing radiation.

râles See *crepitations*.

random sample probability sample Antonym: *biased sample* Subset of units of a population that is arrived at by selecting units such that each possible unit has a fixed and known probability of selection.

rate (in epidemiology) Measure of the frequency with which an event occurs in a defined population in a specified period of time.

Note 1: Most such rates are ratios, calculated by dividing a numerator (e.g., the number of deaths) or newly occurring cases of a disease in a given period, by a denominator, (e.g., the average population during that period).

Note 2: Some rates are proportions, i.e., the numerator is contained within the denominator (as when a number of patients with a given disease is divided by the total population from which they come).
[2]

rate constant, k rate coefficient Numerical constant in a rate-of-reaction (v) equation; for example, $v = k$ [A]α[B]β…….where [A], [B] etc. are reactant concentrations, k is the rate constant, and α, β, etc. are corresponding empirical constants.

Note: For further consideration of the relevant mathematics, see [3].

rate-controlling step rate-determining step rate-limiting step In a reaction occurring by a composite reaction sequence, an elementary reaction, the rate constant for which exerts a strong effect – stronger than that of any other rate constant – on the overall rate.

Note 1: It is recommended that the expressions *rate-controlling*, *rate-determining*, and *rate-limiting* be regarded as synonymous, but some special meanings sometimes given to the last two expressions are considered under a separate heading.

Note 2: For further consideration of this term, see [3].
After [3]

rate-determining step See *rate-controlling step*.

rate difference (RD) Absolute difference between two *rates*.

Note 1: For example, the difference in *incidence* rate between a population group *exposed* to a causal factor and a population group not exposed to the factor.

Note 2: In comparisons of exposed and unexposed groups, the term *excess rate* may be used as a synonym for rate difference.

rate-limiting step See *rate-controlling step*.

rate ratio (in epidemiology) (RR) Value obtained by dividing the *rate* in an *exposed* population by the rate in an unexposed population.

ratticide Substance intended to kill rats.

reabsorption (in biology) *Absorption* by a living organism of a substance which it has previously absorbed and then released (e.g., the uptake of a substance from the proximal renal tubule following glomerular filtration).

reactive nitrogen species (RNS) Radical nitrogen-based molecules that can act to facilitate nitrosylation reactions; reactive nitrogen species include dioxidonitrogen(•) (nitrogen dioxide, nitryl radical) NO_2•, oxidonitrogen(•) (nitrogen monoxide, nitrosyl radical) $NO^{\bullet}$ oxidonitrogen(1+) (nitrosyl cation) NO^+, hydroxyoxidonitrogen (nitrous acid) HNO_2, and oxidonitrate(1−) NO^-.

reactive oxygen species (ROS) Intermediates in the reduction of molecular dioxygen O_2 to water.

Note: Examples are superoxide $O_2{}^-$•, hydrogen peroxide H_2O_2, and hydroxyl HO•.
[2]

readily biodegradable Arbitrary classification of substances that have passed certain specified screening tests for ultimate biodegradability; these tests are so stringent that such compounds will be rapidly and completely biodegraded in a wide variety of *aerobic* environments.
See also *biodegradation*.

reasonable maximum exposure (RME) Highest *exposure* that is reasonably expected to occur.

Note: Typically, the 95% upper confidence limit of the *toxicant* distribution is used: If only a few data points (6–10) are available, the maximum detected *concentration* is used.

recalcitrance Ability of a substance to remain in a particular environment in an unchanged form.

receptor Molecular structure in or on a cell which specifically recognizes and binds to a compound and acts as a physiological signal transducer or mediator of an effect.
[2]

receptor-mediated endocytosis *Endocytosis* of a substance and its *receptor* following receptor binding.
[2]

recessive gene *Allele* which in the heterozygous state is expected to have no effect on the *phenotype* of the organism which carries it.
After [9]

recombinant DNA *DNA* made by transplanting or splicing DNA into the DNA of host cells in such a way that the modified DNA can be replicated in the host cells in a normal fashion.

recombinant DNA technology Methods involving the use of *restriction enzymes* to cleave *DNA* at specific sites, allowing sections of DNA molecules to be inserted into *plasmid* or other vectors and cloned in an appropriate host organism (e.g., a bacterial or yeast cell).
After [9]

recommended exposure level (REL) (in toxicology) Highest allowable regulatory airborne concentration.

Note: This exposure concentration is not expected to injure workers. It may be expressed as a ceiling limit or as a time-weighted average (TWA).

reconstitution Restoration to original form of a substance previously altered for preservation and storage.
[2]

recovery

1. Process leading to partial or complete restoration of a cell, tissue, organ, or organism following its damage from *exposure* to a harmful substance or agent.

2. Term used in analytical and preparative chemistry to denote the fraction of the total quantity of a substance recoverable following a chemical procedure.

recovery factor Fraction or percentage of the total quantity of a substance extracted under specified conditions.

recycling (of waste) Process or method allowing for the recovery of some value from a *waste*, either as reusable material or as energy.

reference concentration (RfC) An estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation *exposure* to the human population (including sensitive subgroups which include children, asthmatics, and the elderly) that is likely to be without an appreciable risk of deleterious effects during a lifetime.

Note: It can be derived from various types of human or animal data such as NOAEL, LOAEL, or benchmark concentration, with uncertainty factors generally applied to reflect limitations of the data used. It is generally used in USEPA's noncancer health assessments.

reference distribution Statistical distribution of reference values.

reference dose (RfD) An estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral *exposure* to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.

Note: It can be derived from a NOAEL, LOAEL, or benchmark dose, with uncertainty factors generally applied to reflect limitations of the data used. It is generally used in USEPA's noncancer health assessments.

reference group See *reference sample group*.

reference individual Person selected with the use of defined criteria for comparative purposes in a clinical study.

reference interval Area between and including two reference limits, for example, the percentiles 2.5 and 97.5.

reference limit Boundary value defined so that a stated fraction of the reference values is less than or exceeds that boundary value with a stated probability.

reference material (RM) sufficiently homogeneous and stable regarding one or more properties, used in *calibration*, in assignment of a value to another material, or in quality assurance.
[7]

reference population Group of all reference individuals used to establish criteria against which a population that is being studied can be compared.

reference sample group Selected reference individuals, statistically adequate numerically to represent the reference population.

reference value Quantity value, generally accepted as having a suitably small measurement uncertainty, to be used as a basis for comparison with values of quantities of the same kind.
[14]

regioselectiv/ity n., -e adj. Terms referring to a reaction in which one direction of bond making or breaking occurs preferentially over all other possible directions.

Note: Reactions are termed completely (100%) regioselective if the discrimination is complete, or partially (x%), if the product of reaction at one site predominates over the product of reaction at other sites.
[2]

regression analysis Statistical methods for modeling a set of dependent variables, Y, in terms of combinations of predictors, X.
[2]

regulatory dose Term used by the USEPA to describe the expected dose resulting from human *exposure* to a substance at the level at which it is regulated in the environment.

regulatory sequence *DNA* sequence to which specific proteins bind to activate or repress the expression of a *gene*.

relative excess risk (RER) Measure that can be used in comparison of adverse reactions to *drugs*, or other *exposures*, based solely on the component of *risk* due to the exposure or drug under investigation, removing the risk due to background exposure experienced by all in the population. The *relative excess risk*, R, is given by

$$R = (R_1 - R_0)/(R_2 - R_0)$$

where R_1 is the *rate* in the population, R_2 is the rate in the comparison population, and R_0 is the rate in the general population.

Note: Rate is used here as in epidemiology.
[2]

relative odds See *odds ratio*.

relative risk (RR) risk ratio rate ratio

1. Ratio of the *risk* of disease or death among the *exposed* to the risk among the unexposed.

2. Ratio of the *cumulative incidence rate* in the exposed to the cumulative incidence rate in the unexposed.

relative systemic availability Quantity of metabolizable substance divided by product of quantity of absorbed substance and *exposure*.
[2]

remediation
1. Giving a remedy.
2. Removal of pollution or contaminants from environmental media such as soil, groundwater, sediment, or surface water for the general protection of human health and the environment.

remedy Anything, such as a medicine or therapy, that relieves pain, cures disease, or corrects a disorder.

renal Pertaining to the kidneys.
[2]

renal plasma flow Volume of *plasma* passing through the kidneys in unit time.
[2]

renopathy See *nephropathy*.

repeatability measurement repeatability Measurement precision under *repeatability* conditions of measurement.
[14]

repeatability condition repeatability condition of measurement Condition of measurement in a set of conditions including the same measurement procedure, operator, measuring system, operating conditions, and location, and replicated measurements over a short period of time.
[14]

repellent Substance used mainly to repel blood-sucking insects in order to protect humans and animals.

Note: This term may also be used for substances used to repel mammals, birds, rodents, mites, plant pests, etc.

replicate sampling Act of taking multiple *sample*s concurrently under comparable conditions.

Note: Replicate sampling may be accomplished by taking samples adjacent in time or space.

replication
1. Duplicated or repeated performance of an experiment under similar (controlled) conditions to reduce to a minimum the error, and to estimate the variations and thus obtain a more precise result: Each determination, including the first, is called a replicate.
2. Process whereby the genetic material is duplicated.

reproducibility measurement reproducibility Measurement precision under reproducibility conditions of measurement.
[14]

reproducibility condition reproducibility condition of measurement Condition of measurement in a set of conditions including different locations, operators, and measuring systems.

Note 1: The different measuring systems may use different measurement procedures.

Note 2: A specification should give the conditions changed and unchanged, to the extent practical.

[14]

reproductive toxicant Substance or preparation that produces nonheritable *adverse effects* on male and female reproductive function or capacity and on resultant progeny.

reproductive toxicology Study of the nonheritable *adverse effect*s of substances on male and female reproductive function or capacity and on resultant progeny.

reserve capacity Physiological or biochemical capacity that may be available to maintain homeostasis when the body or an organism is *exposed* to an environmental change.

reservoir (in biology) Storage *compartment* from which a substance may be released with subsequent biological effects.
[2]

residence time See *mean residence time*.

residual risk *Health risk* remaining after risk reduction actions are implemented.
[2]

residual time See *mean residence time*.

residue *Contaminant* remaining in an organism or in other material such as food or packaging, following *exposure*.

resistance (in toxicology) Ability to withstand the effect of various factors, including potentially *toxic* substances.

resorption (in biology) Process in which the components of some differentiated structure that has been produced by the body undergo lysis and assimilation.

Note: Specifically in developmental toxicology, term applied to the lysis and assimilation of the fetus caused by chemical or biological stress of the pregnant mother.

resorptive effect Action of a substance after its reabsorption from the gut into the blood.

respirable dust respirable particles Mass fraction of dust (particles) that penetrates to the unciliated airways of the lung (the alveolar region).

Note: This fraction is represented by a cumulative log-normal curve having a median aerodynamic diameter of 4μm, standard deviation 2μm (values for humans).

[2]

response Proportion of an *exposed* population with a defined effect or the proportion of a group of individuals that demonstrates a defined effect in a given time at a given *dose rate*.

restriction enzymes Endonucleases that recognize specific base sequences within a *DNA* helix, creating a double-strand break of DNA.

Note: Type I restriction *enzymes* bind to these recognition sites but subsequently cut the DNA at different sites. Type II restriction enzymes both bind and cut within their recognition or *target* sites.

[3]

retention

1. Amount of a substance that is left from the total absorbed after a certain time following *exposure*.
2. Holding back within the body or within an organ, tissue, or cell of matter that is normally eliminated.

retrospective study Research design used to test etiological hypotheses in which inferences about *exposure* to the putative causal factor(s) are derived from data relating to characteristics of the persons or organisms under study or to events or experiences in their past.

Note: The essential feature is that some of the persons under study have the *disease* or other outcome condition of interest, and their characteristics and past experiences are compared with those of other, unaffected persons. Persons who differ in the severity of the disease may also be compared.

returned effect of poisons Enhancement of the *dose–effect* relationship for a poison following repeated *exposure* to decreasing doses.

reverse mutation (back mutation) *Mutation* in a mutant *allele* which makes it capable of producing the nonmutant *phenotype*; this may result from restoration of the original *DNA* sequence of the *gene* or from production of a new DNA sequence which has the same effect.

reverse transcription Process by which an *RNA* molecule is used as a template to make a single-stranded *DNA* copy.

reversible alteration Change from normal structure or function, induced by a substance or other agent(s), that returns to normal status or within normal limits after cessation of *exposure*.

rhabdomyolysis Acute, fulminating, potentially lethal disease of skeletal muscle that causes disintegration of striated muscle fibers as evidenced by myoglobin in the blood and urine.

rhinitis *Inflammation* of the nasal mucosa.

rhonch/us sing., /i pl. Harsh *crepitation* in the throat, often resembling snoring.

ribonucleic acid (RNA) Linear, usually single-stranded, polymer of ribonucleotides, each containing the sugar ribose in association with a phosphate group and one of four nitrogenous bases: adenine, guanine, cytosine, or uracil.

Note: RNA encodes the information for the sequence of amino acids in proteins synthesized using it as a template.

risk

1. Probability of *adverse effects* caused under specified circumstances by an agent in an organism, a population, or an ecological system.
2. Probability of a hazard causing an adverse effect.
3. Expected frequency of occurrence of a harmful event arising from such an *exposure.*

After [2]

risk assessment Identification and quantification of the *risk* resulting from a specific use or occurrence of a chemical or physical agent, taking into account possible harmful effects on individuals or populations *exposed* to the agent in the amount and manner proposed and all the possible routes of *exposure*.

Note: Quantification ideally requires the establishment of *dose–effect* and *dose–response* relationships in likely *target* individuals and populations.

risk assessment management process Global term for the whole process from *hazard* identification to *risk* management.

risk associated with a lifetime exposure Probability of the occurrence of a specified undesirable event following *exposure* of an individual person from a given population to a specified substance at a defined level for the expected lifetime of the average member of that population.

risk aversion Tendency of an individual person to avoid *risk*.

risk characterization Outcome of *hazard* identification and *risk* estimation applied to a specific use of a substance or occurrence of an environmental *health* hazard.

Note: Risk characterization requires quantitative data on the *exposure* of organisms or people at risk in the specific situation. The end product is a quantitative statement about the proportion of organisms or people affected in a target population.

risk communication Interpretation and communication of *risk* assessments in terms that are comprehensible to the general public or to others without specialist knowledge.

risk *de minimis* negligible risk *Risk* that is negligible and too small to be of societal concern (usually assumed to be a probability below 10^{-5} or 10^{-6}).

Note 1: This term can also mean 'virtually safe'.

Note 2: In the United States, this is a legal term used to mean 'negligible risk to the individual'.

risk estimation Assessment, with or without mathematical modeling, of the probability and nature of effects of *exposure* to a substance based on quantification of *dose–effect* and *dose–response* relationships for that substance and the population(s) and environmental components likely to be *exposed* and on assessment of the levels of potential exposure of people, organisms, and environment at *risk*.

risk evaluation Establishment of a qualitative or quantitative relationship between *risk*s and benefits, involving the complex process of determining the significance of the identified *hazard*s and estimated risks to those organisms or people concerned with or affected by them.

risk identification Recognition of a potential *hazard* and definition of the factors required to assess the probability of *exposure* of organisms or people to that hazard and of harm resulting from such exposure.

risk indicator See *risk marker*.

risk management Decision-making process involving considerations of political, social, economic, and engineering factors with relevant *risk* assessments relating to a potential *hazard* so as to develop, analyze, and compare regulatory options and to select the optimal regulatory response for safety from that hazard.

Note: Essentially risk management is the combination of three steps: *risk evaluation*; *emission* and *exposure* control; *risk monitoring*.

risk marker risk indicator Attribute that is associated with an increased probability of occurrence of a disease or other specified outcome and that can be used as an indicator of this increased *risk*.

Note: A risk marker is not necessarily a causal factor.

risk monitoring Process of following up the decisions and actions within *risk management* in order to check whether the aims of reduced *exposure* and risk are achieved.

risk perception Subjective perception of the gravity or importance of the *risk* based on a person's knowledge of different risks and the moral, economic, and political judgment of their implications.

risk phrases Word groups identifying potential *health* or environmental *hazard*s required under CPL Directives (European Community); may be incorporated into *Safety* Data Sheets.

risk quotient Ratio of *predicted environmental concentration* to *predicted no-effect concentration*.

Note: The higher this value above 1, the greater the risk. If the value is below 1, there should be no risk as a result of the predicted *exposure*.

risk ratio Value obtained by dividing the probability of occurrence of a specific effect in one group by the probability of occurrence of the same effect in another group, or the value obtained by dividing the probability of occurrence of one potentially hazardous event by the probability of occurrence of another.

Note: Calculation of such ratios is used in choosing between options in *risk management*.

risk-specific dose Amount of *exposure* corresponding to a specified level of *risk*.

RNA See *ribonucleic acid*.

rodenticide Substance intended to kill rodents.

route of *exposure* Means by which a *toxic* agent gains access to an organism by administration through the gastrointestinal tract (ingestion), lungs (inhalation), skin (topical), or by other routes such as intravenous, subcutaneous, intramuscular, or intraperitoneal routes.

S9 fraction Supernatant fraction obtained from an organ (usually liver) homogenate by centrifuging at $9000\,g$ for 20 min in a suitable medium; this fraction contains cytosol and microsomes.

safety Reciprocal of *risk*: practical certainty that injury will not result from a *hazard* under defined conditions.

Note 1: Safety of a *drug* or other substance in the context of human *health*: the extent to

which a substance may be used in the amount necessary for the intended therapeutic purpose with a minimum risk of *adverse* health *effects*.

Note 2: Safety (toxicological): The high probability that injury will not result from *exposure* to a substance under defined conditions of quantity and manner of use, ideally controlled to minimize exposure.

safety data sheet Single page giving toxicological and other *safety* advice, usually associated with a particular preparation, substance, or process.

safety factor (SF) See *uncertainty factor*.

safety pharmacology Science directed to the discovery, development, and safe therapeutic use of biologically active substances as a result of the identification, monitoring, and characterization of potentially undesirable pharmacodynamic activities of these substances in nonclinical studies.

saluretic See *natriuretic*. sample (in statistics)

1. Group of individuals often taken at random from a population for research purposes.
2. One or more items taken from a population or a process and intended to provide information on the population or process.
3. Portion of material selected from a larger quantity so as to be representative of the whole.

sampling error That part of the total error (the estimate from a *sample* minus the population value) associated with using only a fraction of the population and extrapolating to the whole, as distinct from analytical or test error.

Note: Sampling error arises from a lack of homogeneity in the parent population.

[2]

sarcoma *Malignant tumor* arising in a connective tissue and composed primarily of *anaplastic* cells resembling supportive tissue (see *anaplasia*).

saturable elimination *Elimination* that becomes *concentration*-independent at a concentration at which the elimination process is functioning maximally.

[2]

saturnia Pain in a joint resulting from lead poisoning.

saturnism plumbism Intoxication caused by lead. *Scatchard plot* Method for analyzing data for freely reversible ligand/*receptor* binding interactions.

Note: The graphical plot is [bound ligand]/[free ligand] against [bound ligand], with slope the negative reciprocal of the binding affinity and intercept on the *x*-axis the number of receptors.

[2]

scotoma Area of diminished or lost vision within the visual field, surrounded by an area of less affected or normal vision.

sclerosis Hardening of an organ or tissue, especially that due to excessive growth of fibrous tissue.

screening

1. Carrying out of a test(s), examination(s), or procedure(s) in order to expose undetected abnormalities, unrecognized (incipient) diseases, or defects: Examples are mass X-rays and cervical smears.
2. Pharmacological or toxicological screening consists of a specified set of procedures to which a series of compounds is subjected to characterize pharmacological and toxicological properties and to establish *dose–effect* and *dose–response* relationships.

screening level Decision limit or cut-off point at which a *screening* test is regarded as positive.

secondary metabolite Product of biochemical processes other than the normal metabolic pathways, mostly produced in microorganisms or plants after the phase of active growth and under conditions of nutrient deficiency.

secondhand smoke See *sidestream smoke*.

second messenger Intracellular effector substance increasing or decreasing as a result of the stimulation of a *receptor* by an *agonist*, considered as the 'first messenger'.

[2]

secretion

1. Process by which a substance such as a hormone or *enzyme* produced in a cell is passed through a *plasma membrane* to the outside, for example, the intestinal lumen or the blood (internal secretion).
2. Solid, liquid, or gaseous material passed from the inside of a cell through a plasma membrane to the outside as a result of cell activity.

sedative Substance that exerts a soothing or tranquillizing effect.

self-cleaning of water (in a reservoir) Water purification by natural biological and physicochemical processes.

self-purification of the atmosphere Purification of the atmosphere from contaminants by natural biological and physicochemical processes.

semichronic See *subchronic*.

semiochemical Substance produced by plants or animals, or a synthetic analogue thereof, that evokes a behavioral response in individuals of the producing species or other species (e.g., *allomones*, *kairomones*, *pheromones*, and *synomones*).

semipermeable (selectively or differentially permeable) membrane Membrane that will preferentially allow certain molecules or ions to pass through it while preventing the passage of others.

sensibilization See *sensitization*.

sensitivity (in metrology and analytical chemistry),

1. Quotient of the change in the *indication* and the corresponding change in the value of the quantity being measured.

[7]

2. Slope of the calibration curve. If the curve is in fact a 'curve', rather than a straight line, then of course sensitivity will be a function of analyte concentration or amount. If sensitivity is to be a unique performance characteristic, it must depend only on the chemical measurement process, not upon scale factors.

[3]

sensitivity (of a screening test) Extent (usually expressed as a percentage) to which a method gives results that are free from false negatives.

Note 1: The fewer the false negatives, the greater the sensitivity.

Note 2: Quantitatively, sensitivity is the proportion of truly diseased persons in the screened population who are identified as diseased by the screening test.

sensitization *Immune response* whereby individuals become *hypersensitive* to substances, pollen, dandruff, or other agents that make them develop a potentially harmful *allergy* when they are subsequently *exposed* to the sensitizing material (*allergen*).

sensitizer Substance causing *sensitization*.

sensory effect level

1. Intensity, where the detection *threshold* level is defined as the lower limit of the perceived intensity range (by convention, the lowest *concentration* that can be detected in 50% of the cases in which it is present).
2. Quality, where the recognition threshold level is defined as the lowest concentration at which the sensory effect can be recognized correctly in 50% of the cases.
3. Acceptability and annoyance, where the nuisance threshold level is defined as the concentration at which not more than a small proportion of the population, less than 5%, experiences annoyance for a small part of the time, less than 2%.

Note: Since annoyance will be influenced by a number of factors, a nuisance threshold level cannot be set on the basis of concentration alone.

serum Clear watery fluid especially that moistens the surface of serous membranes or that exudes through *inflammation* of any of these membranes.

[2]

serum blood serum Watery proteinaceous portion of the blood that remains after clotting.

[2]

shellfish poisoning Serious illness which is a consequence of consumption of bivalve shellfish (mollusks) such as mussels, oysters, and clams that have ingested, by filter feeding, large quantities of microalgae. See *amnesic shellfish poisoning, diarrheal shellfish poisoning, neurologic shellfish poisoning, paralytic shellfish poisoning*.

short-term effect See *acute effect*.

short-term exposure limit (STEL) Fifteen-minute *time-weighted average* (TWA) *exposure* recommended by ACGIH which should not be exceeded at any time during a workday, even if the 8-h TWA is within the *threshold limit value: time-weighted average*, TLV-TWA.

Note: Workers can be exposed to a maximum of four STEL periods per 8-h shift, with at least 60 min between exposure periods.

[2]

short-term toxicity See *acute toxicity*.

side-effect Action of a *drug* other than that desired for beneficial pharmacological effect.

siderosis

1. *Pneumoconiosis* resulting from the inhalation of iron dust.
2. Excess of iron in the urine, blood, or tissues, characterized by hemosiderin granules in urine and iron deposits in tissues.

sidestream smoke environmental tobacco smoke (ETS) secondhand smoke Cloud of small particles and gases that is given off from the end of a burning tobacco product (cigarette, pipe, cigar) between puffs and is not directly inhaled by the smoker.

Note: This is the smoke that gives rise to passive inhalation on the part of bystanders.

sign Objective evidence of a disease, deformity, or an effect induced by an agent, perceptible to an examining physician.

signal transduction Molecular pathways through which a cell senses changes in its external or internal environment and changes its pattern of *gene* expression or *enzyme* activity in response.
After [9]

silicosis *Pneumoconiosis* resulting from inhalation of silica dust.

simulation test Procedure designed to predict the rate of *biodegradation* of a compound under relevant environmental conditions.

single nucleotide polymorphism (SNP) Single base variation at a chromosomal locus which exists stably within populations (typically defined as each variant form being present in at least 1–2% of individuals).
After [8]

sink In environmental chemistry, an area or part of the environment in which, or a process by which, one or more *pollutants* is removed from the medium in which it is dispersed.

Note: For example, moist ground acts as a sink for sulfur dioxide in the air.

sister chromatid exchange (SCE) Reciprocal exchange of *chromatin* between two replicated *chromosome*s that remain attached to each other until anaphase of *mitosis*; used as a measure of *mutagenicity* of substances that produce this effect.

skeletal fluorosis Osteosclerosis due to fluoride.

slimicide Substance intended to kill slime-producing organisms.

Note: Used on paper stock, water cooling systems, paving stones, etc.

slope factor Value, in inverse *concentration* or *dose* units, derived from the slope of a *dose–response* curve; in practice, limited to *carcinogenic* effects with the curve assumed to be linear at low concentrations or doses.

Note: The product of the slope factor and the *exposure* is taken to reflect the probability of producing the related effect.

societal risk Total probability of harm to a human population including the probability of *adverse effects* to *health* of descendants and the probability of disruption resulting from loss of services such as industrial plant or loss of material goods and electricity.

soil partition coefficient (soil K_d) Experimental ratio of a substance's concentration in the soil to that in the aqueous (dissolved) soil phase at equilibrium: It is valid only for the specific concentration and solid/solution ratio of the test.

See also *organic carbon partition coefficient*.
[6]

solvent abuse solvent sniffing Deliberate inhalation (or drinking) of volatile solvents, in order to become intoxicated.

solvent-sniffing See *solvent abuse*.

somatic
1. Pertaining to the body as opposed to the mind.
2. Pertaining to nonreproductive cells or tissues.
3. Pertaining to the framework of the body as opposed to the viscera.

soporific Substance producing sleep.

sorption Noncommittal term used instead of *adsorption* or *absorption* when it is difficult to discriminate experimentally between these two processes.

speciation (in chemistry) *Distribution* of an element among defined *chemical species* in a system.
[3]

speciation analysis (in chemistry) Analytical activities of identifying and (or) measuring the quantities of one or more individual *chemical species* in a *sample*.
[3]

species
1. In biological systematics, group of organisms of common ancestry that are able to reproduce only among themselves and that are usually geographically distinct.
2. See *chemical species*.

species differences in sensitivity Quantitative or qualitative differences of response to the action(s) of a potentially *toxic* substance on various species of living organisms.

species-specific sensitivity Quantitative and qualitative features of response to the action(s) of a potentially *toxic* substance that are characteristic for a particular species of living organism.

specific death rate Death rate computed for a subpopulation of individual organisms or people having a specified characteristic or attribute, and named accordingly.

Example: Age-specific death rate, the number of deaths of persons of a specified age during a given period of time, divided by the total number of persons of that age in the population during that time.

specificity (of a screening test) Proportion of truly nondiseased persons who are identified by the screening test.

specific pathogen free (SPF) Describing an animal removed from its mother under sterile conditions

just prior to term and subsequently reared and kept under sterile conditions.

specimen Specifically selected portion of any substance, material, organism (specifically tissue, blood, urine, or feces) or environmental medium assumed to be representative of the parent substance, etc. at the time it is taken for the purpose of diagnosis, identification, study, or demonstration.

spectral radiant power The radiant power at wavelength lambda (λ) per unit wavelength interval.

splicing Processes through which *introns* are removed from a m*RNA* prior to translation and the *exons* joined.
[9]

spreader Agent used in some *pesticide* formulations to extend the even disposition of the active ingredient.

stability half life (half time) Time required for the amount of a substance in a formulation to decrease, for any reason, by one-half (50%).
See also *half life, half time*.

standard That which is established as a measure or model to which others of a similar nature should conform.

standard (in law or regulation) technical directive Technical specification, usually in the form of a document available to the public, drawn up with the consensus or general approval of all interests affected by it, based on the consolidated results of science, technology, and experience, aimed at the promotion of optimum community benefits and approved by a body recognized on the national, regional, or international level.

standard (in analytical chemistry) See *reference material*, *standard material.*

standardization
1. Making any substance, *drug*, or other preparation conform to type or precisely defined characteristics.
2. Establishment of precisely defined characteristics, or precisely defined methods, for future reference.
3. Definition of precise procedures for administering, scoring, and evaluating the results of a new method that is under development.

standard material (in analytical chemistry) standard
See *reference material*.

standard(ized) morbidity ratio (SMR) Ratio of the number of patients with a particular *disease* observed in a study group or population to the total number of people in the group or population multiplied by 100.

Note: This ratio is usually expressed as a percentage.

standard(ized) mortality ratio (SMR) Ratio of the number of deaths observed in the study group or population to the number of deaths that would be expected if the study population had the same specific rates as the standard population, multiplied by 100.

Note: This ratio is usually expressed as a percentage.

stannosis *Pneumoconiosis* resulting from inhalation of tin dust.

steady state (in chemistry and toxicology) State of a system in which the conditions do not change in time.

Note: For further information, see [3].
[2]

stem cell *Multipotent* cell with mitotic potential that may serve as a precursor for many kinds of differentiated cells.
[2]

stereoselective synthesis Chemical reaction (or reaction sequence) in which one or more new elements of chirality are formed in a substrate molecule and which produces the stereoisomeric (enantiomeric or diastereoisomeric) products in unequal amounts.

Note: Traditionally called asymmetric synthesis.
[2]

stereoselectivity Specificity of chemical reactivity of stereoisomers based on their three-dimensional molecular structure.
[2]

stochastic Pertaining to or arising from chance and hence obeying the laws of probability.

stochastic effect stochastic process Phenomenon pertaining to or arising from chance, and hence obeying the laws of probability.

stochastic process See *stochastic effect*.

stratification (in epidemiology) Process of or result of separating a *sample* into several subsamples according to specified criteria such as age groups, socioeconomic status, etc.

stratified sample Subset of a population selected according to some important characteristic.

stress proteins See *heat shock proteins*.

structural alert Chemical grouping which is known to be associated with a particular type of toxic effect (e.g., mutagenicity).

structure–activity relationship (SAR) Association between specific aspects of molecular structure and defined biological action.
See also *quantitative structure–activity relationship*.

structure–metabolism relationship (SMR) Association between the physicochemical and (or) the structural properties of a substance and its metabolic behavior.
[2]

subacute See *subchronic*.

subchronic Repeated over a short period, usually about 10% of the life span; an imprecise term used to describe *exposure*s of intermediate duration.

subchronic effect Biological change resulting from an environmental alteration lasting about 10% of the lifetime of the test organism.

Note: In practice with experimental animals, such an effect is usually identified as resulting from multiple or continuous *exposures* occurring over 3 months (90 days). Sometimes a subchronic effect is distinguished from a *subacute* effect on the basis of its lasting for a much longer time.

subchronic toxicity test Animal experiment serving to study the effects produced by the test substance when administered in repeated *doses* (or continually in food, drinking water, air) over a period of up to about 90 days.

subclinical effect Biological change with detectable symptoms following *exposure* to an agent known to cause *disease* either before symptoms of the disease occur or when they are absent.

subfertility Fertility below the normal range for a given species.
[8]

subjective environment perceived environment
Surrounding conditions as perceived by persons living in these conditions.

substrate (in biology)
1. Substance material on which an *enzyme* acts.
2. Surface on which an organism grows or to which is attached.

subthreshold dose See *no-effect dose*.

sudorific See *diaphoretic*.

sufficient evidence According to the USEPA's Guidelines for *Carcinogen Risk Assessment*, sufficient evidence is a collection of facts and scientific references that is definite enough to establish that an *adverse effect* is caused by the agent in question.

suggested no-adverse-response level (SNARL) Maximum *dose* or *concentration* that on current understanding is likely to be tolerated by an *exposed* organism without producing any harm.

suicide reaction Formation of irreversible cleavage complexes (also referred to as "suicide complexes") leading to cell death.

summary sheet Two-to-four page summary of a *risk assessment*.

summation (in neurophysiology) Process of addition of separate postsynaptic responses caused by stimuli that are adjacent in time and space.

Note: Excitation of a synapse evokes a graded potential change in the postsynaptic membrane that may be below the threshold required to trigger an impulse. If two or more such potentials are caused either nearly simultaneously, at different synapses on the same neuron (spatial summation), or in rapid succession at the same synapse (temporal summation), the summed response may be sufficient to trigger a postsynaptic impulse. Summation may occur between excitatory potentials, inhibitory potentials, or between an excitatory and an inhibitory potential.

Superfund Federal authority, established by the U.S. Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) in 1980, to respond directly to releases or threatened releases (such as from landfills or waste disposal areas) of hazardous substances that may endanger *health* or welfare.

superoxide dismutase Enzymatic antioxidant that removes the potentially toxic superoxide ion (O^{2-}) by disproportionating it to O_2 and hydrogen peroxide (H_2O_2).

superthreshold dose See *toxic dose*.

surface layer Region of space comprising and adjoining the phase boundary between a solid and liquid phase, between a solid and gas phase, or between a liquid and gas phase within which properties of matter are significantly different from the values in the adjoining bulk phases.

surrogate Relatively well studied *toxicant* whose properties are assumed to apply to an entire chemically and toxicologically related class; for example, benzo(a)pyrene data may be used as toxicologically equivalent to that for all *carcinogenic* polynuclear aromatic hydrocarbons.

surveillance Systematic ongoing collection, collation, and analysis of data and the timely dissemination of information to those who need to know in order that action can be taken to initiate investigative or control measures.

susceptible vulnerable Describing a group of organisms more vulnerable to a given *exposure* than the majority of the population to which they belong.

Note: Susceptibility may reflect gender, age, physiological status, or genetic constitution of the organisms at risk.

[2]

susceptibility biomarker See *biomarker of susceptibility*.

susceptibility Condition of lacking the power to resist a particular *disease* or infection; thus, in susceptible people, 'normal expected' results occur, but with a lower *exposure* (or *dose*) than in the rest of the population.

sympathetic nervous system Part of the autonomic nervous system originating in the thoracic and lumbar regions of the spinal cord that tends to inhibit or oppose the physiological effects of the *parasympathetic* nervous system, as in tending to reduce digestive secretions, speed up the heart, and contract blood vessels.

See *parasympathetic*.

sympatholytic anti-adrenergic

1. adj., Blocking transmission of impulses from the adrenergic (sympathetic) postganglionic fibers to effector organs or tissues.
2. n., Agent that blocks transmission of impulses from the adrenergic (sympathetic) postganglionic fibers to effector organs or tissues.

sympathomimetic adrenergic

1. adj., Producing effects resembling those of impulses transmitted by the postganglionic fibers of the *sympathetic nervous system*.
2. n., Agent that produces effects resembling those of impulses transmitted by the postganglionic fibers of the sympathetic nervous system.

symptom Any subjective evidence of a disease or an effect induced by a substance as perceived by the affected subject.

symptomatology General description of all of the signs and symptoms of *exposure* to a *toxicant*.

Note: Signs are the overt (observable) responses associated with exposure (such as convulsions, death, etc.), whereas symptoms are covert (subjective) responses (such as nausea, headache, etc.).

synapse Functional junction between two neurons, where a nerve impulse is transmitted from one neuron to another.

synaptic transmission See *synapse*.

syndrome Set of *signs* and *symptoms* occurring together and often characterizing a particular *disease*-like state.

synergism (in toxicology) synergistic effect

synergy (in toxicology) Pharmacological or toxicological interaction in which the combined biological effect of *exposure* to two or more substances is greater than expected on the basis of the simple summation of the effects of each of the individual substances.

synergist (in toxicology) Substance that contributes more than additively to a mutual effect with another substance.

synergistic effect See *synergism*.

synergy See *synergism*.

synomone *Semiochemical* that is produced by one organism inducing a response in an organism of another species that is favorable to both the emitter and the responding organism.

See *allomone, kairomone*.

synteny Property of *gene*s which reside on the same *chromosome*.

systematic sample Subset selected according to some simple rule such as specified date or alphabetic classification.

systemic

1. Relating to the body as a whole.
2. Occurring at a site in the body remote from the point of contact with a substance.

After [1]

systemic effect Consequence that is either of a generalized nature or that occurs at a site distant from the point of entry of a substance.

Note: A systemic effect requires *absorption* and distribution of the substance in the body.

systems biology Study of the mechanisms underlying complex biological processes as integrated systems of many diverse, interacting components.

Note: It involves (1) collection of large sets of experimental data (by high-throughput technologies and/or by mining the literature of reductionist molecular biology and biochemistry), (2) proposal of mathematical models that might account for at least some significant aspects of this data set, (3) accurate

computer solution of the mathematical equations to obtain numerical predictions, and (4) assessment of the quality of the model by comparing numerical simulations with the experimental data.

tachy- Prefix meaning rapid as in *tachycardia* and *tachypnoea*.

tachycardia Antonym: *bradycardia* Abnormally fast heartbeat.

tachypnoea Antonym: *bradypnoea* Abnormally fast breathing.

taeniacide Substance intended to kill tapeworms.

target (in biology) Any organism, organ, tissue, cell, or cell constituent that is subject to the action of an agent.

target population (in epidemiology)
1. Collection of individuals, items, measurements, etc. about which inferences are required: The term is sometimes used to indicate the population from which a *sample* is drawn and sometimes to denote any reference population about which inferences are needed.
2. Group of persons for whom an intervention is planned.

T cell See *T lymphocyte*.

technical directive See *standard*.

telomere Structure which terminates the arm of a *chromosome*.

Note: A similar term 'telomere', with a different meaning is found in the IUPAC "Gold Book".

[3]

temporary acceptable daily intake Value for the *acceptable daily intake* (ADI) proposed for guidance when data are sufficient to conclude that use of the substance is safe over the relatively short period of time required to generate and evaluate further safety data, but are insufficient to conclude that use of the substance is safe over a lifetime.

Note: A higher-than-normal *safety* factor is used when establishing a temporary ADI, and an expiration date is established by which time appropriate data to resolve the safety issue should be available.

temporary maximum residue limit Regulatory value established for a specified, limited time when only a temporary *acceptable daily intake* has been established for the *pesticide* concerned or, with the existence of an agreed acceptable daily intake, the available residue data are inadequate for firm maximum residue recommendations.

teratogen Substance that, when administered prenatally (to the mother), induces permanent structural malformations or defects in the offspring.

teratogenicity
1. Potential to cause the production of nonheritable structural malformations or defects in offspring.
2. Production of nonheritable structural malformations or defects in offspring.

teratology Study of malformations, monstrosities, or serious deviations from normal development in organisms.

testing of chemicals
1. In *toxicology*, evaluation of the therapeutic and potentially *toxic* effects of substances by their application through relevant routes of *exposure* with appropriate organisms or biological systems so as to relate effects to *dose* following application.
2. In chemistry, qualitative or quantitative analysis by the application of one or more fixed methods and comparison of the results with established standards.

tetanic Pertaining to tetanus, characterized by tonic muscle spasm.

theoretical maximum daily intake (TMDI) Predicted maximum daily intake of a residue, assuming that it is present at the *maximum residue level* and that average daily consumption of foods per person is represented by assessed regional diets: It is expressed in milligrams of residue per person per day.

After [14]

therapeutic cloning Generation and manipulation of stem cells with the objective of deriving cells of a particular organ or tissue to treat a disease.

therapeutic index Ratio between *toxic* and therapeutic doses (the higher the ratio, the greater the safety of the therapeutic dose).

three-dimensional quantitative structure–activity relationship (3D-QSAR) Quantitative association between the three-dimensional structural properties of a substance and its biological properties.

[2]

See *quantitative structure–activity relationship*.

threshold Dose or *exposure concentration* below which a defined effect will not occur.

See also *critical effect*.

threshold concentration See *threshold*.

threshold dose See *threshold*.

threshold limit value–ceiling (TLV–C) As defined by ACGIH, *concentration* of a potentially *toxic* substance

that should not be exceeded during any part of the working *exposure*.

[2]

threshold limit value–short-term exposure limit (TLV–STEL) As defined by ACGIH, *concentration* to which it is believed that workers can be *exposed* continuously for a short period of time without suffering from (1) irritation, (2) *chronic* or irreversible tissue damage, or (3) *narcosis* of sufficient degree to increase the likelihood of accidental injury, impair self-rescue or materially reduce work efficiency, and provided that the daily TLV-TWA is not exceeded.

Note: It is not a separate independent *exposure* guideline; rather, it supplements the TLV-TWA limit where there are recognized *acute* effects from a substance whose *toxic* effects are primarily of a chronic nature. TLV-STELs are recommended only where *toxic* effects have been reported from high short-term exposures in either humans or animals.

[2]

threshold limit value–time-weighted average (TLV–TWA) As defined by ACGIH, *time-weighted average concentration* for a conventional 8-h workday and a 40-h workweek, to which it is believed nearly all workers may be repeatedly *exposed*, day after day, without *adverse effect*.

[2]

threshold of toxicological concern (TTC) Human *exposure* threshold value for a group of chemicals below which there should be no appreciable risk to human health.

thrombocytopenia Decrease in the number of blood platelets (thrombocytes).

thyrotoxicosis Condition resulting from excessive concentrations of thyroid hormones, as in hyperthyroidism, characterized by bulging eyes and rapid heart rate.

tidal volume Quantity of air or test gas that is inhaled and exhaled during one respiratory cycle.

time-weighted-average-exposure (TWAE) time-weighted-average concentration (TWAC) *Concentration* in the *exposure* medium at each measured time interval multiplied by that time interval and divided by the total time of observation.

Note: For occupational exposure, a working shift of 8 h is commonly used as the averaging time.

tinnitus Continual noise in the ears, such as ringing, buzzing, roaring, or clicking.

tissue dose Amount of a substance or physical agent (radiation) absorbed by a tissue.

tissue/plasma partition coefficient See *partition ratio*.

T lymphocyte Animal cell that possesses specific cell surface *receptor*s through which it binds to foreign substances or organisms, or those which it identifies as foreign, and which initiates *immune responses*.

tolerable daily intake (TDI) Estimate of the amount of a potentially harmful substance (e.g., contaminant) in food or drinking water that can be ingested daily over a lifetime without appreciable *health risk*.

Note 1: For regulation of substances that cannot be easily avoided, a provisionally *tolerable weekly intake* (PTWI) may be applied as a temporary limit.

Note 2: *Acceptable daily intake* is normally used for substances not known to be harmful, such as food additives.

[2]

tolerable risk Probability of suffering disease or injury that can, for the time being, be tolerated, taking into account the associated benefits, and assuming that the *risk* is minimized by appropriate control procedures.

tolerable weekly intake (TWI) Estimate of the amount of a potentially harmful substance (e.g., a contaminant) in food or drinking water that can be ingested weekly over a lifetime without appreciable *health risk*.

[2]

tolerance

1. Adaptive state characterized by diminished effects of a particular *dose* of a substance: The process leading to tolerance is called 'adaptation'.
2. In food *toxicology*, dose that an individual can tolerate without showing an effect.
3. Ability to experience *exposure* to potentially harmful amounts of a substance without showing an *adverse effect*.
4. Ability of an organism to survive in the presence of a *toxic* substance: Increased tolerance may be acquired by adaptation to constant *exposure*.
5. In immunology, state of specific immunological unresponsiveness.

tonic

1. Characterized by tension, especially muscular tension.
2. Medical preparation that increases or restores normal muscular tension.

topical (in medicine) Applied directly to the surface of the body.
[2]

topical effect Consequence of application of a substance to the surface of the body which occurs at the point of application.
[2]

torsade de pointes Potentially lethal form of ventricular *tachycardia* following chronic abuse of alcohol and mainly due to hypomagnesemia.

total diet study
1. Study designed to establish the pattern of *pesticide* residue intake by a person consuming a defined diet.
2. Study undertaken to show the range and amount of various foodstuffs in a typical diet or to estimate the total amount of a specific substance in a typical diet.

total terminal residue (of a pesticide) Summation of levels of all the residues of a defined *pesticide* in a food.
See also *residue*.
After [6]

toxemia (blood poisoning)
1. Condition in which the blood contains *toxins* produced by body cells at a local source of infection or derived from the growth of microorganisms.
2. Pregnancy-related condition characterized by high blood pressure, swelling, and fluid retention, and proteins in the urine.

toxic Able to cause injury to living organisms as a result of physicochemical interaction.

toxicant See *toxic substance*.

toxic chemical See *toxic substance*.

toxic dose superthreshold dose Amount of a substance that produces intoxication without lethal outcome.

toxicity
1. Capacity to cause injury to a living organism defined with reference to the quantity of substance administered or absorbed, the way in which the substance is administered and distributed in time (single or repeated *doses*), the type and severity of injury, the time needed to produce the injury, the nature of the organism(s) affected, and other relevant conditions.
2. *Adverse effect*s of a substance on a living organism defined as in 1.
3. Measure of incompatibility of a substance with life: This quantity may be expressed as the reciprocal of the absolute value of *median lethal dose* ($1/LD_{50}$) or *concentration* ($1/LC_{50}$).

toxicity equivalency factor (TEF), *f* Ratio of the toxicity of a chemical to that of another structurally related chemical (or index compound) chosen as a reference.
[6]

toxicity equivalency factor (in *risk assessment*) (TEF), *f* Ratio of the toxicity of a chemical to that of another structurally related chemical (or index compound) chosen as a reference. Factor used to estimate the *toxicity* of a complex mixture, commonly a mixture of chlorinated dibenzo-*p*-dioxins [oxanthrenes], furans, and biphenyls: In this case, TEF is based on relative toxicity to 2,3,7,8-tetrachlorodibenzo-*p*-dioxin [2,3,7,8-tetrachlorooxanthrene] for which the $f = 1$.

toxicity equivalent (TEQ), T_{xe} Contribution of a specified component (or components) to the *toxicity* of a mixture of related substances.

Note 1: The amount-of-substance (or substance) *concentration* of total toxicity equivalent is the sum of that for the components B, C … N.

Note 2: Toxicity equivalent is most commonly used in relation to the reference *toxicant* 2,3,7,8-tetrachlorodibenzo-p-dioxin [2,3,7,8-tetrachlorooxanthrene] by means of the *toxicity equivalency factor* (TEF, *f*) which is 1 for the reference substance. Hence, where c is the amount-of-substance concentration:

$$T_{xe} = \sum_{i=B}^{N} f_1 c_i$$

toxic substance Substance causing injury to living organisms as a result of physicochemical interactions.
[2]

$t_{1/2}$
See *half life*, *half time.*

toxicity exposure ratio (TER) Ratio of the measure of the effects (e.g., LD_{50}, LC_{50}, NOEC) to the estimated *exposure*.

Note: It is the reciprocal of a *risk quotient* or *hazard quotient*.

[6]

toxicity test Experimental study of the *adverse effect*s of *exposure* of a living organism to a substance for a defined duration under defined conditions.

toxic material See *toxic substance*.

toxicodynamics Process of interaction of potentially *toxic substance*s with *target* sites, and the biochemical and physiological consequences leading to *adverse effect*s.

toxicogenomics Scientific subdiscipline that combines *toxicology* with *genomics* to determine how an organism's genetic make-up influences its response to a toxic substance.

toxicogenetics Study of the influence of hereditary factors on the effects of potentially *toxic* substances on individual organisms.

toxicokinetics

1. Generally, the overall process of the *absorption* in biology (*uptake*) of potentially *toxic* substances by the body, the distribution of the substances and their metabolites in tissues and organs, their *metabolism* (*biotransformation*), and the *elimination* of the substances and their metabolites from the body.
2. In validating a toxicological study, the collection of toxicokinetic data, either as an integral component in the conduct of nonclinical toxicity studies or in specially designed supportive studies, in order to assess systemic *exposure*.

toxicological data sheet Document that gives in a uniform manner data relating to the *toxicology* of a substance, its production and application, properties and methods of identification.

Note: The data sheet may also include recommendations on protective measures.

toxicologically based pharmacokinetic modeling (TBPK) See *physiologically based pharmacokinetic modeling*.

toxicology Scientific discipline involving the study of the actual or potential danger presented by the harmful effects of substances on living organisms and ecosystems, of the relationship of such harmful effects to *exposure*, and of the mechanisms of action, diagnosis, prevention, and treatment of intoxications.

toxicometry Term sometimes used to indicate a combination of investigative methods and techniques for making a quantitative assessment of *toxicity* and the *hazard*s of potentially *toxic* substances.

toxicophobia Morbid dread of *poisons*.

toxicophoric group toxogenic group toxophoric group Structural moiety that upon metabolic activation exerts *toxic* effects: The presence of a toxicophoric group indicates only potential and not necessarily actual *toxicity* of a *drug* or other substances.

toxicovigilance Active process of identification, investigation, and evaluation of various *toxic* effects in the community with a view to taking measures to reduce or control *exposure*(s) involving the substance(s) which produces these effects.

toxic substance chemical etiologic agent poison toxicant toxic chemical toxic material Material causing injury to living organisms as a result of physicochemical interactions.

toxification Metabolic conversion of a potentially *toxic* substance to a product that is more toxic.

toxin Poisonous substance produced by a biological organism such as a microbe, animal, plant, or fungus.

Note: Examples are botulinum toxin, tetrodotoxin, pyrrolizidine alkaloids, and amanitin.

toxinology Scientific discipline involving the study of the chemistry, biochemistry, pharmacology, and *toxicology* of *toxins*.

toxogenic group See *toxicophoric group*.

toxophoric group See *toxicophoric group*.

traceability (in metrology) Property of a measurement result whereby the result can be related to a stated reference through a documented unbroken chain of calibrations, each contributing to the measurement uncertainty.

[7]

tracer

1. Means by which something may be followed; for example, a radioactive isotope may replace a stable chemical element in a *toxic* compound enabling the toxicokinetics to be followed.
2. Labeled member of a population used to measure certain properties of that population.

tracer substance Substance that can be tracked through one or more reactions or systems, often by detecting an incorporated isotope.

[2]

transcription Process by which the genetic information encoded in a linear sequence of nucleotides in one strand of *DNA* is copied into an exactly complementary sequence of *RNA*.

transcriptome Total m*RNA* expressed in a cell or tissue at a given point in time.

transcriptomics Global analysis of *gene* expression to identify and evaluate changes in synthesis of m*RNA* after chemical *exposure*.

[2]

transformation

1. Alteration of a cell by incorporation of foreign genetic material and its subsequent expression in a new *phenotype*.
2. Conversion of cells growing normally to a state of rapid division in culture resembling that of a *tumor*.
3. Chemical modification of substances in the environment.

transformed cell Cell that has become genetically altered spontaneously or by incorporation of foreign *DNA* to produce a cell with an extended lifetime in culture.
[2]

transformed cell line See *cell line*, *transformed cell.*

transgene *Gene* from one source that has been incorporated into the genome of another organism.

transgenic Adjective used to describe animals carrying a *gene* introduced by micro-injecting *DNA* into the nucleus of the fertilized egg.

translation Process through which a polypeptide chain of amino acid molecules is generated as directed by the sequence of a particular m*RNA* sequence.

transposon Mobile nucleic acid element.

treatability In relation to *waste* water, the amenability of substances to removal without adversely affecting the normal operation of biological treatment processes (such as a sewage treatment plant).

triage
1. Process for sorting people into groups based on their need for or likely benefit from immediate medical treatment.

   Note: Triage is used in hospital emergency rooms, on battlefields, and at disaster sites when limited medical resources must be allocated.
2. System used to allocate a scarce commodity, such as food, to those most likely to benefit from it.
3. Process in which things are ranked in terms of importance or priority.

trophic level Amount of energy in terms of food that an organism needs.

Note: Organisms not needing organic food, such as plants, are said to be on a low trophic level, whereas predator species needing food of high energy content are said to be on a high trophic level. The trophic level indicates the level of the organism in the food chain.

trueness Closeness of agreement between the average of a theoretically infinite number of replicate measured quantity values and a reference quantity value.

tubular reabsorption Transfer of solutes from the *renal* tubule lumen to the tubular epithelial cell and normally from there to the peritubular fluid.
[2]

tumorigenic Able to cause *tumors*.

tumor tumour neoplasm
1. Any abnormal swelling or growth of tissue, whether *benign* or *malignant*.
2. An abnormal growth, in rate and structure, that arises from normal tissue, but serves no physiological function.

tumor necrosis factor (TNF) cachectin cachexin Protein produced by several of the body's cell types, such as white blood cells, red blood cells, and other cells that line the blood vessels; it promotes the destruction of some types of *cancer* cells and is a *cytokine* involved in systemic *inflammation*.

tumor progression Sequence of changes by which a *benign tumor* develops from the initial lesion to a *malignant* stage.

tumor suppressor gene *Gene* that serves to protect cells from entering a cancerous state.

Note: According to Knudson's "two-hit" hypothesis, both alleles of a particular *tumor* suppressor *gene* must acquire a mutation before the cell will enter a transformed state.

turnover time See *mean life*.

two-compartment model Product of *compartmental analysis* requiring two *compartments*.
[2]
See *compartmental modeling, multicompartment model*.

ulcer Defect, often associated with *inflammation*, occurring locally or at the surface of an organ or tissue owing to sloughing of necrotic (see *necrosis*) tissue.

ultrafine particle Particle in air of *aerodynamic diameters* 100 nm.

Note: As a group, ultrafine particles are referred to as PM0.1 (100 nm is 0.1 μm).
[2]

uncertainty (in metrology) Parameter characterizing the dispersion of the quantity values being attributed to a measurand, based on the information used.

Note: The parameter may be, for example, a standard deviation or the half width of an interval, having a stated coverage probability.
[7]

uncertainty factor (UF)
1. In assay methodology, confidence interval or fiducial limit used to assess the probable precision of an estimate.
2. In *toxicology*, value used in extrapolation from experimental animals to man (assuming that man may be more sensitive) or from selected individuals to the general population. For example, a value applied to the *no-observed-effect-level* (NOEL) or *no-observed-adverse-effect-level* (NOAEL) to

derive an *acceptable daily intake* (ADI) or *tolerable daily intake* (TDI).

Note: The NOEL or NOAEL is divided by the value to calculate the ADI or TDI.

See also *modifying factor, safety factor*.

unit risk Upper-bound excess lifetime *cancer risk* estimated to result from continuous *exposure* to an agent at a *concentration* of $1\,\mu g\ L^{-1}$ in water, or $1\,\mu g\ m^{-3}$ in air.

Note: The interpretation of unit risk is as follows: if unit risk $= 1.5 \times 10^{-6}\,\mu g\ L^{-1}$, 1.5 excess tumors are expected to develop per 1 000 000 or 10^6 people if exposed daily for a lifetime to $1\,\mu g$ of the chemical in 1 liter of drinking water.

upper boundary Estimate of the plausible upper limit to the true value of a quantity.

Note: This is usually not a statistical confidence limit.

uptake Entry of a substance into the body, an organ, a tissue, a cell, or the body fluids by passage through a membrane or by other means.

urticaria Vascular reaction of the skin marked by the transient appearance of smooth, slightly elevated patches (wheals, hives) that are redder or paler than the surrounding skin and often attended by severe itching.

vacuole Membrane-bound cavity within a cell.

validity of a measurement Expression of the degree to which a measurement measures what it purports to measure.

validity of a study Degree to which the inferences drawn, especially generalizations extending beyond the study *sample*, are warranted when account is taken of the study methods, the representativeness of the study sample, and the nature of the population from which it is drawn.

vasoconstriction Antonym: *vasodilation* Decrease of the caliber of the blood vessels leading to a decreased blood flow.

vasodilation Antonym: *vasoconstriction* Increase in the caliber of the blood vessels, leading to an increased blood flow.

vector See *cloning vector*.

vehicle Substance(s) used to formulate active ingredients for administration or use.

Note: In this context, it is a general term for solvents, suspending agents, etc.

venom Animal *toxin* generally used for self-defense or predation and usually delivered by a bite or sting.

ventilation

1. Process of supplying a building or room with fresh air.
2. Process of exchange of air between the ambient atmosphere and the lungs.
3. In physiology, the amount of air inhaled per day.
4. Oxygenation of blood.

ventricular fibrillation Irregular heartbeat characterized by uncoordinated contractions of the ventricle.

vermicide Substance intended to kill intestinal worms.

vermifuge See *anthelmint(h)ic*.

vertigo Dizziness; an illusion of movement as if the external world were revolving around one's self or as if one's self were revolving in space.

vesicant

1. adj., Producing blisters on the skin.
2. n., Substance that causes blisters on the skin.

vesicle

1. In cell biology, small bladder-like, membrane-bound sac containing aqueous solution or fat.
2. In pathology, blisterlike elevation on the skin containing serous fluid.

virtually safe dose (VSD) Human *exposure* over a lifetime to a carcinogen which has been estimated, using mathematical modeling, to result in a very low incidence of *cancer*, somewhere between zero and a specified incidence (e.g., 1 cancer in 1 000 000 exposed people).

virucide antiviral Substance used to control viruses. [6]

volume of distribution Apparent (hypothetical) volume of fluid required to contain the total amount of a substance in the body at the same *concentration* as that present in the *plasma* assuming equilibrium has been attained.

volatile organic chemical (VOC) Any organic compound having, at 293.15 K, a vapor pressure of 0.01 kPa or more, or having a corresponding volatility under the particular condition of use. [15]

waste Anything that is discarded deliberately or otherwise disposed of on the assumption that it is of no further use to the primary user.

wasting syndrome Disease marked by weight loss and atrophy of muscular and other connective tissues that is not directly related to a decrease in food and water consumption.

water potential (in physiology) Difference in free energy or chemical potential (per unit molal volume) between pure water and water in cells and solutions.

Weibull model *Dose–response* model of the form

$$P(d) = \gamma + (1 - \gamma)(1 - e^{-\beta d\alpha})$$

where $P(d)$ is the probability of a tumor (or other response) from lifetime, continuous *exposure* at dose d until age t (when tumor is fatal), α is a fitted dose parameter (sometimes called the Weibull parameter), β is a fitted dose parameter, and γ is the background response rate.

weight-of-evidence for toxicity Extent to which the available biomedical data support the hypothesis that a substance causes a defined *toxic* effect such as cancer in humans.

withdrawal effect Adverse event following withdrawal from a person or animal of a *drug* to which they have been chronically *exposed* or on which they have become dependent.

working zone Space measuring up to 2 m over the level of the floor or platform that contains a worker's permanent or temporary station.

x-disease Hyperkeratotic disease in cattle following *exposure* to chlorinated dibenzo-*p*-dioxins, naphthalenes, and related compounds.

xenobiotic Compound with a chemical structure foreign to a given organism.

Note: Frequently restricted to man-made compounds.

yeast two-hybrid system Genetic method for analyzing the interactions of proteins.

zero-order kinetics *Kinetics* of a reaction in which the *rate* is independent of the *concentration*(s) of the reactants.

[2]

zoocide Substance intended to kill animals.

zygote

1. Cell such as a fertilized egg resulting from the fusion of two *gametes*.
2. Cell obtained as a result of complete or partial fusion of cells produced by *meiosis*.

ANNEX 1: ABBREVIATIONS AND ACRONYMS USED IN TOXICOLOGY LITERATURE

ADI	acceptable daily intake
ADME	absorption, distribution, metabolism, excretion
ADMET	absorption, distribution, metabolism, excretion, toxicokinetics
AF	assessment factor
AIC	Akaike Information Criterion, *C*: a measure of the goodness of fit of an estimated statistical model calculated in the general case from the equation $C = 2k - 2 \ln L$
ALARA(P)	as low as reasonably achievable (practicable) In UK, regulations relating to worker exposure In USA, goal of risk management (USNRC regulations)
ASP	amnesic shellfish poisoning
ATP	adenosine triphosphate
AUC	area under the concentration–time curve
AUMC	area under the moment curve
BAC	bacterial artificial chromosome
BAL	British anti-Lewisite
BCF	bioconcentration factor
BEI	biological exposure indices (ACGIH)
BEM	biological effect monitoring
BMC	benchmark concentration
BMCL	confidence limit for BMC
BMD	benchmark dose
BMDL	confidence limit for BMD
BMDS	benchmark dose at a given standard deviation
BMR	benchmark rate
BOD	biochemical oxygen demand; biological oxygen demand b.w., b.wt. body weight
cDNA	complementary DNA
CMR	carcinogenic, mutagenic, and reproductive (toxicant)
COD	chemical oxygen demand
CoMFA	comparative molecular field analysis
COPC	compound of probable concern
CRM	certified reference material
CSAF	chemical specific adjustment factor
CTD	common technical document (drug registration)
CYP	cytochrome P450
Cyt	cytochrome
CV	ceiling value
D	absorbed dose of radiation
DDT	dichloro diphenyl trichloroethane
DNA	deoxyribonucleic acid
DNEL	derived no-effect level
DSP	diarrheal shellfish poisoning; diarrheic shellfish poisoning
EC	effective concentration, Enzyme Commission, European Community
EC_{50}	median effective concentration to 50% of a population
EC_n	median effective concentration to *n* % of a population
eCTD	electronic common technical document (drug registration)
ED	effective dose
EDC	endocrine-disrupting compound
EDI	estimated daily intake
ED_{50}	median effective dose to 50% of a population
ED_n	median effective dose to *n*% of a population
EEC	estimated environmental exposure concentration; estimated exposure concentration; expected environmental exposure concentration
EED	estimated exposure dose
EEL	environmental exposure level
EIA	environmental impact assessment
EIS	environmental impact statement
ELISA	enzyme-linked immunosorbent assay
EMDI	estimated maximum daily intake
EQO	environmental quality objective
EQS	environmental quality standard
ERL	extraneous residue limit
EST	expressed sequence tag
ETS	environmental tobacco smoke
f	toxicity equivalency factor
F	fraction of dose absorbed; bioavailability
FONSI	finding of no significant impact
GAP	good agricultural practice
GCP	good clinical practice
GHS	global harmonization system for classification of hazardous substances
GLP	good laboratory practice
GFR	glomerular filtration rate
GMO	genetically modified organism
GMP	good manufacturing practice
GRAS	generally regarded as safe
HAL	health advisory level
HAZOP	hazard and operability study
HEQ	human equivalent dose
HSG	Health and Safety Guide (IPCS)

HQ	hazard quotient
i.c.	intracutaneous
IC	inhibitory concentration
IC_n	inhibitory concentration to n% of a population
i.d.	intradermal
ID	inhibitory dose
ID_n	inhibitory dose to n% of a population
IDLHC	immediately dangerous to life and health concentration
i.m.	intramuscular
inhl	by inhalation
i.p.	intraperitoneal
IPD	individual protective device
I-TEF	international toxicity equivalency factor
i.v.	intravenous
K_d	soil partition coefficient
K_M	Michaelis constant
K_{oc}	organic carbon partition coefficient
K_{ow}	octan-1-ol–water partition coefficient
K_D	partition ratio
LADD	lifetime average daily dose
LC_{min}	minimum lethal concentration
LC_n	median concentration lethal to n% of a test population
LC_{50}	see LC_n
LD	lethal dose
LD_{min}	minimum lethal dose
LD_n	median dose lethal to n% of a test population
LD_{50}	see LD_n
LED	lowest effective dose
LED_x	lowest effective dose for a biological effect in x% of the individuals in the test population
LEL	lowest-effect level, same as LOEL
LOEL	lowest-observed-effect level
LOAEL	lowest-observed-adverse-effect level
LT_n	median time for death of n% of a test population
LV	limit value
MAC	maximum allowable concentration
MAK	maximal arbeitsplatz konzentration (German)
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MCS	multiple chemical sensitivity
MEL	maximum exposure limit
MF	modifying factor
MFO	mixed-function oxidase
MN	micronucleus
MOE	margin of exposure
MOS	margin of safety
MPC	maximum permissible concentration
MPL	maximum permissible level
MRL	maximum residue limit; minimal risk level (ATSDR)
MRT	mean residence time
mRNA	messenger ribonucleic acid
MSDS	material safety data sheet
MTC	maximum tolerable concentration
MTD	maximum tolerable dose; maximum tolerated dose
MTEL	maximum tolerable exposure level
NADP(H)	nicotinamide adenine dinucleotide phosphate (reduced)
NAG	*N*-acetyl-d-glycosaminidase
NC_n	median concentration narcotic to n% of a population
ND_n	median dose narcotic to n% of a population
NED	no-effect dose
NEL	no-effect level, same as NOEL
NOAEL	no-observed-adverse-effect level
NOEL	no-observed-effect level
NRL	no-response level
NSAID	nonsteroidal anti-inflammatory drug
NSC	normalized sensitivity coefficient
NSP	nanosized particle; nanoparticle (ultrafine)
OEL	occupational exposure level
OES	occupational exposure standard
OR	odds ratio
PADI	pseudo-acceptable daily intake
PAH	polycyclic aromatic hydrocarbon
PBPK	physiologically based pharmacokinetic modeling
PBPD	physiologically based pharmacodynamic modeling
PBTK	physiologically based toxicokinetic modeling
PBB	polybrominated biphenyl
PCB	polychlorinated biphenyl
PCC	population critical concentration
PCDF	polychlorinated dibenzofuran
PCR	polymerase chain reaction
PEC	predicted environmental concentration; predicted exposure concentration
PEL	permissible exposure limit
PBT	persistent, bioaccumulative, and toxic
p.c.	per cutim (Latin) = through the skin
PEL	permissible exposure limit
PIC	prior informed consent
PIP	persistent inorganic pollutant
$PM_{0.1}$	ultrafine particles in air with a maximum aerodynamic diameter $<0.1\,\mu m$
$PM_{2.5}$	particles in air with a maximum aerodynamic diameter of $2.5\,\mu m$

PM_{10}	particles in air with a maximum aerodynamic diameter of 10 μm
PMR	proportionate mortality rate, ratio
PNEC	predicted no-effect concentration
p.o.	per os (Latin) = by mouth
POP	persistent organic pollutant
P_{OW}	octan-1-ol–water partition coefficient
Q	quality factor (radiation)
PPAR	peroxisome proliferator-activated receptor
PPD	personal protective device
PPE	personal protective equipment
PSP	paralytic shellfish poisoning
PTWI	provisional tolerable weekly intake
QSAR	quantitative structure–activity relationship
3D-QSAR	three-dimensional quantitative structure–activity relationship
QSMR	quantitative structure–metabolism relationship
RD	rate difference
REL	recommended exposure limit (NIOSH)
RER	relative excess risk
RfC	reference concentration
RfD	reference dose
RIA	radio-immunoassay
RME	reasonable maximum exposure
RNA	ribonucleic acid
RNS	reactive nitrogen species
RR	rate ratio; relative risk
ROS	reactive oxygen species
S-9	rat liver microsome preparation
SAR	structure–activity relationship; standard absorption rate
s.c.	subcutaneous
SCE	sister chromatid exchange
SD	standard deviation
SE	standard error
SF	safety factor
SMR	standard morbidity ratio; standard mortality ratio; structure–metabolism relationship
SNARL	suggested no-adverse-response level
SNP	single nucleotide polymorphism
SPF	specific pathogen free
STEL	short-term exposure limit
$t_{1/2}$	half life; half time
T_{eq}	toxicity equivalent
TBPK	toxicologically based pharmacokinetic modeling
TCDD	2,3,7,8-tetrachlorodibenzo-*p*-dioxin [2,3,7,8-tetrachlorooxanthrene]
TDI	tolerable daily intake
TEF	toxicity equivalency factor
TEQ	toxicity equivalent
TER	toxicity exposure ratio
TL_n	see LT_n
TLV	threshold limit value (ACGIH)
TLV-C	threshold limit value (ACGIH)–ceiling
TLV–STEL	threshold limit value (ACGIH)–short-term exposure limit
TLV–TWA	threshold limit value (ACGIH)–time-weighted average
TMDI	theoretical maximum daily intake
TTC	threshold of toxicological concern
TWA	time-weighted average
TWAC	time-weighted average concentration
TWAE	time-weighted average exposure
TWI	tolerable weekly intake
UDP	uridine diphosphate
UF	uncertainty factor
V_{max}	maximum velocity
VOC	volatile organic compound
vPvB	very persistent and very bioaccumulative
VSD	virtually safe dose

ANNEX 2: ABBREVIATIONS AND ACRONYMS OF NAMES OF INTERNATIONAL BODIES AND LEGISLATION

ABT	American Board of Toxicology
ACGIH	American Conference of Governmental Industrial Hygienists
ATS	Academy of Toxicological Science
ATSDR	Agency for Toxic Substances and Diseases Registry
BCR	Bureau Communautaire de Référence (Bruxelles)
BIBRA	British Industrial Biological Research Association
CCFA	Codex Committee on Food Additives
CCPR	Codex Committee on Pesticide Residues
CDC	Centers for Disease Control and Prevention
CEC	Commission of the European Communities
CEN	Committee Européen de Normalisation
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (USA)
CHIP	Classification, Hazard Information, and Packaging (UK)
COSHH	Control of Substances Hazardous to Health Regulations (UK)
CPL	Classification, Packaging, and Labeling
CTD	Common Technical Document for the Registration of Pharmaceuticals for Human Use for submission to the FDA and ICH
DFG	Deutsche Forschungsgemeinschaft (German Research Council)
EC	European Community; European Commission
ECB	European Chemicals Bureau
ECHA	European CHemicals Agency
EEA	European Environmental Agency
EEC	European Economic Community
EINECS	European Inventory of Existing Chemical Substances
ELINCS	European List of New Chemical Substances
EMEA	European Medicines Agency
EPA	Environmental Protection Agency (USA), same as USEPA
EU	European Union
EUROTOX	European Society of Toxicology
EUSES	European Uniform System for Evaluation of Substances
FAO	Food and Agricultural Organization
FDA	Food and Drug Administration (USA), same as USFDA
FIOH	Finnish Institute of Occupational Health
HSE	Health and Safety Executive (UK)
IAEA	International Atomic Energy Agency
IARC	International Agency for Research on Cancer
ICCA	International Council of Chemical Associations
ICH	International Conference for Harmonization
ICRP	International Commission on Radiological Protection
ICSU	International Council of Scientific Unions (since 1998, International Council of Science)
IFCC	International Federation of Clinical Chemists
ILO	International Labor Organization
IoB	Institute of Biology
IPCS	International Program on Chemical Safety, UNEP, ILO, WHO
IRIS	Integrated Risk Information System (USA)
IRPTC	International Register of Potentially Toxic Chemicals, now UNEP Chemicals
ISEAAA	International Society for Exposure Assessment and Analysis
ISO	International Organization for Standardization
IUCLID	International Uniform Chemical Information Database, containing unvalidated property and hazard information for 2 604 EU high production volume chemicals, submitted under the Existing Substances Regulation, EC 793/93
IUPAC	International Union of Pure and Applied Chemistry
IUTOX	International Union of Toxicology
JECFA	Joint FAO/WHO Expert Committee on Food Additives
JMPR	Joint FAO/WHO Meeting on Pesticide Residues
NAS	National Academy of Sciences (USA)
NBS	National Bureau of Standards (USA), now NIST

NIH	National Institutes of Health (USA)
NIOSH	National Institute of Occupational Safety and Health (USA)
NIST	National Institute of Standards and Technology (USA), formerly NBS
NRC	National Research Council (USA)
OECD	Organization for Economic Cooperation and Development
OEHHA	Organization of Environmental Health Hazard Assessment (USA)
OMS	Organisation Mondiale de la Santé, same as WHO
OSHA	Occupational Safety and Health Administration (USA)
RCPath	Royal College of Pathologists
REACH	Registration, Evaluation, and Authorisation of CHemicals
RIVM	Rijksinstituut voor Volksgezondheid en Milieu
RSC	Royal Society of Chemistry
SCOPE	Scientific Committee on Problems of the Environment (ICSU)
SOT	Society of Toxicology (USA)
TSCA	Toxic Substances Control Act (USA)
UNEP	United Nations Environment Program
USEPA	United States Environmental Protection Agency, same as EPA
USFDA	United States Food and Drug Administration, same as FDA
WHO	World Health Organization, same as OMS

ANNEX 3: CLASSIFICATION OF CARCINOGENICITY

1 Classification according to IARC [16]

Classification based on the weight of the evidence and not on *potency* as follows.

1. Sufficient evidence. Causal relationship has been established between *exposure* to the agent and human cancer: a positive relationship has been observed between exposure to the agent and cancer in studies in which chance, bias, and confounding could be ruled out with reasonable confidence.
2. Limited evidence. Positive association has been observed between exposure to the agent and cancer for which a causal interpretation is considered to be credible, but chance, bias, or confounding could not be ruled out with reasonable confidence.
3. Inadequate evidence. Available studies are of insufficient quality, consistency, or statistical power to permit a conclusion regarding the presence or absence of a causal association.
4. Evidence suggesting lack of carcinogenicity. There are several adequate studies covering the full range of doses to which human beings are known to be *exposed*, which are mutually consistent in not showing a positive association between exposure to the agent and any studied cancer at any observed level of exposure. A conclusion of "evidence suggesting lack of *carcinogenicity*" is inevitably limited to the cancer sites, circumstances, and doses of exposure and length of observation covered by the available studies. In addition, the possibility of a very small *risk* at the levels of exposure studied can never be excluded.
5. Overall evaluation. Total body of evidence is taken into account; the agent is described according to the wording of one of the following categories, and the designated group is given. The categorization of an agent is a matter of scientific judgement, reflecting the strength of the evidence derived from studies in humans and in experimental animals and from other relevant data.

Group 1 The agent (mixture) is carcinogenic to humans. The exposure circumstance entails exposures that are carcinogenic to humans. This category is used only when there is sufficient evidence of carcinogenicity in humans. Exceptionally, an agent (mixture) may be placed in this category when evidence of carcinogenicity in humans is less than sufficient, but there is sufficient evidence of carcinogenicity in experimental animals and strong evidence in exposed humans that the agent (mixture) acts through a relevant mechanism of carcinogenicity.

Group 2 This category includes agents, mixtures, and exposure circumstances for which, at one extreme, the degree of evidence of carcinogenicity in humans is almost sufficient, as well as those for which, at the other extreme, there are no human data but for which there is evidence of carcinogenicity in experimental animals. Agents, mixtures, and exposure circumstances are assigned to either 2A (probably carcinogenic to humans) or 2B (possibly carcinogenic to humans) on the basis of epidemiological and experimental evidence of carcinogenicity and other relevant data.

Group 2A The agent (mixture) is probably carcinogenic to humans. The exposure circumstance entails exposures that are probably carcinogenic to humans. This category is used when there is limited evidence of carcinogenicity in humans and sufficient evidence of carcinogenicity in experimental animals. In some cases, an agent (mixture) may be classified in this category when there is inadequate evidence of carcinogenicity in humans and sufficient evidence of carcinogenicity in experimental animals and strong evidence that the carcinogenesis is mediated by a mechanism that operates in humans. Exceptionally, an agent, mixture, or exposure circumstance may be classified in this category solely on the basis of limited evidence of carcinogenicity in humans.

Group 2B The agent (mixture) is possibly carcinogenic to humans. The exposure circumstance entails exposures that are probably carcinogenic to humans. This category is generally used for agents, mixtures, and exposure circumstances for which there is limited evidence of carcinogenicity in humans and less than sufficient evidence of carcinogenicity in experimental animals. It

may also be used when there is inadequate evidence of carcinogenicity in humans but there is sufficient evidence of carcinogenicity in experimental animals. In some instances, an agent, mixture, or exposure circumstance for which there is inadequate evidence of carcinogenicity in humans but limited evidence of carcinogenicity in experimental animals together with supporting evidence from other relevant data may be placed in this group.

Group 3 The agent (mixture or exposure circumstance) is not classifiable as to its carcinogenicity to humans. This category is used most commonly for agents, mixtures, and exposure circumstances for which the *evidence of carcinogenicity is inadequate* in humans and *inadequate or limited* in experimental animals. Exceptionally, agents (mixtures) for which the *evidence of carcinogenicity is inadequate* in humans but *sufficient* in experimental animals may be placed in this category when there is strong evidence that the mechanism of carcinogenicity in experimental animals does not operate in humans. Agents, mixtures, and exposure circumstances that do not fall into any other group are also placed in this category.

Group 4 The agent (mixture) is probably not carcinogenic to humans. This category is used for agents or mixtures for which there is evidence suggesting lack of carcinogenicity in humans and in experimental animals. In some circumstances, agents or mixtures for which there is inadequate evidence of carcinogenicity in humans but evidence suggesting lack of carcinogenicity in experimental animals, consistently and strongly supported by a broad range of other relevant data, may be classified in this group.

2 Classification according to the USEPA [17,18]

Group A: "Human Carcinogen"
"This group is used only when there is sufficient evidence from epidemiologic studies to support a causal association between exposure to the agents and cancer."

Group B (1 and 2): "Probable Human Carcinogen"
"This group includes agents for which the weight of evidence of human carcinogenicity based on epidemiologic studies is 'limited' and also includes agents for which the weight of evidence of carcinogenicity based on animal studies is 'sufficient'. The group is divided into two subgroups. Usually, Group B1 is reserved for agents for which there is limited evidence of carcinogenicity from epidemiological studies. It is reasonable, for practical purposes, to regard an agent for which there is 'sufficient evidence of carcinogenicity' in animals as if it presented a carcinogenic risk to humans. Therefore, agents for which there is 'sufficient' evidence from animal studies and for which there is 'inadequate evidence' or 'no data' from epidemiologic studies would usually be categorized under Group B2."

Group C: "Possible Human Carcinogen"
"This group is used for agents with limited evidence of carcinogenicity in animals in the absence of human data. It includes a wide variety of evidence, e.g., (a) a malignant tumor response in a single well-conducted experiment that does not meet conditions for sufficient evidence, (b) tumor responses of marginal statistical significance in studies having inadequate design or reporting, (c) benign but not malignant tumors with an agent showing no response in a variety of short-term tests for mutagenicity, and (d) responses of marginal statistical significance in a tissue known to have a high or variable background rate."

Group D: "Not Classifiable as to Human Carcinogenicity"
"This group is generally used for agents with inadequate human and animal evidence of carcinogenicity or for which no data are available."

Group E: "Evidence of Non-Carcinogenicity for Humans"
"This group is used for agents that show no evidence for carcinogenicity in at least two adequate animal tests in different species or in both adequate epidemiologic and animal studies. The designation of an agent as being in Group E is based on the available evidence and should not be interpreted as a definitive conclusion that the agent will not be a carcinogen under any circumstances."

3 Classification according to the European Union [19]

For the purpose of classification and labeling and having regard to the current state of knowledge, such substances are divided into three categories:

Category 1
Substances known to be carcinogenic to man. There is sufficient evidence to establish a casual association

between human exposure to a substance and the development of cancer.

Category 2
Substances which should be regarded as if they are carcinogenic to man. There is sufficient evidence to provide a strong presumption that human exposure to a substance may result in the development of cancer, generally on the basis of

- appropriate long-term animal studies and
- other relevant information.

Category 3
Substances which cause concern for humans owing to possible carcinogenic effects but in respect of which the available information is not adequate for making a satisfactory assessment. There is some evidence from appropriate animal studies, but this is insufficient to place the substance in category 2.

4 Classification according to the American Conference of Governmental Industrial Hygienists, Inc. (ACGIH) [5]

A1: Chemical substances that are confirmed to be carcinogenic for humans
A2: Chemical substances that are suspected to be carcinogenic for humans
A3: Chemical substances that are carcinogenic for animals
A4: Substances that are not classified as carcinogenic
A5: Substances that are not suspected to be carcinogenic for humans

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APPENDIX

III

TOXICOLOGICAL QUOTATIONS: FAMOUS, INFAMOUS, OBSCURE

The widely subscribed to, generally accurate, but not infallible, rule of toxicology:

Alle Dinge sind Gift und nichts ist ohne Gift; allein die Dosis macht, dass ein Ding kein Gift ist. (Theophrastus Phillipus Auroleus Bombastus von Hohenheim, aka Paracelsus, 1493–1541)

Literal Translation: All things are poison, and nothing is without poison. The dosage alone determines that a thing isn't poison.

Loose Translation: All substances are poisons; there is none which is not a poison. The right dose differentiates a poison and a remedy.

Looser Translation: The dose makes the poison.

First Witch:

Round about the cauldron go,
In the poisoned entrails throw.
Toad that under cold stone
Days and nights has thirty-one.
Sweltered venom sleeping got,
Boil thou first I'th' charmed pot.

All:

Double, double, toil and trouble,
Fire burn, and cauldron bubble.
Second Witch:
Fillet of a fenny snake,
In the cauldron boil and bake.
Eye of newt and toe of frog,
Wool of bat and tongue of dog,
Adder's fork and blind-worm's sting,
Lizard's leg and owlet's wing,
For a charm of powerful trouble,
Like a hell-broth boil and bubble.

All:

Double, double, toil and trouble,
Fire burn, and cauldron bubble.

(William Shakespeare, *Macbeth*)

My heart aches, and a drowsy numbness pains
My sense, as though of hemlock I had drunk,
Or emptied some dull opiate to the drains
One minute past, and Lethe-wards had sunk.

(John Keats, *Ode to a Nightingale*)

He who has recourse to poison in order to think will soon be unable to think without poison.

(Charles Baudelaire, *Artificial Paradise*)

It is his theory that all medicinal virtues are comprised within those substances which we term vegetable poisons. These he cultivates with his own hands, and is said even to have produced new varieties of poison, more horribly deleterious than Nature, without the assistance of this learned person, would ever have plagued the world withal.

(Nathaniel Hawthorne, *Rappaccini's Daughter*)

Continual dreams of junk: I am looking for a poppy field… Moonshiners in black Stetsons direct me to a Near East café…One of the waiters is a connection for Yugoslav opium…

Buy a packet of heroin from a Malay Lesbian in white belted trenchcoat…I cop the paper in Tebetan section of a museum. She keeps trying to seal it back…I am looking for a place to fix…

(William S. Burroughs, *Naked Lunch*)

"When you come to a patient's house you should ask him what sort of pains he has, what caused them, how many days he has been ill, whether the bowels are working and what sort of food he eats." So says Hippocrates in his work *Affections*. I may venture to add one more question: What occupation does he follow?

(Bernardino Ramazzini, *Diseases of Workers*)

No one should drink beer with henbane seeds except those who have forfeited their lives, because doing so results in frenzy of the brain, loss of reason and sometimes sudden death.

(Joacobus Theodorus Tabernaemontanus, *Kraeuterbuch*, 1664)

But once, when my father was soaring high in self-confident absentmindedness, and made tea by pouring hot coffee over tea leaves, she called him "The Great Poisoner." He laughed, I remember, but looked abashed and sorrowful.

(Donald Hall, *Willow Temple*)

The Goddess brought them inside, bade them sit down, and mixed for them a potion of ground barley, cheese, pale honey, and Pramneian wine, but added to the mixture the medicines of gloom, that make one utterly forget his true home.

(Homer, *Odyssey*)

Now that we may understand it, I will tell you why different creatures have different foods, and why what is bitter and acrid to one can nevertheless seem very sweet to another. In this matter there are such great differences and variations that what is food for one can be bitter poison for others. For example, there is a serpent that dies if touched by the saliva of a man, biting itself to death. Moreover, hellebore is a dire poison to us, but it fattens goats and quails.

(Lucretius, *De Rerum Natura (On Nature)*, Book IV)

She had never forgotten that, if you drink much from a bottle marked "poison," it is almost certain to disagree with you, sooner or later.

(Lewis Carroll, *Alice in Wonderland*)

Expect poison from the standing water.

(William Blake, *The Marriage of Heaven and Hell*)

After the first glass you see things as you wish they were. After the second, you see things as they are not. Finally, you see things as they really are, and this is the most horrible thing in the world.

(attributed to Oscar Wilde, in Conrad, Barnaby, III, *Absinthe: History in a Bottle*)

There would be meat stored in great piles in rooms; and the water from leaky roofs would drip over it, and thousands of rats would race about on it. It was too dark in these storage places to see well, but a man could run his hand over these piles of meat and sweep off handfuls of the dried dung of rats. These rats were nuisances, and the packers would put poisoned bread out for them, they would die, and then rats, bread, and meat would go into the hoppers together. This is no fairy story and no joke; the meat would be shoveled into carts, and the man who did the shoveling would not trouble to lift out a rat even when he saw one – there were things that went into the sausage in comparison with which a poisoned rat was a tidbit.

(Upton Sinclair, *The Jungle*)

The very idea of being in a canoe in the waters off the New Jersey Turnpike was viscerally thrilling but this thrill was counterbalanced by a gnawing consideration of the toxicity of the environment.

(Robert Sullivan, *The Meadowlands: Wilderness Adventures at the Edge of a City*)

Toxic waste, poison air, beach goo, eroded roads draw nations together, whereas magnanimous platitude and sweet semblance ease each nation back into its comfort or despair.

(A.R. Ammons, *Garbage*)

Our Adonais has drunk poison – oh!
What deaf and viperous murderer could crown
Life's early cup with such a draught of woe?

(Percy Bysshe Shelley, *Adonais*)

London … loses at least two out of three sunrises, owing to the environing smoke.

(John Ruskin, *Modern Painters*)

A friend told him that the particular drink he was drinking was slow poison, and he replied, "So who's in a hurry?"

(Nathaniel Benchley in *Robert Benchley*, spoken by Robert Benchley)

After a heated argument on some trivial matter Nancy … shouted, "If I were your wife I would put poison in your coffee!" Whereupon Winston [Churchill] with equal heat and sincerity answered, "And if I were your husband I would drink it."

(Consuelo Vanderbilt Balsam, *Glitter and Gold*, spoken by Nancy Astor)

I got them before they could get me.

(Vachel Lindsay, last words after drinking Lysol)

Television is the thalidomide of the 1990s. In 1995, American children spend about one-third of their awake time watching television.

(Robert Bly, *The Sibling Society*)

…rotten little verses transformed by the innocent, the decent, the good and the young into hymns of detonated twilights along toxic shores…

(Jane Miller, *Far Away*)

I want to love you but I better not touch (Don't touch)
I want to hold you but my senses tell me to stop
I want to kiss you but I want it too much (Too much)
I want to taste you but your lips are venomous poison
You're poison running through my veins
You're poison, I don't want to break these chains

(Alice Cooper, *Poison*)

Cocaine habit forming? Of course not. I ought to know, I've been using it for years.

(Tallulah Bankhead)

There is poison in the fang of the serpent, in the mouth of the fly and in the sting of a scorpion; but the wicked man is saturated with it.

(Chanakya)

There is thy gold, worse poison to men's souls, Doing more murders in this loathsome world, Than these poor compounds that thou mayst not sell.
I sell thee poison; thou hast sold me none.
Farewell: buy food, and get thyself in flesh.
Come, cordial and not poison, go with me To Juliet's grave; for there must I use thee.

(Shakespeare, *Romeo and Juliet*)

Malice sucks up the greater part of her own venom, and poisons herself.

(Michel de Montaigne (1533–1592))

Every form of addiction is bad, no matter whether the narcotic be alcohol, morphine or idealism.

(Carl Jung (1875–1961))

The United States is like the guy at the party who gives cocaine to everybody and still nobody likes him.

(Jim Samuels)

I kissed my first girl and smoked my first cigarette on the same day. I haven't had time for tobacco since.

(Arturo Toscanini)

Never take the antidote before the poison

(Latin Proverb)

I think it's ironic that for once dad's butt prevented the release of toxic gas.

(Bart Simpson)

A little learning is a dangerous thing; Drink deep, or taste not the Pierian spring: There shallow draughts intoxicate the brain, And drinking largely sobers us again (An Essay on Criticism)

(Alexander Pope)

Is the chemical aftertaste the reason why people eat hot dogs, or is it some kind of bonus?

(Neil Gaiman)

Actually, it only takes one drink to get me loaded. Trouble is, I can't remember if it's the thirteenth or fourteenth.

(George Burns)

Yes, madam, I am drunk. But in the morning I will be sober and you will still be ugly.

(Winston Churchill) *(replying to Lady Astor's comment 'Sir, you're drunk!')*

I feel sorry for people who don't drink. When they wake up in the morning, that's as good as they're going to feel all day.

(Frank Sinatra)

I hate to advocate drugs, alcohol, violence, or insanity to anyone, but they've always worked for me.

(Hunter S. Thompson)

Take me, I am the drug; take me, I am hallucinogenic.

(Salvador Dali)

Junk is the ideal product… the ultimate merchandise. No sales talk necessary. The client will crawl through a sewer and beg to buy.

(William S. Burroughs)

"Exactly," said Challenger, rubbing his hands, "we are all poisoned. Our planet has swum into the poison belt of ether, and is now flying deeper into it at the rate of some millions of miles a minute. Our young friend has expressed the cause of all our troubles and perplexities in a single word, `poison.'"

(Arthur Conan Doyle, *The Poison Belt*)

Everything one does in life, even love, occurs in an express train racing toward death. To smoke opium is to get out of the train while it is still moving. It is to concern oneself with something other than life or death.

(Jean Cocteau)

I cannot see her tonight.
I have to give her up
So I will eat fugu.

(Yosa Buson, 1716–1783. Note: Fugu, in this famous haiku, refers to the pufferfish, a Japanese delicacy when prepared properly, but a deadly poison if eaten otherwise.)

You will conceive and bear a son…now then be careful to take no wine or strong drink and to eat nothing unclean

(Bible, Judges 13:3–4)

'T is not the drinking that is to be blamed, but the excess.

(John Selden (1584–1654) In "Table Talk" 1689)

The choice, after all, is ours to make….If we have concluded that we are being asked to take senseless and frightening risks, then we should no longer accept the counsel of those who tell us that we must fill our world with poisonous chemicals: we should look about and see what other course is open to us.

(Rachel Carson, Silent Spring, 1962)

I can't believe that Godzilla was the only surviving member of its species… But if we continue conducting nuclear tests… it's possible that another Godzilla might appear somewhere in the world again.

(Kyohei Yamane-hakase, character in *Gojira* (the original Godzilla movie, 1954, last lines of the film)

Black as hell, strong as death, sweet as love.

(Turkish proverb, about coffee)

If we were to judge of the interest excited by any medical subject by the number of writings to which it has given birth, we could not but regard the poisoning by lead as the most important to be known of all those that have been treated of, up to the present time.

(M.P. Orfila, A General system of Toxicology, 1817)

Wipe off this glass three times.
There is arsenic in it.
I hear messages from God
through the fillings in my teeth.

Anne Sexton (1928–1974)

Sweet are the uses of adversity,
Which like the toad, ugly and venomous,
Wears yet a precious jewel in his head:
And this our life, exempt from public haunt,
Finds tongues in trees, books in the running brooks,
Sermons in stones, and good in every thing.

William Shakepeare (1564–1616) (As You Like It, Act ii, Sc I)

Everybody's youth is a dream, a form of chemical madness.

F. Scott Fitzgerald (1896–1940) (The Diamond as Big as the Ritz)

It is time to get drunk! So as not to be the martyred slaves of Time, get drunk; get drunk without stopping! On wine, on poetry, or on virtue, as you wish.

Charles Baudelaire (1821–1867)

Drugs bring us to the gates of paradise, then keep us from entering.

Mason Cooley (b. 1927)

No monster vibration, no snake universe hallucinations. Many tiny jeweled violet flowers along the path of a living brook that looked like Blake's illustration for a canal in grassy Eden: huge Pacific watery shore, Orlovsky dancing naked like Shiva long-haired before giant green waves, titanic cliffs that Wordsworth mentioned in his own Sublime, great yellow sun veiled with mist hanging over the planet's oceanic horizon. No harm.

Allen Ginsberg (letter, describing an LSD experience)

There are days when solitude, for someone my age, is a heady wine that intoxicates you with freedom, others when, it is a bitter tonic, and still others when it is a poison that makes you beat your head against the wall.

Colette, 'Freedom,'1908

If the headache would only precede the intoxication, alcoholism would be a virtue.

Samuel Butler

Malice sucks up the greater part of her own venom, and poisons herself.

Michel de Montaigne

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