Nutrition Essentials and Diet Therapy

Peckenpaugh

11th Edition

SAUNDERS
ELSEVIER

Includes online access to
Nutritrac Nutrition Analysis 5.0

evolve
learning system

GRAINS
Make half your grains whole

Eat at least 3 oz. of whole-grain cereals, breads, crackers, rice, or pasta every day

1 oz. is about 1 slice of bread, about 1 cup of breakfast cereal, or 1/2 cup of cooked rice, cereal, or pasta

Eat 6 oz. every day

VEGETABLES
Vary your veggies

Eat more dark-green veggies like broccoli, spinach, and other dark leafy greens

Eat more orange vegetables like carrots and sweet potatoes

Eat more dry beans and peas like pinto beans, kidney beans, and lentils

Eat 2 1/2 cups every day

FRUITS
Focus on fruits

Eat a variety of fruit

Choose fresh, frozen, canned, or dried fruit

Go easy on fruit juices

Eat 2 cups every day

MILK
Get your calcium-rich foods

Go low-fat or fat-free when you choose milk, yogurt, and other milk products

If you don't or can't consume milk, choose lactose-free products or other calcium sources such as fortified foods and beverages

Get 3 cups every day;
for kids aged 2 to 8, it's 2

MEAT & BEANS
Go lean with protein

Choose low-fat or lean meats and poultry

Bake it, broil it, or grill it

Vary your protein routine — choose more fish, beans, peas, nuts, and seeds

Eat 5 1/2 oz. every day

For a 2,000-calorie diet, you need the amounts below from each food group. To find the amounts that are right for you, go to MyPyramid.gov.

Find your balance between food and physical activity

- Be sure to stay within your daily calorie needs.
- Be physically active for at least 30 minutes most days of the week.
- About 60 minutes a day of physical activity may be needed to prevent weight gain.
- For sustaining weight loss, at least 60 to 90 minutes a day of physical activity may be required.
- Children and teenagers should be physically active for 60 minutes every day, or most days.

Know the limits on fats, sugars, and salt (sodium)

- Make most of your fat sources from fish, nuts, and vegetable oils.
- Limit solid fats like butter, margarine, shortening, and lard, as well as foods that contain these.
- Check the Nutrition Facts label to keep saturated fats, *trans* fats, and sodium low.
- Choose food and beverages low in added sugars. Added sugars contribute calories with few, if any, nutrients.

MyPyramid.gov
STEPS TO A HEALTHIER YOU

U.S. Department of Agriculture
Center for Nutrition Policy and Promotion
April 2005
CNPP-15

USDA

Anatomy of MyPyramid

One size doesn't fit all

USDA's new MyPyramid symbolizes a personalized approach to healthy eating and physical activity. The symbol has been designed to be simple. It has been developed to remind consumers to make healthy food choices and to be active every day. The different parts of the symbol are described below.

Activity

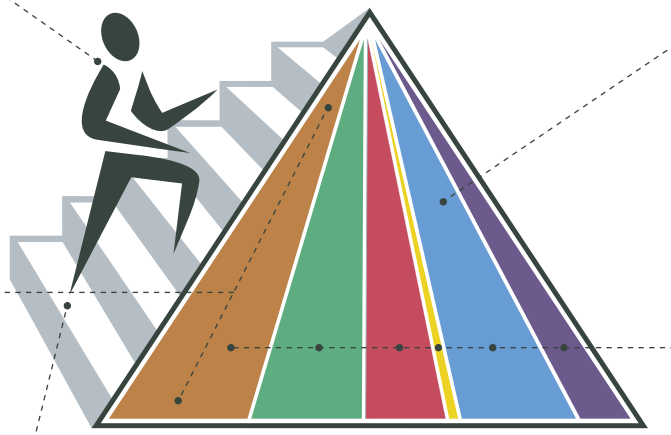
Activity is represented by the steps and the person climbing them, as a reminder of the importance of daily physical activity.

Moderation

Moderation is represented by the narrowing of each food group from bottom to top. The wider base stands for foods with little or no solid fats or added sugars. These should be selected more often. The narrower top area stands for foods containing more added sugars and solid fats. The more active you are, the more of these foods can fit into your diet.

Personalization

Personalization is shown by the person on the steps, the slogan, and the URL. Find the kinds and amounts of food to eat each day at MyPyramid.gov.



Proportionality

Proportionality is shown by the different widths of the food group bands. The widths suggest how much food a person should choose from each group. The widths are just a general guide, not exact proportions. Check the Web site for how much is right for you.

Variety

Variety is symbolized by the 6 color bands representing the 5 food groups of the Pyramid and oils. This illustrates that foods from all groups are needed each day for good health.

Gradual Improvement

Gradual improvement is encouraged by the slogan. It suggests that individuals can benefit from taking small steps to improve their diet and lifestyle each day.

USDA U.S. Department of Agriculture
Center for Nutrition Policy and Promotion
April 2005 CNPP-16

GRAINS | VEGETABLES | FRUITS | OILS | MILK | MEAT & BEANS

Nutrition Essentials and Diet Therapy

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To access your Student Resources, visit:

http://evolve.elsevier.com/Peckenpaugh/essentials/

Evolve Student Resources for Peckenpaugh: *Nutrition Essentials and Diet Therapy,* Eleventh Edition, offer the following features:

- **Nursing Review Questions**
  50 questions in multiple-choice NCLEX format designed to help you prepare for this examination.
- **Nutritrac Nutrition Analysis Program, Version 5.0**
  This food database contains more than 5000 foods in 18 different categories and allows you to enter and edit their intake and output. It includes a weight management planner, a detailed energy expenditure section, and sample diets.
- **Food Composition Table**
  This detailed listing allows you to search the nutrient values of more than 5000 foods contained in the Nutritrac Nutrition Analysis Program, Version 5.0. This table is separated and alphabetized into 18 different food categories.

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Nutrition Essentials and Diet Therapy

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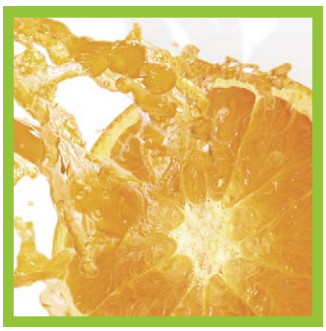

11th Edition

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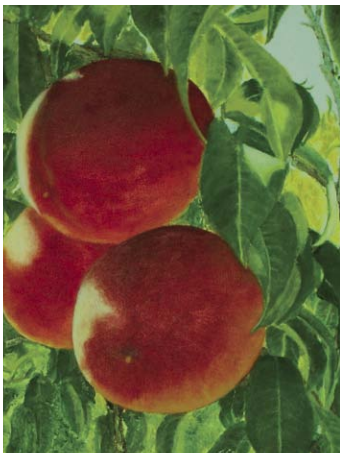
To Norman, who continues to support all of my endeavors, including the many hours of writing this edition, who helped me recognize my artistic eye and inspired my budding talent as an oil painter and, most importantly, who makes me laugh virtually every day



Original oil paintings by Nancy Peckenpaugh from orchards in the central Finger Lakes region of New York State. Nancy began oil painting in the summer of 2005 with the goal of painting fruits and vegetables in their natural state. Her intent is to increase children's appreciation for these foods.

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Acknowledgments

The origins of this textbook began with handwritten notes by the first author, Alberta Schackelton. The development into its present-day format was facilitated by my former co-author, Charlotte Poleman, RD, until her retirement after the eighth edition. This edition continues with the supportive oversight and direction of Yvonne Alexopoulos, senior editor; the instrumental and very significant contributions of Danielle Frazier, senior developmental editor; and the rigorous editorial review by Cheryl Abbott, senior project manager, and Lois Lasater, the copyeditor for this edition. The suggestions and feedback of the many reviewers of the early drafts of the revision work and the learning needs of former students at State University of New York at Cortland have served to make this an even stronger textbook. Many individuals have influenced the writing of this textbook, including clients and colleagues.

Special appreciation goes to Sue McGinley, the first dietitian I worked under, who paved the way to my success and fascinating career with the simple premise of advising people on what they can eat rather than what they can't. Ginny Huszagh, MSN, RD, CDN, has been a more recent collaborator in our work together at Groton Nursing Facility, and her insight into acute care needs within a long-term care setting has allowed my continued growth as a registered dietitian. I have also learned a great deal from the many physicians I have worked with over the years. Special appreciation goes to Dr. Peter Clark, who has challenged my thinking on a variety of nutrition-related concerns. I continue to learn about diabetes management from working with Dr. Adam Law and Anne Neirynk, NP, CDE. Nutritional needs across the life span are regularly reinforced in my work with Dryden Family Medicine.

A final tribute goes to family and friends whose patience and support was crucial in the completion of this endeavor.

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Preface to the Instructors

Nutrition continues to expand as a science, with new research propelling our understanding of the dependence of cellular function on the interplay with nutrients found in food. Research continues to challenge long-held beliefs and to force continual updating to provide sound nutritional policies and messages. Biopsychosocial changes continue to influence how the science of nutrition applies to the multitude of complex individual needs. We may again see nutritional deficiency diseases, once mostly eradicated in this country, because of the financial straits in which many individuals find themselves. At the same time, there are many sophisticated, intelligent, and financially secure consumers who still are adversely influenced by the snake-oil propaganda of our times. Although the Internet is a wealth of sound nutritional guidance, slick messages that are not based on evidence continue to be a risk to the health of this nation. Health care professionals may be influenced with questionable nutrition messages that have no scientific credibility. Limited class time devoted to nutrition in the education of the health care professional compounds the potential for harm in the delivery of health care.

In writing the eleventh edition of *Nutrition Essentials and Diet Therapy,* the goal has been to provide rigorous updated review of science-based information in a concise, focused, and practical approach to basic health care nutrition. The emphasis of the current edition is to prepare health care professionals to provide appropriate and useful nutritional guidance based on individual need.

The earlier groupings of the macronutrients carbohydrate, protein, and fat remain in one chapter. This best allows for discussion of the application of this information with food choices because food typically contains more than one macronutrient. The chapter on vitamins, minerals, and phytochemicals also takes this approach. These two chapters are subdivided for instructors who prefer to teach these nutrients separately.

BOOK FORMAT

The format continues with 3 sections and 15 chapters to meet curriculum needs.

Section 1: The Art and Science of Nutrition in Health and Disease has been modified to include the role of the health care team members and assessment skills to help students recognize their role in providing appropriate nutrition care. Chapter 2 has expanded coverage on carbohydrate classifications and the role

of amino acids and peptides as part of the protein needs for health. Chapter 4, Digestion, Absorption, and Metabolism in Health and Disease, now follows coverage of both macronutrients and micronutrients to better allow an appreciation of how impaired digestion and absorption affects cellular function and health status. Review of the role of water has been moved to Chapter 4 because it is involved in all processes related to digestion and utilization of the nutrients in foods. The PowerPoint slides continue to include two video clips to help students identify the macronutrient content of foods. New to the PowerPoint slides are sample calculations on determining macronutrient goals using the Exchange List System.

Section 2: Chronic and Acute Illness has expanded coverage on the impact of insulin resistance and the metabolic syndrome with a focus on the health care professional's role in the identification of individuals at risk and strategies to help reduce the prevalence of a variety of chronic health conditions such as diabetes. The use and implications of bariatric surgery have been expanded in the chapter on weight management.

Section 3: Life Span and Wellness Concerns in Promoting Health and Managing Illness includes increased coverage on the issue of childhood obesity and prevention, starting in utero. Strategies for helping hospitals develop protocols to support breastfeeding are included. There is greater emphasis on the needs of the young adult, with the goal to help prevent chronic health conditions from occurring later in life and consequently promoting older adults to lead productive and fulfilling lives. There is expanded coverage on chronic care needs in acute and long-term care settings, including preventing and managing pressure ulcers.

FEATURES

- This edition continues as **part of the popular LPN Threads series.**
- **Cultural Considerations** boxes appear in each chapter and include various scenarios aimed at the biopsychosocial influences on nutritional intake and status.
- **Facts and Fallacies** address common nutrition misconceptions, presenting the facts to help students better understand the subject matter.
- **Teaching Pearls** provide practical counseling messages and analogies.
- **Chapter Challenge Questions and Classroom Activities** at the end of each chapter present students with the opportunity to review and discuss relevant content.
- **Critical Thinking Case Studies** help students apply concepts to clinical practice.
- The question format continues for the major headings within the text, and basic readability is emphasized to help with student learning.
- **Chapter Topics** are based on primary headings and begin each chapter to make students aware of key content that will be covered.
- **Objectives** help students focus on essential content to better prepare them for learning.
- **Terms to Identify** at the beginning of each chapter emphasize pertinent terminology covered throughout the chapter.
- Use of full-color design increases interest by adding to visual appeal.

ANCILLARIES

Evolve Resources for instructors and students can be found online at http://evolve.elsevier.com/Peckenpaugh/essentials/.

The Instructor Resources are designed to help instructors present the material in this text and include the following assets:

- Instructor's Manual
- Answers to Chapter Challenge Questions and Classroom Activities
- Answers to Case Study Critical Thinking Applications
- Two Video Clips: (1) carbohydrate content of plant-based foods and (2) the protein and fat content of foods
- ExamView Test Bank with more than 225 questions with answers
- PowerPoint slides with over 600 slides that include more than 100 images; the slides now indicate with a medical symbol the information that is primarily for nursing/medical students and an FYI symbol for coverage of new research that may be of a personal and professional interest but that students are not expected to know for testing purposes
- Full-color Electronic Image Collection

Student Resources provide students with additional tools for learning and include the following assets:

- Nursing Review Questions
  - 50 questions written in multiple-choice NCLEX format give students immediate feedback to help them prepare for this examination.
- Food Composition Table
  - This detailed listing allows you to search the nutrient values of more than 5000 foods contained in the Nutritrac Nutrition Analysis Program, Version 5.0. This table is separated and alphabetized into 18 different food categories.
- **New Online Version!** Nutritrac Nutrition Analysis Program, Version 5.0
  - A food database that contains over 5000 foods in 18 different categories: Baby Food, Baked Goods, Beverages, Breads/Grains and Pasta, Breakfast Foods/Cereals, Dairy and Eggs, Fats and Oils, Fruits and Vegetables, Meats and Beans, Nuts and Seeds, Frozen Entrees and Packaged Foods, Restaurant Chains–Fast Foods, Restaurant Chains–Other, Seafood and Fish, Snacks and Sweets, Soups, Supplements, and Toppings and Sauces.
  - A complete listing of more than 150 activities—daily/common, sporting, recreational, and occupational—is included in the *Detailed Energy Expenditure* section.
  - The profile feature allows users to enter and edit the intake and output of an unlimited number of individuals, and the weight management planner helps outline healthy lifestyles tailored to various personal profiles. In addition to foods and activities, new program features include an ideal body weight (IBW) calculator, a Harris-Benedict calculator to estimate total daily energy needs, and the complete *Exchange Lists for Meal Planning*.

PHILOSOPHY

The guiding principle throughout the writing of this text has been that nutrition is and increasingly will be one of the core disciplines for health care as we continue in

the twenty-first century. Not everyone takes medications, not everyone undergoes surgery or other extraordinary procedures, but everyone needs good nutrition. It is the single most important factor in the care of the well and ill client. Medical nutrition therapy saves health care dollars while improving the quality of lives. As previously stated, the aim has been to make this body of information more accessible and useful to the people who need it most, the health care providers. I would be very interested in your view concerning how well the objectives of this textbook have been met and how future editions might be improved. Please write in care of Saunders, an imprint of Elsevier Inc., with your suggestions.

NANCY J. PECKENPAUGH, MSEd, RD, CDN, CDE

Content Threads

This eleventh edition of *Nutrition Essentials and Diet Therapy* shares a number of learning features with other Elsevier titles used in LPN nursing programs. These user-friendly "Content Threads" are designed to streamline the learning process among the variety of books and content areas included in this fast-paced and demanding curriculum.

The learning features included in this edition are as follows:

- Reading level is presented in an easy-to-read and user-friendly format. The often personal writing style engages the reader and helps unfold the information simply and effectively.
- Cover design includes similarities to help readers instantly recognize the book as containing content and features relevant to today's nursing curricula.
- Terms to Identify on each chapter opener page emphasize pertinent terminology covered throughout the chapter.
- Chapter Challenge Questions and Classroom Activities at the end of each chapter present students with the opportunity to review and discuss relevant content.
- Critical Thinking Case Studies help students apply concepts to clinical practice.
- A complete list of References is available at the end of each chapter.
- The Glossary is an alphabetical listing of the Terms to Identify presented throughout the textbook.

Preface to the Students

Now in its eleventh edition, *Nutrition Essentials and Diet Therapy* continues to concentrate on what is most important for the health care provider to know about nutrition basics and the application of nutrition knowledge. It presents science-based information in a concise, focused, and practical approach to basic health care nutrition.

Check out the following features to familiarize yourself with this easy-to-read, user-friendly format. This will help you get the most value out of this text.

Chapter Topics are based on primary headings and begin each chapter to make you aware of key content that will be covered.

Objectives help you focus on essential content to better prepare you for learning.

Terms to Identify at the beginning of each chapter emphasize pertinent terminology covered throughout the chapter.

Chapter Topics

Health Problems Found With Overweight and Obesity
Weight Standards
Rates of Overweight and Obesity
Causes and Theories of Obesity Etiology
Prevention of Obesity
Treatment Strategies for Obesity
Review of the Popular Weight-Loss Diet Approaches
The Impact of Bariatric Surgery
The Role of Physical Activity in Weight Management
The Role of the Nurse and Other Health Care Professionals in the Prevention and Management of Obesity

Objectives

After completing this chapter, you should be able to:

- Describe obesity and discuss its prevention and treatments.
- Recognize healthy weight management practices.
- Relate the importance of physical activity to healthy weight management.

Terms to Identify

Adipocytokines
Adiponectin
Adipose tissue
Aerobic exercise
Anaerobic exercise
Apple shaped
Asterixis
Bariatric surgery
Body mass index (BMI)
Cholecystectomy
Cholelithiasis
Class I obesity
Class II obesity
Class III obesity
Conjugated linoleic acid (CLA)
Cortisol
C-reactive protein (CRP)
Dehydroepiandrosterone (DHEA)
Desirable weight
Distal gastric bypass biliopancreatic diversion (DBP)
Dopamine
Duodenal switch (DS)
Energy balance
Extreme obesity
Gastric banding
Gastrojejunostomy
Ghrelin
Glucocorticoid
Healthy weight
Hemeralopia
Hypothyroidism
Ideal body weight
Incretin

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Cultural Considerations boxes appear in each chapter aimed at awareness of perceptions and biopsychosocial influences that affect the consumer's ability or willingness to follow through on nutritional guidance.

Cultural Considerations

A significant number of people in the United States have "tried all the diets." Some of this may be a result of attempts to find an approach that works. However, some individuals enjoy the excitement of trying a new diet. This can be one reason for diet failure, because the excitement fades away with long-term adherence to a dietary regimen.

Thus such individuals purposely try all the latest diets. ■

Teaching Pearls provide practical counseling messages and analogies.
Facts and Fallacies address common nutrition misconceptions, presenting the facts to help students better understand the subject matter.

Teaching Pearl

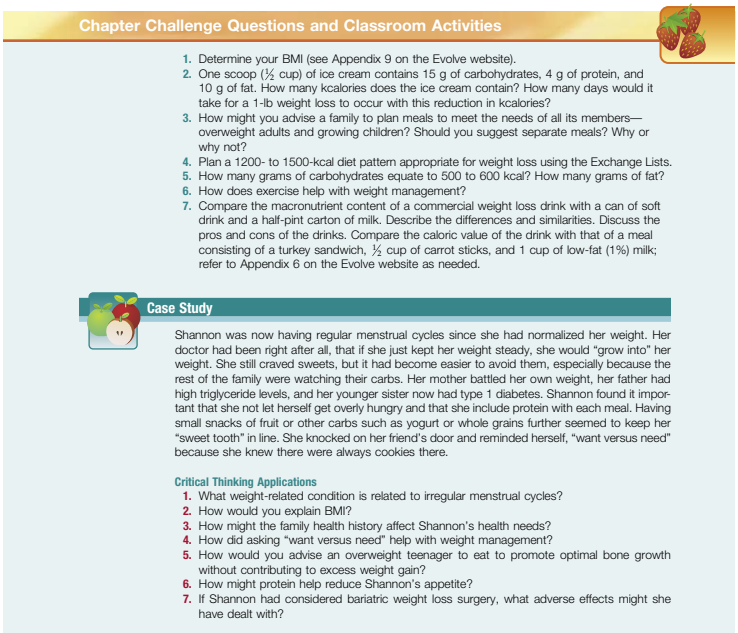
It may be argued that our ancestors likely ate a lot of meat; however, it was not from commercially raised cattle sitting in a stall being force-fed all day. A 1-lb steak today has the equivalent of ½ cup of pure lard, whereas 1 lb of wild game contains about 1 to 2 tablespoons of fat. Unsaturated fats would have been the primary source of fat (e.g., from nuts and seeds for those living in forests or from fatty fish for those living near the sea). With an emphasis on unsaturated fats, insulin sensitivity is improved, allowing for better cellular use of glucose from carbohydrates, especially those high in fiber. ■

Fact & Fallacy

FALLACY Until his untimely death, Dr. Atkins continued to promote saturated fat as found in steak, sausage, bacon, and cheese, while promoting a very low-carbohydrate intake.

FACT Dr. Atkins was on national television the month before he died promoting a change to lean meats and use of unsaturated fats with increased intake of high-fiber foods. The book *Atkins Diabetes Revolution*, completed by his colleagues after his death, explains his change in thinking. ■

Chapter Challenge Questions and Classroom Activities at the end of each chapter present an opportunity to review and discuss relevant content.
Critical Thinking Case Studies help you apply concepts to clinical practice.



Chapter Challenge Questions and Classroom Activities

1. Determine your BMI (see Appendix 9 on the Evolve website).
2. One scoop (½ cup) of ice cream contains 15 g of carbohydrates, 4 g of protein, and 10 g of fat. How many kcalories does the ice cream contain? How many days would it take for a 1-lb weight loss to occur with this reduction in kcalories?
3. How might you advise a family to plan meals to meet the needs of all its members—overweight adults and growing children? Should you suggest separate meals? Why or why not?
4. Plan a 1200- to 1500-kcal diet pattern appropriate for weight loss using the Exchange Lists.
5. How many grams of carbohydrates equate to 500 to 600 kcal? How many grams of fat?
6. How does exercise help with weight management?
7. Compare the macronutrient content of a commercial weight loss drink with a can of soft drink and a half-pint carton of milk. Describe the differences and similarities. Discuss the pros and cons of the drinks. Compare the caloric value of the drink with that of a meal consisting of a turkey sandwich, ½ cup of carrot sticks, and 1 cup of low-fat (1%) milk; refer to Appendix 6 on the Evolve website as needed.

Case Study

Shannon was now having regular menstrual cycles since she had normalized her weight. Her doctor had been right after all, that if she just kept her weight steady, she would "grow into" her weight. She still craved sweets, but it had become easier to avoid them, especially because the rest of the family were watching their carbs. Her mother battled her own weight, her father had high triglyceride levels, and her younger sister now had type 1 diabetes. Shannon found it important that she not let herself get overly hungry and that she include protein with each meal. Having small snacks of fruit or other carbs such as yogurt or whole grains further seemed to keep her "sweet tooth" in line. She knocked on her friend's door and reminded herself, "want versus need" because she knew there were always cookies there.

Critical Thinking Applications

1. What weight-related condition is related to irregular menstrual cycles?
2. How would you explain BMI?
3. How might the family health history affect Shannon's health needs?
4. How did asking "want versus need" help with weight management?
5. How would you advise an overweight teenager to eat to promote optimal bone growth without contributing to excess weight gain?
6. How might protein help reduce Shannon's appetite?
7. If Shannon had considered bariatric weight loss surgery, what adverse effects might she have dealt with?

- You have access to the **New Online Version! Nutritrac Nutrition Analysis Program, Version 5.0.** This innovative program is available on our Evolve website at http://evolve.elsevier.com/Peckenpaugh/essentials/. Here are some of its features:
- A food database contains over 5000 foods in 18 different categories: Baby Food, Baked Goods, Beverages, Breads/Grains and Pasta, Breakfast Foods/Cereals, Dairy and Eggs, Fats and Oils, Fruits and Vegetables, Meats and Beans, Nuts and Seeds, Frozen Entrees and Packaged Foods, Restaurant Chains–Fast Foods, Restaurant Chains–Other, Seafood and Fish, Snacks and Sweets, Soups, Supplements, and Toppings and Sauces.
- A complete listing of more than 150 activities—daily/common, sporting, recreational, and occupational—is included in the *Detailed Energy Expenditure* section.
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We thank you for including *Nutrition Essentials and Diet Therapy,* Eleventh Edition, as a part of your nutrition education. Be sure to check out our website at www.elsevierhealth.com for all of your health science educational needs!

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chapter 1

The Art of Nutrition in a Social Context

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Chapter Topics

Introduction
Basic Nutrition and Health Terms to Understand
Development of Food and Dietary Patterns
Biopsychosocial Concerns in Health Care
Cultural and Societal Influences
Moderation, Variety, and Balance
Food Guides
Nutrition as an Aspect of Total Health Care
Interviewing and Communication Skills
The Nutrition Care Planning Process

Objectives

After completing this chapter, you should be able to:

- Define terms used in the study of nutrition.
- Identify biopsychosocial influences on nutritional intake and health.
- Evaluate a daily diet for moderation, variety, and balance.
- Explain the significance of nutrition labeling.
- Recognize and differentiate among the various food guides available.
- Discuss the role of the health care team.
- Discuss interviewing and counseling strategies.
- Explain strategies to serve as a change agent in the promotion of positive eating habits.
- Describe the nutrition care planning process.
- Identify your personal strengths and weaknesses in nutrition knowledge and its application.

Terms to Identify

Acculturation
Active listening
Activities of daily living (ADL)
Affective
Albumin
Anthropometry
Biopsychosocial
Change agent
Chronic disease
Cognitive
Daily Reference Values (DRVs)
Empty kcalories
Exchange Lists for Meal Planning
Glucocorticoids

Health care provider
"I" versus "you" statements
Kilocalorie (kcalorie or kcal)
Learned food aversions
Medical genealogy
Medical nutrition therapy (MNT)
Medicare
Metabolic
Nonverbal communication
Nursing process
Nutrient density
Nutrigenetics
Nutrigenomics
Nutrition care process
Pescetarian diet
Psychomotor
Transtheoretical model of health behavior change
Vegan

INTRODUCTION

As a nation of immigrants, our genetically based health problems can be traced back to the roots of our many heritages, whether our ancestors originated in Northern Europe, Southern Europe, Africa, or other parts of the world. Even Native Americans are believed to have originally migrated from Asia. Although there may not be a direct familial link, persons with common ancestry share a common gene pool and hence may resemble one another (biochemically and physically) more than they resemble people from other groups. Diabetes, high blood pressure, obesity, and atherosclerosis appear in families, in part, for genetic reasons. This is referred to as **medical genealogy.**

More recent terms used to discuss medical genealogy are **nutrigenetics,** related to how genetic predisposition affects susceptibility to diet, and the opposite, **nutrigenomics,** which addresses how diet influences gene expression and metabolism (Kussmann and colleagues, 2006). Nutrigenomics is aimed at individualized nutrition guidance for health and prevention of disease.

Partly because of medical genealogy, a return to or maintenance of plant-based diets is being promoted around the world. Traditional ethnic cooking is often based around legumes (beans), which have been a mainstay of cooking for centuries. Lentils are one of the oldest foods known, having been eaten for at least 8000 years. From Northern Africa, through the Mediterranean, to Syria, people commonly sit down to half a plate of spinach, not a small dollop as Americans typically eat, if they eat it at all. In England, people to this day love baked beans on toast, and sardines are eaten as frequently as tuna is in the United States. Asian foods, including Chinese, Japanese, and Thai foods, are now popular in the United States, and all are heavily focused on a variety of vegetables, fruits, and soybean products. The Mediterranean diet, with its emphasis on legumes and olive oil, has seen renewed interest. Mexican meals, with an emphasis on beans, are another favorite.

Environmental forces affect food choices. In tandem with genetic predisposition, various health conditions can develop. Traditional food habits that are not commonly followed anymore by most Americans include eating wild greens like dandelion and burdock greens, other wild plants such as cattails, eating organ meats, or consuming a variety of seafood, including sardines and herring. The homogenization of the typical diet with chain restaurants offering the same foods throughout the country, and in some cases the world, along with reduced numbers and varieties of foods

potentially is contributing to various health conditions. This is likely due to excess kilocalorie (kcalorie or kcal) intake from large portions with excess fats and sugars, and reduced diet quality from limited intake of a variety of vitamins and minerals (see Chapter 3).

Knowledge of what constitutes healthy eating has developed over the years. Guidelines on eating behavior, food choices, and food preparation have been addressed in philosophical and religious writings over the centuries. The consumption of certain foods in maintaining health was recognized, such as the consumption of citrus fruits by ocean-voyaging sailors. As the field of science developed in the nineteenth century, public health policy has developed. In the first half of the twentieth century, the focus was on sanitation and prevention of nutrient-deficiency diseases. In the early 1900s pediatricians routinely prescribed daily or weekly cod-liver oil for growing children. This was for the vitamin D value needed to replace the benefits of sunlight for the many urban-dwelling children who worked long hours in factories at this time. Then nutrients were chemically isolated with the resulting research that continues to this day. In the 1920s salt was fortified with iodine, the 1930s brought vitamin D–fortified milk, and in the 1940s bread and flours were fortified with B vitamins.

In the second half of the twentieth century, the focus shifted to prevention of chronic disease and dietary excesses. Meal-planning guides began in the 1940s when there were seven recommended food groups, butter being one of them as a vitamin D source. By the 1950s, when the baby-boom generation was being born, the Basic Four Food Groups classification (meat, grains, dairy, and vegetables and fruits) was developed by the U.S. Department of Agriculture (USDA) to replace the older concept of seven food groups. Because milk was now being fortified with vitamin D, the advice for butter consumption was no longer recommended. The 1960s brought the research that indicated heart disease could be prevented with less saturated fat. Eventually, in 1990 the USDA replaced the Basic Four with the Food Guide Pyramid with the message that less meat and fats was desirable. In 2005 the new MyPyramid was developed. The updated version includes an online resource at MyPyramid.gov that provides individualized guidance. The current food guidelines recognize the importance of lifestyle as well as food and nutrition choices.

WHAT ARE THE BASIC TERMS TO UNDERSTAND IN THE STUDY OF NUTRITION?

1. A *nutrient* is a chemical substance that is present in food and needed by the body. The macronutrients include the energy nutrients carbohydrate, fat, and protein. The micronutrients include vitamins, minerals, and water. A food high in **nutrient density** is one that has a high proportion of micronutrients in relation to the macronutrients. **Empty kcalories** implies the opposite.
2. *Nutrition* is the science of the processes by which the body uses food for energy, maintenance, and growth. Good nutritional status implies appropriate intake of the macronutrients—carbohydrates, proteins, and fats—and the various vitamins and minerals often referred to as "micronutrients" because they are needed in small quantities. If there is good digestion, absorption, and cellular metabolism of these nutrients in the diet, a person can generally achieve good nutritional status.

3. *Malnutrition* or *poor nutritional status* is a state in which a prolonged lack of one or more nutrients retards physical development or causes the appearance of specific clinical conditions (anemia, goiter, rickets, etc.). This may occur because the diet is poor or because of a digestion and metabolism problem. Excess nutrient intake creates another form of malnutrition when it leads to conditions such as obesity, heart disease, hypertension, and hypercholesterolemia.
4. *Optimal nutrition status* means that a person is receiving and using the essential nutrients to maintain health and well-being at the highest possible level.
5. A **kilocalorie (kcalorie or kcal)** is a unit of measure used to express the fuel value of carbohydrates, fats, and proteins. The large Calorie (or kcalorie) used in nutrition represents the amount of heat necessary to raise the temperature of 1 kg of water 1° C. One pound of body fat equates to 3500 kcal. Carbohydrates, proteins, fats, and alcohol are the only sources of kcalories. One kcalorie equals approximately 4 kilojoules (kj) in the metric system.
6. *Health* is currently recognized as being more than the absence of disease. High-level health and wellness are present when an individual is actively engaged in moving toward the fulfillment of his or her potential. The art of nutrition includes the application of nutrition science to meet individual needs for the goal of optimal health status.
7. *Public health* is the field of medicine that is concerned with safeguarding and improving the health of the community as a whole. Public health nurses may work out of public health departments or private health organizations. Other public health programs have been developed for various population groups such as women who are pregnant or the elderly (see Chapter 14).
8. *Holistic health* is a system of preventive medicine that takes into account the whole individual. It promotes personal responsibility for well-being and acknowledges the total influences—biologic, psychologic, and social—that affect health, including nutrition, exercise, and emotional well-being.
9. **Medical nutrition therapy (MNT)** (referred to in the past as "diet therapy") is the treatment of disease through nutritional therapy by registered dietitians (RDs). RDs are uniquely qualified to provide MNT because of their extensive training in food composition and preparation, nutrition and biochemistry, anatomy and physiology, as well as life-cycle concerns and disease states. MNT may be necessary for one or more of the following reasons:
   - To maintain or improve nutritional status
   - To improve clinical or subclinical nutritional deficiencies
   - To maintain, decrease, or increase body weight
   - To rest certain organs of the body
   - To eliminate particular food constituents to which the individual may be allergic or intolerant
   - To adjust the composition of the normal diet to meet the ability of the body to absorb, metabolize, and excrete certain nutrients and other substances

HOW DO FOOD AND DIETARY PATTERNS DEVELOP?

Sound nutrition begins before birth, through the influence of food culture and exposure to food flavors through amniotic fluid in utero. Persons of various cultural

communities consume differing types and amounts of foods. (See Table 1-1 for common and regional food habits.) The family later affects the growing child's meal environment and exposure to food.

In the ideal scenario the infant is exposed to a variety of foods and is fed in a manner that promotes positive meal association. Then the infant is more likely to become a child who learns to like a variety of foods that are of high quality and dense in nutrients. When a child has been allowed to eat on the basis of his or her own hunger and satiety cues in a positive meal environment, eating takes place according to growth needs; thus an appropriate quantity of food intake is maintained. (See Chapter 12 for more detailed information on child development and nutritional needs.)

Many factors can change this ideal scenario. Children may have food allergies or food intolerances, and these foods become associated with physical discomfort. **Learned food aversions** fall into this classification. For example, a food that is eaten before the onset of an illness that is unrelated to the food (such as a viral illness) becomes mistakenly associated with the illness. If this food is avoided in the future, the phenomenon is appropriately termed a learned food aversion.

Improvement in food selection patterns for bettering health status frequently means changing established habits. This is a slow, step-by-step, almost never-ending process that requires a real desire to change, a deep conviction that change is important, and the willingness to substitute desirable food habits for undesirable ones. Health care professionals dealing with nutritional improvement, although primarily concerned with the **metabolic** (biochemical) role of food in health, must also have some understanding of the circumstances under which dietary habits are acquired and the various meanings that food may have for different individuals. This is especially true in dealing with persons who suffer from a disorder or disease that requires drastic, long-term changes in dietary habits.

WHAT ARE BIOPSYCHOSOCIAL CONCERNS IN HEALTH CARE?

Biopsychosocial concerns address the interplay between external environmental (psychologic and social factors) and internal forces (genetic or biochemical/physiologic requirements). For example, the diagnosis of diabetes is primarily a biochemical or internal problem, but for the person hearing this diagnosis it involves psychologic issues of acceptance versus denial and anger and social concerns of healthy living in an environment that may be stressful and that discourages adherence to a healthy diet (external problems or social forces). The biochemical problem of either very high or very low blood sugars can also affect emotions and the ability to think. Another relatively common physical condition adversely affecting food choices and nutritional status is lack of teeth. One study found that with the loss of 14 teeth or more there was significantly lower intake of salad vegetables. This was found to result in lower blood levels for vitamins A and C and the B vitamin folate (Nowjack-Raymer and Sheiham, 2007).

Religious impact on eating, such as giving up chocolate for Lent or following a kosher diet, occurs. Religious holiday dietary practices have long been observed, such as 24-hour fasting for the Jewish holiday Yom Kippur, or abstaining from meat on Fridays among Catholics (which has developed into the Friday fish fry), or fasting

Table 1-1 Ethnic and Regional Food Patterns According to the Basic Food Groups of the MyPyramid Food Guidance System

ETHNIC GROUP	BREAD AND CEREAL	EGGS, MEAT, FISH, POULTRY	DAIRY PRODUCTS	FRUITS AND VEGETABLES	SEASONINGS AND FATS
Italian	*Northern Italy*: Crusty white bread Cornmeal and rice *Southern Italy*: Pasta	Beef, chicken, eggs, fish, anchovies	Milk in coffee, cheese	Broccoli, zucchini, other squash, eggplant, artichokes, string beans, legumes,* tomatoes, peppers, asparagus, fresh fruit	Olives and olive oil, balsamic vinegar, salt, pepper, garlic, capers, basil
Puerto Rican	Rice, noodles, spaghetti, oatmeal, cornmeal	Dry salted codfish, meat, salt pork, sausage, chicken, beef	Hot milk in coffee	Beans,* starchy root vegetables, green bananas, plantains, legumes,* tomatoes, green pepper, onion, pineapple, papaya, citrus fruits	Lard, herbs, oil, vinegar
Near Eastern	Bulgur (wheat)	Lamb, mutton, chicken, fish, eggs	Fermented milk, sour cream, yogurt, cheese	Nuts, grape leaves	Sheep's butter, olive oil
Greek	Plain wheat bread, phyllo dough	Lamb, pork, poultry, eggs, organ meats	Yogurt, cheese, butter	Onions, tomatoes, legumes,* fresh fruit	Olive oil, parsley, lemon, vinegar
Mexican	Lime-treated corn tortillas	Little meat (ground beef or pork), poultry, fish	Cheese, evaporated milk as beverage for infants	Pinto beans,* tomatoes, potatoes, onions, lettuce, black beans	Chili pepper, salt, garlic
Chinese	Rice, wheat, millet, corn, noodles	Little meat and no beef; fish (including raw fish); eggs of hen, duck, and pigeon; tofu and soybeans	Water buffalo milk occasionally, soybean milk, cheese	Soybeans,* soybean sprouts, bamboo sprouts, soy curd cooked in lime water, radish leaves, legumes,* vegetables, fruits	Sesame seeds, ginger, almonds, soy sauce, peanut oil

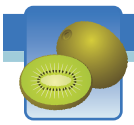
*Beans and legumes are also counted as a meat substitute.

Table 1-1 Ethnic and Regional Food Patterns According to the Basic Food Groups of the MyPyramid Food Guidance System—cont'd

ETHNIC GROUP	BREAD AND CEREAL	EGGS, MEAT, FISH, POULTRY	DAIRY PRODUCTS	FRUITS AND VEGETABLES	SEASONINGS AND FATS
African American or Southern United States	Hot breads, pastries, cakes, cereals, white rice	Chicken, salt pork, ham, bacon, sausage	Milk and milk products (often lactose-free for African heritage)	Kale, mustard, turnip, collard greens; hominy; grits; sweet potatoes; watermelon; black-eyed peas	Molasses
Jewish	Noodles, crusty white seed rolls, rye bread, pumpernickel bread	Kosher meat (from forequarters and organs from beef, lamb, veal); fish (except shellfish)	Milk and milk products Milk not eaten at same meal as meat	Vegetables—usually cooked with meat; fruits	

by Muslims during daylight hours during the month of Ramadan. Fasting for religious reasons can be detrimental, such as development of hypoglycemia for persons with diabetes. Individuals with medical conditions in which adverse health outcomes are expected are not obligated to adhere to religious fasts.

An individual's eating habits can have strong emotional reasons that health educators need to consider before providing nutritional advice. Too many individuals worry excessively over what they eat. We all need a variety of foods and flavors for good emotional and physical health. Feeling embarrassed regarding food choices is not conducive to good mental well-being. Health care professionals can promote the idea that "all foods can fit."



Cultural Considerations

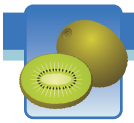
In a semirural area in Louisiana, various biopsychosocial factors were found to influence food choices. Those families with incomes of $15,000 or less were more likely to eat burgers and sandwiches than those with income over $45,000, and those with income over $30,000 up to $45,000 had lower consumption of mixed dishes. Intake of grains, dairy, fruits, 100% fruit juice, and vegetables was higher in those having some college education. European American men had more dairy products and sweetened beverages than African American men. European American women had more dairy products, vegetables, and fats than African American women. African Americans in general consumed more fruits and 100% fruit juices than European Americans. Married individuals consumed more snacks and desserts, but less alcohol (Deshmukh-Taskar and colleagues, 2007). ■

HOW DO CULTURAL AND SOCIETAL FACTORS INFLUENCE NUTRITIONAL INTAKE?

Many barriers to adequate nutrient intake are external in nature and may stem from a variety of causes:

- *Economic* (inadequate money to purchase food, limited finances for transportation to grocery stores such lack of a car or limited funds for gasoline)
- *Physical* (lack of food storage and cooking facilities, physical impairments that inhibit consumption of a variety of foods or ability to travel to grocery stores)
- *Cultural* (lack of exposure to a variety of foods because of limited parental offerings or overemphasis on excess intake with large portions of food in restaurants or at home)
- *Ecologic* (droughts, floods, earthquakes, snow and ice storms)
- *Emotional* (television advertisements and other media depicting nonnutritious foods as appealing and healthy foods such as spinach as unappealing)
- *Religious* (adherence to restrictive food codes, religious food celebrations)
- *Political* (food boycotts, forced starvation for military purposes)

One factor influencing food choices is availability and food costs found in supermarkets. This can have significant impact on lower-income families. It was found among supermarkets in the Sacramento and Los Angeles areas of California that the cost of a market basket meeting the 2005 Dietary Guidelines was less than the food stamp allotment of the Thrifty Food Plan (see Chapter 14). However, it was estimated to require a low-income family to spend about half of their food budget on fruits and vegetables to meet the Dietary Guidelines (Cassady, Jetter, and Culp, 2007). The situation can be more problematic in nonurban areas. One study found in a rural setting that there are primarily convenience stores, rather than the larger supermarkets. Less than half of convenience stores carried low-fat milk and high-fiber bread, with prices significantly higher than less-healthy choices (Liese and colleagues, 2007).



Cultural Considerations

Data analyzed from the National Health and Nutrition Examination Survey (NHANES) for 2001-2002 showed that among Mexican Americans, those with low **acculturation**, as indicated by lack of speaking English, were found to have less obesity (body mass index [BMI] greater than 30) (see Chapter 6) than those who had assimilated into the U.S. culture. Of those who were overweight (BMI greater than 25), low-acculturated Mexican Americans were less likely to perceive themselves overweight with fewer attempts to lose weight (Ahluwalia and colleagues, 2007). Using data from the National Health Interview Survey, it was found that the typical immigrant entering the United States has had a lower BMI than native-born citizens. However, BMIs increase to virtually the same level for females within 10 years, and men close a third of the gap within 15 years (Antecol and Bedard, 2006). Health care professionals can help slow down this trend by encouraging maintenance of traditional food habits and lifestyles. ■

CHANGING FOOD HABITS

Many young Americans have never had exposure to a variety of vegetables, such as Swiss chard, lentils, or even basic vegetables such as Brussels sprouts and broccoli. There are generational differences in food exposure and acceptance. People born

before World War II (before the process of hydrogenation was used extensively) remember stirring their peanut butter, because the oil rose to the top in the natural form. This natural form of peanut butter has no trans fats, regardless of portion (see section on food labels). Older generations commonly ate salt cod, sardines, and herring along with a variety of vegetables, including turnips and parsnips. The availability of soft drinks into the midtwentieth century was generally limited to vending machines at gas station lots. Meals were typically always in a home setting.

Food cultures have been transported across the United States. For example, traditional Southern foods included okra, collard greens, kale, pinto beans, and black-eyed peas, but as Americans have moved across the country, these foods have followed suit. Bagels, tacos, baked beans, pizza, and other regional and ethnic foods are now commonplace across the country. Unfortunately, some of these foods have become Americanized, with excess fats and sugars. Traditional pizza was made without mozzarella cheese, known as focaccia. When Chinese restaurants first appeared in the mainstream they served foods low in fat, and the foods had the reputation for inducing early hunger. Now these same restaurants increasingly serve food high in fat, with large portions not typical in China.

As restaurant eating has increased in frequency, there have been a variety of effects on this nation's health. One issue is increased portion sizes. Gone are the days of 4-oz juice glasses, with the exception of old-time diner type of restaurants or those juice glasses found in antique stores. Consuming soft drinks (also referred to as soda pop, pop, and carbonated beverages) that have similar kcalories as fruit juice is now commonplace in restaurants and other food venues. A small soft drink can be 32 oz in some locations (Figure 1-1). Data from the nationally representative Nationwide Food Consumption Surveys and the NHANES found the percentage of calories from beverages virtually doubled between 1965 and 2002, equating to an increase of almost 250 kcal daily (Duffey and Popkin, 2007). This increased kcalories of beverages does not appear to be due to milk intake because, on average, preschool children were found to drink less than the 2 cups of milk recommended for children by the 2005 Dietary Guidelines for Americans. Some excess kcalories for children does come from the butterfat content of milk because less than 10% of older children were found to drink low-fat or skim milk as advised for children over 2 years of age (O'Connor, Yang, and Nicklas, 2006).

Family composition and changing roles can influence food choices. Increasing numbers of men are now shopping for and preparing food (Figure 1-2). Households composed of single persons are growing, with an increased demand for more ready-to-use foods, which are often high in fat and salt.

Unfortunately, our society tends to overvalue many foods with empty kcalories. School personnel may still reward academic achievement with candy, divorced parents may give their children extra treats in an attempt to lessen feelings of guilt, and television advertisements tell us, "Go ahead, you deserve it!" Often, due to this reward system and because people like the taste of sweets, many Americans have excess intake of low-nutrient foods that are high in fat and sugar. Food should never be used as a reward in order to promote healthy attitudes toward eating.

Changes in diets are occurring around the world. Some are for the good with various types of cross-cultural cuisine. On the other hand, the so-called Western diet, which is high in saturated fat and sugar and low in fiber, is having an adverse effect on the health of populations around the world. Rates of obesity are increasing at

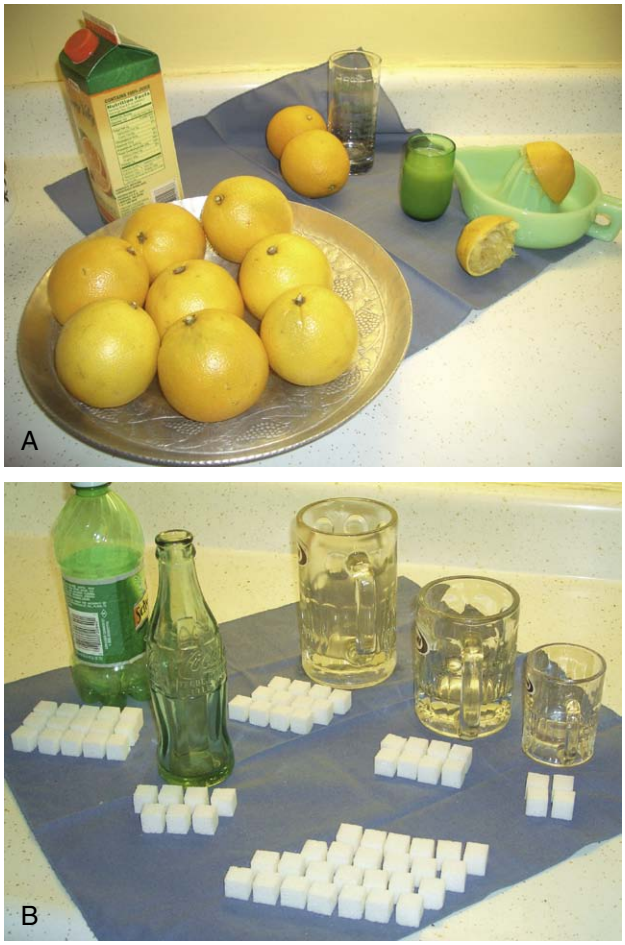


FIGURE 1-1 Fruit juice and soft drink serving size changes. **A,** The equivalent number of oranges per portion of juice (8/qt, 2/cup, 1/4 oz). **B,** The equivalent number of teaspoons of sugar per portion of soda (20 oz bottle original 6 oz bottle, 26 tsp/liter, original large "poppa" mug (now considered small), original medium "mamma" mug (no longer available), baby mug.

alarming rates worldwide as food habits are changing. The World Health Organization (WHO) estimates that at least 1 billion people worldwide are overweight and 300 million are obese. See Chapter 14 for more on international nutrition concerns and programs.

The pace of eating during mealtimes is historically slower throughout the Mediterranean region, and great pride is taken in food selection and method of preparation. However, modern society is affecting this traditional style of eating. What has been termed the *slow food movement* began in the 1980s in Italy in recognition that thousands of food varieties and flavors were being replaced by a few foods with standardized flavors. This movement has spread around the world, including the United States. Traditional ethnic foods and enjoyment of eating are being encouraged by the 80,000 members of this movement.

FIGURE 1-2 Men are becoming more involved in food shopping and meal preparation, which has increased their concern with the nutritional value of foods.

VEGETARIAN DIETS

Two religious groups that forgo consumption of meat and other animal products are Seventh-Day Adventists and Hindus. Many persons of the Jewish faith adopt a vegetarian eating plan to help them follow a kosher diet. Others follow vegetarian diets for health, political, cultural, or economic reasons or a combination of these. Some athletes adopting a vegetarian diet may be masking a disordered eating pattern (see Chapter 12). If a vegetarian diet results in excess weight loss, a referral to a psychologist or eating disorder clinic may be necessary.

There are generally two main forms of vegetarian diets. Lacto-ovo vegetarian diet is the primary one; it excludes meat but includes milk and milk products and eggs. *Lacto* comes from the Latin word for milk, and *ovo* comes from ovum (egg). Lacto-ovo vegetarians may also eat fish, but this is more correctly referred to as a **pescetarian diet**. The lacto-ovo vegetarian diet can easily provide all necessary nutrients needed for health.

The **vegan** diet is increasingly becoming popular. This form of vegetarian diet excludes all animal food sources, including no fish, eggs, or dairy products. For this reason it is far more difficult to meet nutritional needs with the diet. It was once thought in the 1970s, as written in the well-known book *Diet for a Small Planet* by Frances Moore Lappe, that protein combinations were required within the same meal. It is now known that if complementary protein sources are included within a 24-hour period that protein needs can be met (see Chapter 2). Common nutrient deficiencies with the vegan diet include iodine, vitamin B_{12}, iron, calcium, zinc, riboflavin, and vitamin D. Because meat provides protein, a variety of B vitamins, and minerals, alternative foods high in these nutrients need to be included in the vegetarian diet for health (see Table 1-2, Box 1-1, Chapters 2 and 3).

There are potential benefits of following a vegetarian diet. Reduced heart disease can occur with reduced saturated fat from the exclusion of red meat. However, low saturated-fat intake, such as with use of low-fat milk products, remains important. A social impact is reduced armpit body odor (Havlicek and Lenochova, 2006).

Table 1-2 Food Sources for Important Nutrients in the Vegetarian Diet

NUTRIENT	SOURCES
Calcium	Milk and milk products, particularly cheese and yogurt; fortified soy milk; dark green leafy vegetables such as parsley, kale, mustard, dandelion, and collard greens
Iron	Legumes, dark green leafy and other vegetables, whole-grain or enriched cereals or breads, some nuts, and dried fruits (many factors may affect absorption of this nutrient)
Riboflavin (vitamin B_2)	Milk, legumes, whole grains, and certain vegetables
Vitamin B_{12}	Milk and eggs, fortified soybean milk, fortified soy products, Marmite
Zinc	Nuts, beans, wheat germ, and cheese
Protein	Eggs, milk, nuts and seeds, legumes, especially soybeans and tofu

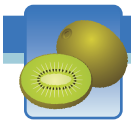
Box 1-1 Sample Menu ■ Nutritious Menu for a Vegan Diet

Breakfast
Oatmeal with soy milk
Whole-wheat toast with peanut butter
Orange juice
Half a grapefruit
Herbal tea

Lunch
Minestrone soup
Apple slices
Pecans and raisins
Whole-wheat bread
Glass of soy milk

Supper/Dinner
Tofu stir-fry with snow peas and carrots
Fresh spinach salad with croutons and dressing
Couscous
Cantaloupe wedges
Herbal iced tea

Snack
Almonds
Whole-wheat crackers
Glass of soy milk



Cultural Considerations

One study of medical students found about 7% of students identified themselves as vegetarians, although this percentage declined by the later years of study. About two thirds followed vegetarian diets for health reasons, and these individuals included more fruits and vegetables in their diets than those who followed vegetarian diets for nonhealth reasons. Vegetarians were more likely than their counterparts to eat fruits and vegetables, be female, politically liberal, of ideal body weight, or Hindu, Buddhist, or Seventh-Day Adventist. The vegetarians were also more likely to perceive nutrition counseling as highly relevant to their intended practices (Spencer, Elon, and Frank, 2007). ■

COMMON ETHNIC EATING HABITS

Chinese

Traditional Chinese meals include tofu or other soybean products at least daily, if not with all three meals. Rice, vegetables, and fish are principal parts of the diet. Traditional Chinese eating includes a very large variety of foods. Dessert often con-

sists of legumes that have minimal amounts of sugar added. Fat and sugar intake is expected to rise as American food products increasingly become available in the Chinese market. Traditional Chinese eating style is low fat.

French

The French are known for their pastries and cheese. However, their portions tend to be much smaller than those of Americans, and they eat plenty of vegetables. Wine provides phytochemicals that are believed to reduce the risk of heart disease.

Japanese

The Japanese typically eat fish and vegetables for breakfast. The traditional diet centers around rice and vegetables but also includes noodles, seaweed, and soybean products. A food that is considered a bar snack in Japan is lightly steamed soybeans in the pods, which are then pulled through the teeth, allowing the beans but not the pods to be consumed. Raw fish is a favorite in Japan. Japanese foods are high in fiber and low in saturated fat.

Mediterranean Region

The traditional Mediterranean diet is based on beans and greens. Vegetables and grains are key elements of the Mediterranean diet. Beans and nuts are regularly consumed, and both are good sources of protein. The consumption of lean red meat historically was limited to a few times per month and fish to about once per week. The amount of cheese used historically has been moderate. Sweets are eaten in small amounts on special occasions only. Olives and olive oil are used liberally, but they are low in saturated fat and cholesterol free (see Chapters 2 and 7).

Table 1-1 shows how the food groups of the MyPyramid Food Guidance System are incorporated into different types of eating patterns. A typical day's diet for any ethnic, regional, or religious group may be evaluated nutritionally by checking it against an acceptable meal plan such as the MyPyramid Food Guidance System.

WHAT IS THE MEANING OF MODERATION, VARIETY, AND BALANCE?

Moderation means avoidance of too much or too little of any food or nutrient. This implies that any food can be worked into a healthy way of eating. There are no good foods or bad foods. Foods that are higher in fat and sugar should be eaten in smaller amounts or less frequently than foods that are nutrient dense. Variety refers to eating a number of different foods, not just the same two or three types of vegetables, for example. Balance refers to the amount of macronutrients and micronutrients in the diet in relation to individual needs. Selecting a variety of whole grains, vegetables, fruits, and protein-rich foods with dairy sources helps promote a positive nutritional status.

It is the position of the American Dietetic Association that the total diet or overall pattern of food eaten is the most important emphasis of a healthful eating style. The value of a food should be determined within the context of the total diet because classifying foods as "good" or "bad" may foster unhealthful eating behaviors (Nitzke and Freeland-Graves, 2007).

FIGURE 1-3 Restaurant eating is often a family socialization experience in the United States.

Snacking that is planned and emphasizes fruits, low-fat milk products, and whole grains can play a positive role in nutritional status. Snacking on processed foods, especially those high in fat, sugar, and salt, is appropriate in moderation. A common cause of excess snacking on high-fat and salty snacks is watching television at night. Snacking that promotes nutritional status is positive. Snacking that promotes excess intake of salt and kcalories from fat and sugar, especially when consumed as an activity, rather than hunger, needs to be limited for optimal health.

Persons of various cultures eat at fast-food restaurants (Figure 1-3). As long as an individual remembers the goals of balance, variety, and moderation, fast-food meals can safely be included in the diet (Box 1-2). Healthy meal choices can be found on fast-food menus. Fast foods can meet nutrient-density criteria and the Dietary Guidelines if chosen wisely. Serving sizes are important. See Appendix 1 on the Evolve website for websites of fast-food restaurants where kcalorie and nutrient analysis can be obtained.

The MyPyramid concept can be applied to fast food, especially because fast-food restaurants are increasingly offering fruits, vegetables, and low-fat milk. Fruit salads, mandarin oranges, coleslaw, different forms of tossed salad, and bean dishes can be found in fast-food restaurants. To include fast foods in a manner consistent with the MyPyramid, the following tips may help:

- Focus on smaller portions of meat and cheese dishes; avoid "super-sizing."
- Remove the skin from cooked chicken.
- Look for bean-based dishes and salads or other vegetables or fruits.
- Choose a small or low-sugar beverage or low-fat milk.
- Ask for salad dressing on the side to help control the quantity.

WHAT IS THE ROLE OF FOOD GUIDES IN GOOD NUTRITION?

NUTRITION LABELING

Mandatory nutrition labeling went into effect in 1994 with the goal of helping consumers adhere to the Dietary Guidelines for Americans (see the following section).

Box 1-2 Sample Menu ■ Nutritious Menu Including Fast Food

Breakfast (at Home)
Toasted English muffin with natural peanut butter
Banana slices dipped in wheat germ*
Glass of 1% or skim milk

Lunch (Cafeteria)
Chili con carne
Piece of cornbread
Mixed salad greens with Italian dressing
Glass of 1% or skim milk or 8 oz yogurt

Afternoon Snack
Bunch of grapes (brought from home)

Supper/Dinner (Fast-Food Restaurant)
Small cheeseburger
Small orange juice
Coleslaw
Soft ice cream or frozen yogurt for dessert

Snack (at Home)
Herb-seasoned low-fat popcorn
Small glass apple cider

*Wheat germ has a nutty flavor and crunchy texture and is found in the cereal section of the grocery store. One tablespoon contains about 10% of the recommended dietary allowance for vitamin B_1, folic acid, vitamin E, zinc, and phosphorus. It is also high in magnesium.

The change is aimed at reducing the prevalence and complications of chronic illnesses, such as heart disease, hypertension, and diabetes (see Chapters 7 and 8). Nutrition labeling is a valuable tool for learning to apply nutrition information in a practical way. A health-conscious shopper uses the percentages shown on the label to determine how well each serving of the food fulfills recommended nutritional requirements. For example, if one serving of a food has 25% of a particular nutrient listed, it means that each serving is good for one fourth of a person's recommended daily intake for that nutrient.

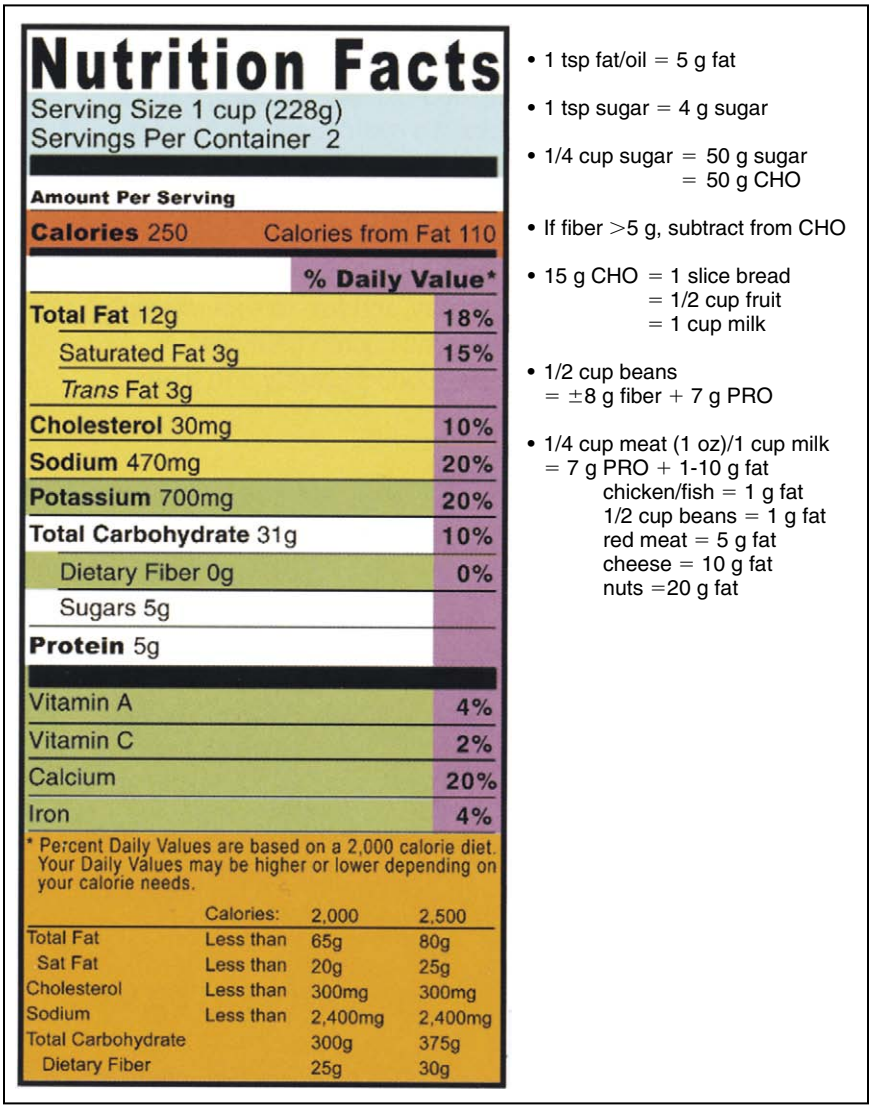
Ingredients are still listed in order of content in a product. If sugar is listed as the first ingredient, the amount of sugar in the product is greater than the amount of any of the other ingredients. It is easy now to quantify exactly how much is included in a serving of food. For example, 1 tsp of sugar equates to 4 g on the food label; therefore a can of a soft drink containing 40 g of sugar contains the equivalent of 10 tsp of sugar. Consumers need to learn how to interpret food labels (Figure 1-4).

To help the consumer calculate the kcalories in a given food, the food label on larger food packages also lists the conversion factor to change grams into kcalories—that is, fat 9, carbohydrate 4, protein 4 (refer also to Chapter 2). Therefore 1 tsp of sugar contains 16 kcal (4 g carbohydrate multiplied by 4). See Chapter 2 for kcalories from alcohol.

A relatively new addition on food labels is the amount of trans fats. Trans fats are found in hydrogenated fats and shortenings. This type of fat is now known to contribute to cardiovascular disease (see Chapter 7).

If consumers use the food labels when making food purchases, they will be promoting their health through the inclusion of appropriate nutrient intake (proteins, carbohydrates, vitamins, and minerals) while reducing their risk of chronic illness through a reduction of fat, salt, and sugar and an increase in fiber. Food labels used in conjunction with the MyPyramid can be a highly effective and ultimately simple means to promote health.

The health claims that can be made on food labels under the labeling law are as follows:



Nutrition Facts

Serving Size 1 cup (228g)
Servings Per Container 2

Amount Per Serving

Calories 250	Calories from Fat 110
	% Daily Value*
Total Fat 12g	18%
Saturated Fat 3g	15%
Trans Fat 3g	
Cholesterol 30mg	10%
Sodium 470mg	20%
Potassium 700mg	20%
Total Carbohydrate 31g	10%
Dietary Fiber 0g	0%
Sugars 5g	
Protein 5g	
Vitamin A	4%
Vitamin C	2%
Calcium	20%
Iron	4%

* Percent Daily Values are based on a 2,000 calorie diet. Your Daily Values may be higher or lower depending on your calorie needs.

	Calories:	2,000	2,500
Total Fat	Less than	65g	80g
Sat Fat	Less than	20g	25g
Cholesterol	Less than	300mg	300mg
Sodium	Less than	2,400mg	2,400mg
Total Carbohydrate		300g	375g
Dietary Fiber		25g	30g

- 1 tsp fat/oil = 5 g fat
- 1 tsp sugar = 4 g sugar
- 1/4 cup sugar = 50 g sugar = 50 g CHO
- If fiber >5 g, subtract from CHO
- 15 g CHO = 1 slice bread = 1/2 cup fruit = 1 cup milk
- 1/2 cup beans = ±8 g fiber + 7 g PRO
- 1/4 cup meat (1 oz)/1 cup milk = 7 g PRO + 1-10 g fat
  - chicken/fish = 1 g fat
  - 1/2 cup beans = 1 g fat
  - red meat = 5 g fat
  - cheese = 10 g fat
  - nuts =20 g fat

FIGURE 1-4 Reading the food label. *CHO,* Carbohydrates; *PRO,* protein.

- Foods high in fiber may reduce the risk of cancer and heart disease.
- A low-fat diet may reduce the risk of cancer and heart disease.
- A low-sodium diet may help prevent high blood pressure.
- Foods high in calcium may help prevent osteoporosis.
- Folate leads to decreased neural tube defects.
- Sugar alcohols reduce dental caries.
- Soy protein reduces cardiovascular disease.

Foods exempt from nutrition labeling include those sold in restaurants, cafeterias, and airplanes, unless a health claim is made. Coffee, tea, spices, and foods produced by small businesses or packaged in small containers are not required to carry a nutrition label.

DAILY REFERENCE VALUES

Daily Reference Values (DRVs), generally referred to as Daily Values (DVs), is a term developed for food labels. The percentage of DVs for the marker nutrients vitamins A and C and the minerals calcium and iron can be found on food labels (see Figure 1-4).

The percentage of DVs for the macronutrients and cholesterol, sodium, and potassium are also included under the Nutrition Facts section of the food label. These percentages are based on the DVs provided in g and mg for a 2000-kcal reference diet. Guidelines for the following are also provided for a 2500-kcal level:

- Fat is based on 30% of kcalories.
- Saturated fat is based on 10% of kcalories.
- Carbohydrate is based on 60% of kcalories.
- Fiber is based on 11.5 g of fiber per 1000 kcal.

The reference quantity for sodium intake on the food labels is 2400 mg/day. This amount differs slightly from the 2005 Dietary Guidelines, which promotes 2300 mg/day. This amount will meet required sodium needs in all healthy Americans without providing excess, although up to 3000 mg of sodium per day for most individuals is also reasonable. Medical conditions may necessitate a smaller or larger intake of sodium. Cholesterol is another DV not based on kcalorie intake (300 mg).

To address current health concerns, the U.S. Food and Drug Administration is reviewing regulations on nutrition labeling and working to update the DVs, most of which are still based on the 1968 estimated upper requirements of various nutrients. There is debate on whether the average requirements or highest requirements for a given population should be used (see Chapter 3).

DIETARY GUIDELINES FOR AMERICANS

In 1980 the Public Health Service of the Department of Health and Human Services (HHS), together with the USDA, published the first edition of *Dietary Guidelines for Americans.* This report, revised every 5 years, includes recommendations that address the relationship between diet and **chronic disease** (diseases such as heart disease that require ongoing management). With the 1985 and later editions, USDA and HHS have appointed a Dietary Guidelines Advisory Committee of prominent experts in nutrition and health to review advances in knowledge and recommend revisions of the Dietary Guidelines, as warranted. *Nutrition and Your Health: Dietary Guidelines for Americans* is based on the best available science using evidence-based reviews, consensus documents, peer-reviewed research studies, and written and oral public comments.

The original Dietary Guidelines emphasized nutrients and generally focused on avoidance of excess intake. Later guidelines have used more positive messages of what to include in the diet with emphasis on food choices rather than individual

nutrients, such as including whole grains. The Dietary Guidelines are the foundation of federal nutrition policy and guide all federal nutrition education activities.

The 2005 version of the Dietary Guidelines for Americans was updated to promote whole grains and increased amounts of vegetables, fruits, and legumes (Figure 1-5). Table 1-3 shows the frequency of foods consumed that allow the Dietary Guidelines to be followed. The 2010 Dietary Guidelines may be found on the Evolve website.

MYPYRAMID FOOD GUIDANCE SYSTEM

The USDA's MyPyramid Food Guidance System has replaced the earlier Food Guide Pyramid and portrays more individualized guidance aimed at meeting the 2005 Dietary Guidelines for Americans. The new MyPyramid symbol was designed to promote physical activity and variety and moderation in the diet (see the front of the book). Table 1-4 shows the evaluation of an adequate diet for an adult.

The MyPyramid continues to promote intake of grains, with the new stated goal of a minimum of three servings of whole grains daily, or half of grains whole, as per the 2005 Dietary Guidelines. Vegetable and fruit recommendation amounts have increased from five servings to nine servings, or 4 ½ cups specifically for adults, as outlined in the 2005 Dietary Guidelines. Legumes are now recommended on most days of the week, or 3 cups weekly. In 1999-2000 less than half of Americans ate an average of five or more servings of fruits and vegetables per day. With the updated guidelines, one study found almost no adolescent boys met their recommended intake of 5 cups, and just under half of young children 2 years of age met their recommended intake of 2 cups. This was especially true for the dark green and orange vegetables and legumes (Guenther and colleagues, 2006). Low-fat milk products are recommended, with three servings daily in the MyPyramid guidelines. The MyPyramid.gov website (see Appendix 1 on the Evolve website) provides individualized guidance on amounts of food for consumption based on age, gender, and usual activity level. There are 12 kcalorie levels of food intake patterns that consumers can print for individual needs. A worksheet is available to help track progress and choose short-term and long-term nutrition goals through MyPyramid.gov; see also Appendix 2 on the Evolve website.

The food intake recommendations are similar to those recommended by the Dietary Approaches to Stop Hypertension eating plan (the DASH diet), the American Heart Association, the American Cancer Society, and the American Diabetes Association and generally meet the kcalorie needs of most Americans (see Chapters 6 to 10). Individual guidance is still needed for MyPyramid to reach its potential (Krebs-Smith and Kris-Etherton, 2007). One concern of the implementation of the MyPyramid.gov website is that readability scores averaged between ninth- and eleventh-grade reading levels, whereas many Americans read at the sixth-grade level or below (Neuhauser, Rothschild, and Rodriguez, 2007).

Other countries have similar guides that vary with cultural food habits and the availability of foods. Canada's food guide has been represented as a rainbow in the past and was updated in 2007. Other guides include the Mediterranean and Asian pyramids, which emphasize legumes and oils as basic parts of a healthy diet, with the Greek Columns food guide specifically recommending that legumes be eaten 6 days a week.

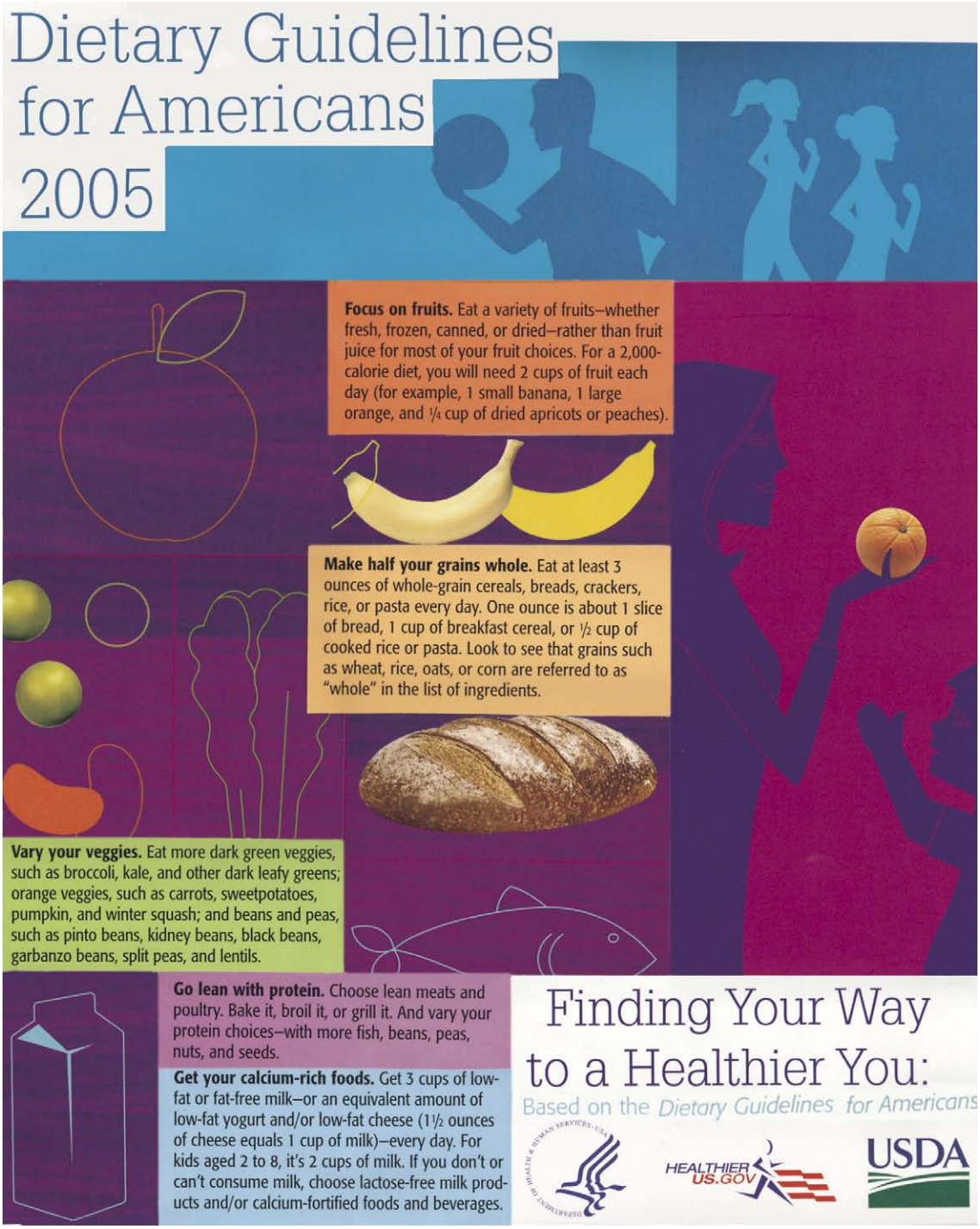


FIGURE 1-5 Dietary Guidelines for Americans for good health.

Table 1-3 Frequency of Use of Foods for Implementing Dietary Guidelines

FOOD GROUPS	CHOOSE MORE OFTEN	CHOOSE LESS OFTEN	MAJOR CONTRIBUTIONS
Fats	Corn, cottonseed, olive, sesame, soybean, safflower, sunflower, peanut, canola oils	Butter, lard	Vitamin A, calories, essential fatty acids, vitamin E in oils
	Mayonnaise or salad dressing (made from above oils)	Margarine made from hydrogenated or saturated fats	
	Avocado	Coconut or palm oil	
	Olives	Hydrogenated vegetable shortening	
		Bacon	
		Meat fat/drippings, gravy, sauces	
Soups	Lightly salted soups with fat skimmed	Commercially prepared soups and mixes	Fluid, calories (may contain a variety of vitamins, minerals, and protein, depending upon type)
	Cream-style soups (with low-fat milk)		
Sweets and desserts	Desserts that have been sweetened lightly and/or contain only moderate fat, such as puddings made from skim milk, angel food cake, fruit-based desserts	Desserts high in sugar and/or fats, candy, pastries, cakes, pies, whole-milk puddings, cookies	Calories (fats, carbohydrates)
Beverages	Water	Sweetened beverages	Fluid, calories (unless sugar-free)
	Unsweetened soft drinks	Caffeine-containing beverages	
	Decaffeinated drinks	Alcoholic beverages	
Milk and milk products	Low-fat or skim milk	Whole milk	Calories, calcium, protein, phosphorus, vitamins A and D, riboflavin
	Low-fat cheeses	Whole-milk cheeses	
	Low-fat yogurt	Whole-milk yogurt	
		Ice cream	
Vegetables, including starchy vegetables	Fresh, frozen, or canned; potatoes—baked or boiled	Deep-fat fried vegetables, chips, salty vegetable juices	Calories, vitamins A and C, dietary fiber, potassium, zinc, cobalt, folic acid, magnesium
	Include one dark leafy green or deep orange vegetable at least 3 times weekly	Pickled vegetables	Vitamin A

Table 1-3 Frequency of Use of Foods for Implementing Dietary Guidelines—cont'd

FOOD GROUPS	CHOOSE MORE OFTEN	CHOOSE LESS OFTEN	MAJOR CONTRIBUTIONS
Fruits	Fresh and unsweetened fruits, juice in moderation	Juice drinks	Vitamin C, potassium, phosphorus
	Include one citrus fruit or one tomato/juice daily	Sweetened fruits or juices Coconut	Calories, dietary fiber, vitamins A and C
Breads, starches, and cereals	Whole-grain breads or cereals, whole-grain crackers; choose three servings daily	Snack chips or processed crackers	Calories, B-complex vitamins, magnesium, copper, iron, dietary fiber
	Muffins, bagels, tortillas	Sweetened cereals	
	Enriched pasta, rice, grits, or noodles	Pancakes, doughnuts, biscuits	
Meats or substitutes	Lean meats, fish, shellfish, poultry without skin, liver at least monthly	Fried or fatty meats/fish Fried poultry or poultry with skin	Calories, protein, iron, zinc, copper, B-complex vitamins, choline, and a variety of vitamins and minerals from liver
	Low-fat cheeses (such as cottage cheese and part-skim mozzarella)	High-fat cheeses (such as cheddar and processed cheeses)	
	Peanut butter, nuts		Monounsaturated fat sources
	Soybeans, tofu	Eggs; up to one daily	Variety of vitamins, minerals and protein; eggs are a rich source of choline
	Dry beans and peas		Fiber, protein, and a variety of vitamins and minerals
Miscellaneous	Herbs, spices, flavorings	Salt and salt/spice combinations	Sodium

Teaching Pearl

A useful analogy to use with children is to explain that some foods (those high in fat and sugar—shown in the small yellow section of the MyPyramid to indicate a small amount) help us grow outward, whereas plant and protein foods (in the larger portions of the MyPyramid) help us grow upward. Using your hands to describe these changes graphically is very effective in aiding young children's understanding. ■

FOOD EXCHANGE SYSTEM

The **Exchange Lists for Meal Planning**, developed by the American Dietetic Association and the American Diabetes Association, is a food guide aimed at managing

Table 1-4 Evaluation of the Foundation of an Adequate Diet for an Adult

	AVERAGE SERVING					MINERALS				VITAMINS			
	HOUSEHOLD MEASURE	WEIGHT (g)	KCAL	PROTEIN (g)	FAT (g)	CARBOHYDRATE (g)	CALCIUM (mg)	IRON (mg)	A (RE)	ASCORBIC ACID (mg)	THIAMIN (mg)	RIBOFLAVIN (mg)	NIACIN (mg)
Dairy													
Milk (low-fat, skim, or equivalent)	1½ pt	732	300	24	~3.75	36	870	0.3	417	6	0.27	1.353	0.6
Meat Group													
Eggs	1	50	80	6	6	1	28	1	78	0	0.04	0.15	Trace
Meat, poultry, fish[1]	3 oz (cooked)	85	322	19	26	0	9	2	Trace	—	0.09	0.19	4.6
Vegetable and Fruit Group													
Vegetables Deep leafy green or orange[2]	1 (salad or cooked)	50 (raw or cooked)	23	0.9	Trace	5	20	0.5	2644	9	0.03	0.06	0.3
Other cooked[3]	1½ c	250	150	6	Trace	20	50	3.0	150	30	0.12	0.75	1.2
Potato, peeled and boiled	1 medium	122	90	3	Trace	20	8	0.7	Trace	22	0.12	0.05	1.6
Fruits Citrus[4]	1 serving	125	50	0.3	Trace	13.5	23	0.4	28	50	0.07	0.03	0.31
Other (fresh and canned)[5]	2 serving	170	200	0.8	Trace	50	16	1.2	46	12	0.06	0.08	0.72
Bread and Cereal Group													
Cereal (whole-grain and enriched)[6]	½ c cooked	25 (dry)	80	2.2	1	16	6	0.65	379	4.5	0.20	0.18	1.5

Bread (whole-grain and enriched) or grain-based foods such as pasta, rice, or crackers	(5 slices) 3 whole wheat 2 white	130	283	11.6	3	75	150	6	Trace	Trace	1.0	0.43	6.5
TOTALS[7]			1465	69.2	64.25	226.5	1120	12.21	3742[8]	133.5	1.29[9]	2.9	13.7[10,11]
Dietary Reference Intakes*													
Man (age 31-50 years: wt 174 lb; ht 70 inches)			2800±	56		130[12]	1000	8	900	90	1.2	1.3	16
Woman (age 31-50 years: wt 138 lb: ht 64 inches)			2200±	46		130[12]	1000	18	700	75	1.1	1.1	14

Data from *Nutritive value of foods*, Home and Garden Bulletin No. 72, U.S. Department of Agriculture; and U.S. Department of Agriculture, Agricultural Research Service: USDA national nutrient database for standard reference, release 17.

*From *Dietary Reference Intakes for calcium, phosphorus, magnesium, vitamin D, and fluoride* (1997); *Dietary Reference Intakes for thiamin, riboflavin, niacin, vitamin B^6, folate, vitamin B^{12}, pantothenic acid, biotin, and choline* (1998); *Dietary Reference Intakes for vitamin C, vitamin E, selenium, and carotenoids* (2000); *Dietary Reference Intakes for vitamin A, vitamin K, arsenic, boron, chromium, copper, iodine, iron, manganese, molybdenum, nickel, silicon, vanadium, and zinc* (2001); and *Dietary Reference Intakes for energy, carbohydrate, fiber, fat, fatty acids, cholesterol, protein, and amino acids*, Washington, DC, 2002, The National Academies Press.

[1]Evaluation based on figures for cooked (lean and fat) beef, lamb, and veal.
[2]Evaluation based on lettuce, cooked carrots, green beans, winter squash, and broccoli.
[3]Evaluation based on average variety of vegetables.
[4]Evaluation based on Florida oranges and white and pink grapefruit—whole and juice.
[5]Evaluation based on canned peaches, applesauce, raw pears, apples, and bananas.
[6]Evaluation based on oatmeal and corn flakes.
[7]With the addition of more of the same foods, or other foods, to meet calorie requirement, the totals will be increased.
[8]With the use of liver, this figure will be markedly increased.
[9]With the use of pork, legumes, and liver, this figure will be markedly increased.
[10]The average diet in the United States, which contains a generous amount of protein, provides enough tryptophan to increase the niacin value by about one third.
[11]These figures are expressed as niacin equivalents, which include dietary sources of the preformed vitamin and the precursor, tryptophan.
[12]Adequate intake.

diabetes and weight (see Chapters 6 and 8 for more information and Appendix 3 on the Evolve website for the complete Exchange Lists). The Exchange Lists group foods primarily according to the amounts of the macronutrients (carbohydrates, proteins, and fats) that they contain. The MyPyramid places more emphasis on amounts of micronutrients in the diet.

Cheese is found in the meat group based on the similar protein content. Cheese is not included in the milk group in the Exchange Lists because, unlike milk, it does not contain significant carbohydrate. The MyPyramid counts equivalent amounts of milk and cheese based on calcium content.

The Exchange Lists for Meal Planning counts legumes in the starch and bread group based on the comparable carbohydrate content (see Chapter 2). Because of the high protein content of legumes, the MyPyramid includes legumes in the meat group. Carbohydrate content of the fruit group is not considered in the MyPyramid. The Exchange Lists calculate 15 g of carbohydrates for one serving of fruit.

The Exchange Lists count a fat serving as 5 g of fat, which is equivalent to 1 tsp of added fat. Foods that are naturally high in fat, such as avocados, nuts, and bacon, are found in the fat group of the Exchange Lists. The MyPyramid does not specifically state portion sizes for fats and includes nuts in the meat group and avocados in the fruit group.

HOW IS NUTRITION PART OF TOTAL HEALTH CARE?

Nutrition is considered an integral part of health care, with physical, social, psychiatric, and economic aspects. Nutritional care may be aimed at maintaining an already adequate nutritional status, or the goal may be to promote positive nutritional status. For many persons contending with an illness, food and the nutrients it provides are the most important factors used to restore good health.

THE HEALTH CARE TEAM

The health care team is composed of all the health care professionals who work with a given person and/or family toward the common goal of optimal health. This includes the medical part of the team (physician or other health care provider, nurse, dietitian, physical therapist [PT], and pharmacist), the social professionals (social worker, occupational therapist [OT], and psychologist), and other community resource personnel who play a role in facilitating good health. Because each type of health care professional has a unique perspective on needs assessment and health care planning, a team approach is most effective in eliciting positive changes in a person's well-being. This includes involving the individual in the health care planning process. This is especially true in managing chronic illness, in which day-to-day management decisions regarding lifestyle changes are made in the home.

The Health Care Provider

Health care providers include the medical doctor (MD), nurse practitioners (NPs), and in some areas, physician assistants (PAs). Usually an NP or a PA works under the supervision of a medical doctor. A **health care provider** is the professional who can prescribe medications. The health care provider knows a person's medical history

and has a general understanding of the relationship between disease states and other health concerns. Increasingly, health care providers are making referrals to other health care professionals. The provider needs to be kept abreast of other health services provided. This may occur through written documentation on a hospital chart, through standardized written correspondence from a community agency or another provider's office (such as from a specialist to the general practitioner), or through telephone contact when there is an urgent concern. Final health care decisions often are the responsibility of the physician, who should be kept informed of concerns of the health care team and their recommendations for individual patient care.

It should be kept in mind that the health provider does not have the training in nutrition that an RD has. Many members of the public believe that physicians are well trained in nutrition and that their advice is accurate and appropriate to one's needs. This is not necessarily true; it was found that among 16 U.S. medical schools only about one in five medical students believed they had been extensively trained in nutrition counseling (Spencer and colleagues, 2006).

The Nurse

The nurse can provide other members of the health care team with good insight into an individual's needs because of in-depth patient contact. Ongoing monitoring of patient's eating habits is an important role of the nurse, whether a licensed practical nurse (LPN) or a registered nurse (RN). Certified nursing assistants (CNAs) also are central to this role. Oral intake is generally monitored as poor (less than or equal to 25%), fair (50%), or good (greater than or equal to 75%) by nursing staff. This documentation is then used by the RD to plan meal provision to meet needs for weight, protein status, and skin integrity. Because nursing staff have daily contact with patients, observed food preferences and dislikes can be noted and relayed to the RD and dietary staff.

The Social Worker

The social worker is the health care professional who has expertise in the area of community resources, including financial, counseling, technical support, and educational services. The social worker often can help a person identify and express barriers—whether perceived or actual—that may need to be addressed to meet the goal of achieving health and wellness. Often a person is not ready to hear health care advice because of the need to resolve and come to terms with a chronic or acute illness.

The Physical Therapist

Assisting in promoting mobility and physical movement, for instance, to control pain, is part of the role of the PT. Physical therapy may be required to help a person enhance physical capabilities that have been impaired by illness or trauma. The PT may suggest exercise that is appropriate for the individual to promote weight loss or increase muscle strength.

The Occupational Therapist

The OT emphasizes the remaining strengths of the individual and identifies adaptive devices that would enhance independent functioning, such as large-handled spoons

and reaching devices. Through occupational therapy the goal is for the individual to increase the amount or types of **activities of daily living (ADL)** such as personal hygiene and eating. This is of particular importance after a person has suffered a stroke or other physical injury that impairs or prevents independent living.

The Speech Language Pathologist

The professional to consult when assessing the seemingly simple act of swallowing is the speech language pathologist (SLP). Swallowing, a series of interrelated steps, can be seriously impaired by stroke or other neurologic damage (see Chapter 4). Aspiration of food (inhaling food into the lungs) is of serious consequence and can lead to partial or full airway obstruction or to pneumonia. A speech pathologist can help determine the degree of risk for aspiration and make appropriate care plans that other health care professionals can use in developing their plans. For example, the PT may be enlisted to help suggest correct positioning needs for good swallowing, the OT may promote the use of eating utensils designed for special feeding needs, and the dietitian may need to plan certain food consistencies to facilitate effective swallowing.

The Pharmacist

The registered pharmacist is responsible for preparing the nutritional solutions that the physician prescribes. These solutions are administered through veins or via enteral routes (see the discussion of nutrition support in Chapter 15). The dietitian often makes recommendations in consultation with the physician regarding the solution used to provide appropriate amounts of nutrients for specific individual needs. Because of specialized knowledge about medications and their actions, the pharmacist is able to serve as a resource person with regard to drug and nutrient interactions.

The Registered Dietitian

The RD is the health care professional best qualified to interpret the science of how food is used by the body in health and disease states and to evaluate how MNT can promote a positive nutritional status. The RD is trained to work with culturally diverse populations in adapting customary foods to meet ongoing health concerns. The RD uses specific terminology referred to as *nutrition care process language*. This includes nutrition diagnoses and interventions, monitoring, and evaluation of plans. The *International Dietetics and Nutrition Terminology (IDNT) Reference Manual* is available from the American Dietetics Association at eatright.org (see Appendix 1 on the Evolve website).

An RD is of special importance when there are complex factors or medical conditions that interfere with nutritional status. The **Medicare** program (a health plan primarily for older adults) is increasingly recognizing prevention as a means to control spiraling health care costs. This focus allowed the addition of RDs as recognized Medicare providers for diabetes and nondialysis renal disease in 2002. The American Dietetic Association continues to develop research documenting benefits of MNT for other chronic illnesses. The use of MNT can help minimize the costs associated with the new prescription drug plan for Medicare recipients. Because other insurance programs are based on Medicare policies, it is expected that broader coverage of MNT will develop.

The Nutritionist

A nutritionist is an educator, as well as a counselor, who usually works in a public health setting and who typically has at least a bachelor's degree in nutrition. The legal credential *certified* or *licensed nutritionist* is used in some states to help indicate qualified nutritionists. All RDs are nutritionists. The term *nutritionist* has no legal definition and may be used erroneously by persons with inadequate formal nutrition training.

All health care professionals can promote nutritional guidance as part of general nutrition such as teaching how to use food labels or the MyPyramid Food Guidance System. Although consumers are aware of general concepts about healthy eating, they lack specific knowledge to help them implement recommendations. Educators can help by providing consumers with concrete examples and specific information (Britten, Haven, and Davis, 2006). The health care professional can help promote harmonious family mealtimes, which will allow the innate satiety cues to function more effectively and also promote the association of eating with positive feelings, by making the following recommendations to family members:

- Focus on positive conversations during mealtimes around the table; avoid points of potential conflict and friction.
- Use soft music, candles, or both to facilitate a quiet, relaxed atmosphere.
- Eat as a family as much as possible, rather than eating on the run.
- Eat slowly to promote satiety, and aim for two or three different food groups in a meal.
- Encourage children to eat with the family, but do not force them to eat. Encourage the "one-taste rule," and emphasize that tastes are learned.
- Serve food that looks appealing by using a combination of colors, textures, and sizes (e.g., orange carrot "coins," white chicken, crisp lettuce wedges, warm biscuits, and cold milk).
- Watch portion sizes; smaller portions are useful for small appetites and for weight control.
- Promote relaxing activities before and after meals.

Fact & Fallacy

FALLACY Children who do not "clean their plates" should not have dessert.

FACT This commonly practiced principle may work in the short term to coerce children to eat their meals, but the long-term implications outweigh any benefits. This approach implicitly conveys to children that desserts have more value than other foods, because dessert is being used as a reward. Parents should be reminded that desserts can be nutritious, such as fresh fruit, a colorful fruit salad, or a piece of pumpkin pie or carrot cake. The "clean the plate" philosophy can also contribute to overeating and excess weight gain. Children (and many adults) need to learn to stop eating when they are comfortably full. ■

WHAT ARE INTERVIEWING AND COMMUNICATION SKILLS?

Imagine yourself, as a health care professional, meeting an individual with a chronic health problem. What do you say? Where do you begin? What questions should you

ask? How do you help the person to be open about expressing health and nutrition needs and concerns? Do you present yourself as very professional and aloof, informal and witty, or perhaps a combination? What are you trying to achieve through contact with the patient? These are just some of the questions that face a new nurse or practicing health care professional.

Interpersonal interactions can either make or break an attempt to positively influence an individual's food habits. Gaining a sense of trust is essential to this process. Nonverbal communication has bearing. Using an authoritative manner is generally not as effective as using an empathetic approach.

For effective intervention, assessment needs to include the psychosocial issues that may be contributing to physical health concerns. For example, social events or poor self-esteem may be causing negative food choices. This part of the assessment phase requires excellent communication skills to promote disclosure of potentially sensitive and personal lifestyle issues. The more thorough the assessment phase, the more likely that appropriate and well-focused intervention strategies can be identified and implemented. A "hit-or-miss" intervention plan not only is potentially a waste of time, energy, and money but can even be harmful to the patient.

The "Teaching Pearl" sections provided throughout this textbook have been found to be well received as used in providing health education. Most include use of analogies that can be very helpful in discussing complex medical concepts in a manner understood by someone without a health care background. The analogies may need to be modified depending on the individual or not used at all, depending on learning needs. A young adult may perceive some analogies as sounding silly, or someone who has training in the sciences may need more technical explanations. In determining the appropriate approach and terminology to use in providing health messages, interviewing and counseling skills are essential to effectively promoting individual changes for the goal of optimal health and nutrition status.

THE IMPORTANCE OF CHOICE IN NUTRITIONAL COMPLIANCE

It is important for the individual to have a feeling of choice in making health care decisions. A verbal commitment (action) from a person can further increase the likelihood that the health change will be adopted.

Teaching Pearl

Choice is important for people of all ages. Even 2-year-olds are more likely to eat vegetables if given a structured choice such as "Which do you want to eat tonight—carrots or broccoli?" This same principle can be applied to an adult situation, such as saying, "One salty food can be worked into your low-salt meal plan. Which would you prefer?" Or the choice might be between having the saturated fat of cheese one day and that of red meat the next to keep the total amount of saturated fat down. ■

THE IMPORTANCE OF HONESTY AND RESPECT IN PATIENT CARE AND EDUCATION

It is okay to admit lack of knowledge when questioned. There is a lot to know regarding how food and nutrition affect health. It is much better to admit you do not know

an answer than to give inaccurate information. This can forever damage your credibility as an educator. Instead, you might say, "That's an interesting question. Perhaps we can find the answer in this brochure."

The most important aspect of patient communication is respect. Without respect, all attempts at effective communication will be lost. For example, if you have to leave the room, tell the person. Do not assume they know you will return. If the person makes a comment unrelated to his or her health care needs, respond anyway. Showing respect for a person's feelings and thoughts will greatly enhance the nutrition care process.

One aspect of showing respect is recognizing learning readiness. You can say to an individual that you suspect he or she is not ready to discuss a health care problem. In this way, you will receive immediate feedback, verbally or nonverbally, regarding the appropriateness of continuing. Health care professionals need to be aware of when an educational message is likely to be effective or noneffective. For example, in an acute health care crisis, high levels of stress are expected. This generally results in an increase of stress-related hormones called **glucocorticoids.** These stress hormones affect memory functions, with elevated cortisol levels being associated with impaired ability to provide verbal statements. One study found that patients could verbalize learning initially, but with the passage of time the delayed recall of information was impaired (Elzinga, Bakker, and Bremner, 2005). This supports the use of outpatient education rather than relying solely on inpatient hospital-based education when stress levels are expected to be higher.

INTERVIEWING STRATEGIES

In the process of nutritional assessment, the following three realms should be considered: (1) **cognitive** (knowledge), (2) **affective** (attitudes), and (3) **psychomotor** or behavioral (behaviors). Does the family have adequate knowledge about good nutritional practices? Does the family value good nutrition? What constraints does the family have in gaining access to and consuming a balanced diet? What is the family meal environment in general? Can the person shop and cook? Is there adequate ability to chew, swallow, and digest food?

A variety of interviewing and assessment methods can be used to identify these three areas (cognitive, affective, and psychomotor), such as diet history and questions based on active-listening techniques (see the next section). It is important to be aware that sometimes prior misconceptions may cause confusion when accurate information is provided. Asking a person to provide an example of a learned concept—for example, to interpret a food label—is useful in evaluating understanding and ability to apply learned nutrition concepts.

ACTIVE LISTENING

Active listening is a manner of questioning and responding to a person that promotes full disclosure of opinions, feelings, emotions, and beliefs. This form of assessment can take time, but the information gathered allows for planning the most effective intervention methods. A few key questions can result in a wealth of information. Active listening is nonjudgmental and uses open-ended questions that elicit feelings and thoughts rather than "yes" or "no" responses. The following are examples of effective active-listening questions:

GOOD INTERVIEWING QUESTIONS

How do you feel about _____?
Can you tell me what you know about _____?
How is _____ a problem for your family?
Can you tell me more about _____?
Can you explain why that is a problem for you?

"I" VERSUS "YOU" STATEMENTS

"I" versus "you" statements complement active-listening techniques. "You" statements can sound judgmental and authoritarian, which can cause a defensive reaction. Rephrasing "you" statements to "I" statements will promote enhanced interaction and communication.

An example of a "you" statement changed to an "I" statement is as follows: "You have a problem with fat intake" is changed to "It sounds to me like excess fat in the diet might be the problem." Follow this comment with an active-listening question such as "How do you feel about the amount of fat in your diet?" for a very effective communication strategy.

An "I" statement is your opinion, making the statement less threatening and final. Your position as an authority figure can prevent many individuals from questioning statements that sound official, even if they believe that your statements are in error. A defensive reaction by the person will essentially end your effectiveness in bringing about health changes. If someone feels that his or her opinions are being listened to, through the use of active-listening techniques, he or she will be more likely to listen to your opinions. This will foster the development of practical strategies for positive change.

LEARNING READINESS ASSESSMENT

By using good interviewing techniques and assessment questions, you can determine learning readiness. Nutritional guidance should be based on willingness to change and interest in doing so. In order to make change, recognition that change is needed is generally the first step. This may include review of laboratory values or explaining the physiology of medical conditions and how MNT may be helpful. Before any behavior change can be made, the individual may want to initially examine the pros and cons of making changes. Health care professionals can help individuals analyze reasons for change that make sense to them and brainstorm practical strategies on how to incorporate behavior change. Suggestions for change should be provided only when the person indicates the readiness to accept such guidance.

The **transtheoretical model of health behavior change** (Table 1-5) offers insight into assessing individuals and targeting interventions for behavior change. For example, school nurses effectively assess parents of school-age children at risk for obesity for readiness for health behavior change, then choose parent-focused interventions based on their stage of readiness for change (Howard, 2007).

WHAT IS THE NUTRITION CARE PROCESS?

The **nutrition care process** of assessment, planning, intervention, and evaluation is the same as the **nursing process** with the omission of nursing diagnosis. Nutrition

Table 1-5 Transtheoretical Model of Health Behavior Change

STAGE OF CHANGE*	SOME APPROPRIATE QUESTIONS/STATEMENTS OF HEALTH CARE PROFESSIONAL
PRECONTEMPLATION (No awareness of benefits of change)	"Do you want to talk about _____?" "Do you need more information or want a referral?" "Do you know what diet changes can be helpful?"
CONTEMPLATION (Benefit of change recognized)	"Are you ready to make changes with your diet?" "What do you think you could do with your diet?" "What problems might you face to make diet changes?" "Is your family supportive in your goal?" "Would like to see a registered dietitian?"
PREPARATION (Beginning steps of behavior change)	"What have you tried so far with your diet changes?" "If you have the Internet, you can go to MyPyramid.gov for ideas." "The American Heart Association has guidance online for insulin resistance."
ACTION (Recent behavior changes occurred)	"What has worked so far for you in your diet changes?" "The local hospital has classes on _____ that can be helpful." "Since you saw a dietitian, was it helpful; would you like to see a different one?" "Tastes have a way of changing, such as learning to eat foods with less salt."
MAINTENANCE (Behavior change has lasted >6 months)	"Do you need a refresher on what you can do to keep up your good habits?" "Here is a list of support groups in the area." "Do you have any concerns that I might be able to help with?"

Modified from Prochaska, DiClemente: Stages and processes of self-change of smoking: toward an integrative model of change, *J Consult Clin Psychol* 5(3): 390-395, 1983.

diagnosis differs with the focus on nutritional status or problems rather than the medical diagnosis. It is both a science and an art. By following the steps of the nursing process you will be a more effective health care professional. With practice and experience it will become easier, but your own unique style can either help or hinder the process of providing nutrition health care. Being very observant of nonverbal communication (facial expressions or other body language) and verbal communication from the persons you work with can guide you to becoming an effective change agent to foster compliance. A positive **change agent** is one who is directly and indirectly involved in promoting improved health of patients and consumers. Generally, each step of the nursing process or nutrition care process should be followed in order. There is also a degree of integration between each step of the process, and the process is usually repeated several times during the course of intervention. The development of rapport is essential in this process and can be better achieved by using good communication skills in the process of assessment, planning, intervention, and evaluation.

To promote discussion of personal health concerns, the following strategies are helpful (Figure 1-6):

- Use a warm, friendly, positive approach.
- Sit in comfortable proximity, neither too close nor too far away.
- Use good eye contact, with eyes intent but not staring.
- Face the person, and lean forward.

FIGURE 1-6 Effective nutrition care starts with good communication and rapport development.

- Have arms unfolded and resting in a relaxed manner.
- Carefully listen to what the person is saying, using affirming responses to encourage further comments.
- Allow pauses in the conversation; take as long a pause as needed to consider how to best make replies—it shows that you are interested in giving correct and appropriate replies.

Terminology used in intervention can further promote or hinder openness. Using overly technical medical jargon can discourage an individual's understanding and willingness to ask questions. As much as possible, the health care professional should use terms and expressions that are understood and used by the person in everyday settings. Observing the **nonverbal communication** signals that are exhibited can assist the health care professional in determining and fine-tuning messages based on individual needs. A person who initially is very talkative but who becomes very quiet or begins to look at the clock is sending a powerful message. The health care professional needs to observe verbal and nonverbal communication and respond accordingly.

Teaching Pearl

Using simple analogies can diffuse any growing tension and help redirect the message based on personal needs. In describing complex medical conditions or the impact of MNT, helping the person develop a mental image based on familiar objects or actions can be very effective. ■

PHYSIOLOGIC ASSESSMENTS

The physiologic needs address the *bio* part of biopsychosocial assessment. This is best done with a variety of tools, including reading of medical charts, care plan meetings with other health care team members, use of interviewing techniques, and actual physical measurements such as body weight.

Determining if the person is overweight or underweight or has had a change in weight may be indicative of a change in health status. Laboratory values—such as those for hemoglobin (to determine iron status), albumin (to determine protein

status), cholesterol and other blood fats such as triglycerides, blood glucose, and other laboratory values—can help determine health needs that should be addressed in the later intervention phase. Physical signs of poor nutritional status also may be evident (Table 1-6).

Anthropometry

The science that deals with body measurements, such as size, weight, and proportions, is called **anthropometry**. It is especially useful in screening individuals who are malnourished with low body weight. Accurate body composition measurements can be more difficult to obtain for obese people than for thin people because of the compression factor involving the use of the calipers. However, anthropometric measurements are very useful because they can help justify the use of special nutritional support when a person is shown to be at risk for development of malnutrition. In an acute care setting, weight may change substantially with correction of either dehydration or edematous states, making the use of anthropometrics less accurate.

A calibrated balance-beam scale is recommended for weighing ambulatory adults. A calibrated chair or bed scale may be used for those who are in wheelchairs or are bedridden. Weight should be monitored weekly in the hospital and monthly in other health facilities, and the caregiver should keep in mind that fluid retention and dehydration can affect weight status. Weight stabilization is critical in the elder population to decrease morbidity and mortality.

It is especially important to regularly monitor weights and heights of children (Figure 1-7), and any undesirable changes should be noted with the child's family. The frail, elderly population also requires regular weight monitoring. Assessment of stature can be difficult, for example, for persons with developmental disabilities such as cerebral palsy and contractures of the muscles (see Figure 12-9; see also Chapter 12) or for a bedridden individual or a non–weight-bearing situation or for a person with kyphosis (hunched shoulders). Knee-height calculations or segmental measurements taken from joint to joint with a flexible measuring tape may be used; see Appendix 1 on the Evolve website for website purchasing of knee-height calipers). Arm span measurement is another alternative to measuring height. Height is approximately twice the measurement from mid-sternum to the tip of the middle finger with the palm facing forward (see Figure 1-8).

Growth charts for children are based on percentiles that are taken from measures of normal growth or "norms." To elaborate, a child with Down syndrome (see Figure 12-9) will have a shorter stature than other children but may still have normal growth as compared with other children with Down syndrome. Growth charts are available for Down syndrome as well as for a few other genetic disorders (see Appendix 1 on the Evolve website for website access).

Thus the science of anthropometry is, in part, an art. For this reason, it is recommended that the same individual, such as a certified nursing assistant (CNA), serve as the primary individual to measure weights. This helps to provide greater consistency and reliability of measured weights.

For pediatric units in an acute care setting, daily weights may be needed to ensure dehydration is avoided. In long-term care settings, such as nursing homes, weight monitoring generally is done on a monthly basis, or weekly for high-risk individuals. High-risk individuals who are acutely ill or having edema managed

Table 1-6 Physical Signs Indicative or Suggestive of Malnutrition

	NORMAL APPEARANCE	SIGNS ASSOCIATED WITH MALNUTRITION	POSSIBLE DISORDER OR NUTRIENT DEFICIENCY	POSSIBLE NONNUTRITIONAL PROBLEM
Hair	Shiny; firm; not easily plucked	Lack of natural shine; dull and dry Thin and sparse Dyspigmented Flag sign Easily plucked (no pain)	Kwashiorkor and, less commonly, marasmus	Excessive bleaching of hair Alopecia
Face	Skin color uniform; smooth, healthy appearance; not swollen	Nasolabial seborrhea (scaling of skin around nostrils) Swollen face (moon face) Paleness	Riboflavin Kwashiorkor	Acne vulgaris
Eyes	Bright, clear, shiny; no sores at corners of eyelids; membranes a healthy pink and moist; no prominent blood vessels or mound of tissue or sclera	Pale conjunctiva Bitot's spots Conjunctival xerosis (dryness) Corneal xerosis (dullness) Keratomalacia (softening of cornea) Redness and fissuring of eyelid corners Corneal arcus (white ring around eye) Xanthelasma (small yellowish lumps around eyes)	Anemia (e.g., iron) Vitamin A Riboflavin, pyridoxine Hyperlipidemia	Bloodshot eyes from exposure to weather, lack of sleep, smoke, or alcohol
Lips	Smooth, not chapped or swollen	Angular cheilosis (white or pink lesions at corners of mouth)	Riboflavin	Excessive salivation from improper fitting dentures

Tongue	Deep red in appearance; not swollen or smooth	Magenta tongue (purplish)	Riboflavin	Leukoplakia
		Filiform papillae atrophy or hypertrophy—red tongue	Folic acid Niacin	
Teeth	No cavities; no pain; bright	Mottled enamel	Fluorosis	Malocclusion
		Caries (cavities)	Excessive sugar	Periodontal disease
		Missing teeth		Health habits
Gums	Healthy; red; do not bleed; not swollen	Spongy, bleeding	Vitamin C	Periodontal disease
		Receding gums		
Glands	Face not swollen	Thyroid enlargement (front of neck swollen)	Iodine	Allergic or inflammatory enlargement of thyroid
			Starvation	
		Parotid enlargement (cheeks become swollen)	Bulimia	
Nervous system	Psychological stability; normal reflexes	Psychomotor changes	Kwashiorkor	
		Mental confusion		
		Sensory loss		
		Motor weakness		
		Loss of position sense		
		Loss of vibration		
		Loss of ankle and knee jerks	Thiamin	
		Burning and tingling of hands and feet (paresthesia)		
		Dementia	Niacin, vitamin B_{12}	

From Mahan LK, Escott-Stump S: *Krause's food, nutrition, and diet therapy,* ed 10, Philadelphia, Saunders, 2000, p. 375.

FIGURE 1-7 Monitoring patient weight. (From Jarvis C: *Physical examination and health assessment,* ed 5, Philadelphia, 2008, Saunders.)

with diuretics can benefit from daily weight monitoring. Persons in hospitals or long-term care settings may be weighed using a Hoyer lift or bed scale (Figure 1-8).

The dietitian is one professional trained in anthropometry. Measurements are taken of elbow breadth, skinfold thickness, and mid-upper-arm circumference to help determine the extent of the body's fat and protein stores in relation to body frame size and height. A discussion of various anthropometric measurements follows.

Weight in pounds needs to be referenced to height. A weight of 100 lb for a child is high, whereas for an adult it likely is low. This has to do with height. Standards to assess weight are expressed as a percentage of ideal body weight as determined by either height or BMI number (see Chapter 6 and Appendix 9 on the Evolve website) and should also include percentage of weight change. Any assessment of body weight can be misleading if an individual is retaining fluid or is dehydrated. Having an accurate height measurement also is of great importance in determining weight goals and kcalorie needs. Significant weight loss that is reflective of malnutrition is an unplanned weight loss of 5% or more in 30 days or 10% or more in 6 months. Weight loss is best expressed in terms of percentage of weight change:

Amount of weight loss Usual or last recorded weight 100

Triceps Skinfold

This is an index of the body's fat or energy stores. A low skinfold thickness measurement may indicate malnutrition. Figure 1-9 shows how the measurement is taken. This technique is used for both men and women. The most common site for measuring skinfold thickness is the posterior side of the nondominant upper arm at the midpoint. Accuracy and consistency of measurement are paramount.

FIGURE 1-8 **A,** Weighing a nonambulatory person in a Hoyer lift. **B,** Assessing weight using a bedscale. (© 2009 Hill-Rom Services, Inc. Reprinted with permission. All rights reserved.) **C**, Estimating height using arm span measurement.

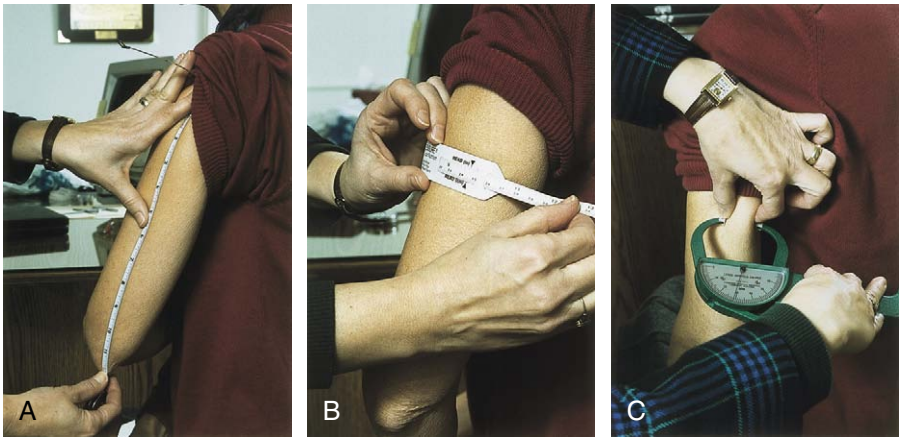


FIGURE 1-9 **A** and **B,** Measuring midarm circumference. **C,** Triceps skinfold thickness.

Midarm Circumference

Taking a measurement of the midarm circumference of the upper arm indicates the level of the body's protein stores, which are found mainly in the muscles. The nondominant arm is flexed at a 90-degree angle, and the circumference is measured with a nonstretchable measuring tape after the midpoint of the upper arm is determined (see Figure 1-9).

Elbow Breadth

This measurement determines body frame size. It is a reliable measurement that changes little with age and is not affected by body fat stores. The elbow breadth measurement is helpful in determining desirable weight ranges because body frame size reflects factors that influence weight, such as bone thickness, muscularity, and length of trunk in relation to total height. Calipers are applied to either side of the two prominent bones of the elbow while the forearm is bent upward at a 90-degree angle. The fingers are straight, and the inside of the wrist is turned toward the body. Most persons have a medium frame size. With experience, it is easy to visually determine when a person has a small or large frame size. See Appendix 4 on the Evolve website for frame size measurements.

Biochemical and Clinical Data

Several laboratory tests of the blood, urine, and skin are used in assessing nutritional status. Protein-energy malnutrition in its various forms can be detected by monitoring the blood serum levels of albumin, transferrin, and lymphocytes. These elements are all associated with body protein status. A person's level of immunity is determined with skin antigen tests.

Laboratory value norms can be different with older age, for example, because of decreased efficiency of the liver. The goal, however, is to aim for standard normal values. **Albumin** status is important to assess, with the goal being at least 3.5 mg/dL. Serum albumin values less than this are associated with poor protein status and can lead to poor immunity, poor healing from surgery, and skin breakdown. An increased protein intake can normalize albumin levels. Anemia, as noted from

reduced hemoglobin and hematocrit, is common. This may be a result of renal insufficiency, but iron studies should be undertaken as warranted to rule out iron deficiency anemia and possible causes such as gastrointestinal blood loss. Anemia caused by poor vitamin B_{12} or folate status can be determined through other laboratory values (see Appendix 5 on the Evolve website).

A nitrogen balance study also can be helpful in determining nutritional status. A negative nitrogen balance signifies that the body is using some of its protein reserves for energy. Nitrogen balance is determined from the urinary urea nitrogen content of a 24-hour urine collection. Clinical dietitians can calculate nitrogen balance with this information and determine an individual's protein needs to promote healing or preserve lean muscle mass. Certain vitamin and mineral deficiencies may also be detected with laboratory tests when the tests are evaluated in conjunction with physical findings and assessment of usual dietary intake.

TAKING A DIET HISTORY

The diet history is typically assessed by an RD, but other health professionals can assist. For example, if a person likes milk and reports an intake of 3 cups per day, this can be corroborated with clinical outcomes such as growth in children or bone density in older adults. A variety of ways exist to assess nutritional intake, including 24-hour food recalls, food frequency checklists, and food diaries. No one approach will provide complete information because food habits change for most persons. Therefore dietary histories should be used in conjunction with physical parameters of health. RDs are trained to take a multitude of factors into account when making nutritional assessments. See Table 1-7 for a summary of the nutritional assessment process.

PLANNING STRATEGIES

The planning stage of the nutrition care process brings together all the findings of the assessment phase, starting with identifying priority health concerns, long-term health goals, and short-term objectives. Identifying small, achievable, and measurable objectives aimed at long-term goals and specified health outcomes is important for facilitating behavioral change as warranted. When the health care professional is clear on the goals and the rationale for change, appropriate objectives and means of intervention can be determined.

Objectives are the steps needed to achieve long-term health goals. They should include measurable action verbs combined in a statement of intent or expected health outcome. For example, the action verbs *identify*, *state*, and *demonstrate* can all be used in educational objectives. The expected time frame for achievement of the objectives is sometimes also included. Educational or intervention objectives might read as follows:

- List food quantities needed to meet the goal of 25 g of fiber.
- Determine insulin-to-carbohydrate ratio for the goal of normalized glucose.
- Increase protein intake to 1.2 to 1.5 g/kg of body weight for the goal of albumin greater than 3.5 mg/dL.
- Consume at least 1500 mL of fluids.
- Describe serving sizes to meet a meal goal of less than 800 mg of sodium using food labels.

These objectives might be evaluated or measured through follow-up counseling sessions, through observation, or from improved laboratory values. Although objec-

Table 1-7 Summary of the Nutritional Assessment Process

AREA OF SCREENING	METHOD	INFORMATION GATHERED
Diet history	Patient/family interview	Food preferences and intolerances; taste, appetite, and recent weight changes; desired weight and usual weight; estimation of typical kilocalorie and nutrient intake
Clinical	Physical examination	Indicators of malnutrition: appearance of hair, skin, oral cavity, fingernails, presence of edema
	Radiography	Skeletal condition
	Anthropometry	Size, weight, and height
Biochemical	Laboratory tests of blood and urine	Composition of blood to compare with normal ranges for hemoglobin, albumin, transferrin, total plasma protein, and so on; nitrogen content in 24-hour urinary output
	Skin tests	Immunity to certain diseases, response to antigens; possible identification of vitamin and mineral deficiencies

tives are aimed at short-term, measurable activities or outcomes, goals should be more broadly based, such as "Will achieve a triglyceride level less than 150 mg/dL." Writing out the planning process is important because it increases the effectiveness of the intervention and communicates the care plan to other members of the health care team.

The short-term objectives may need to be prioritized, starting with the most important change. An individual is more likely to implement easy changes than more complex changes or too many changes at once. As objectives are met in the intervention and evaluation phases, the person should receive positive reinforcement for these changes and should then be encouraged to meet the others as needed.

The evaluation plan also is determined before the intervention phase. Evaluation ultimately means changes in laboratory values or other clinical health outcomes. Because funding is limited, the health care field now expects effective health care intervention and documented positive health outcomes.

The intervention phase can begin once the planned health outcomes are written or at least thought out or expressed verbally. A review of goals, objectives, and means of evaluation as based on the assessment phase can help promote compliance.

INTERVENTION STRATEGIES

Intervention approaches often begin with simple, brief, reinforcing messages. One question might be "Would you eat more lean meat for the goal of increased protein?" A more general question might also be asked, such as "Have you heard of carbohydrate counting?" To increase fluid intake ask, "What are your favorite beverages?"

Teaching Pearl

Quality of life versus quantity of life might be addressed by asking an assessment question such as "How do you feel about eating less cheese and butter to bring down your cholesterol level?" You might add the statement "Eating less saturated fat will help lower your low-density lipoprotein (LDL) cholesterol and triglyceride levels. What do you think about substituting olive oil for butter?" Watch for nonverbal cues of acceptance or rejection of ideas as well. ■

Retention of information is enhanced by combining different modes of giving information. It is known that people remember best what they have heard, seen, and practiced. Therefore verbal reinforcement of written educational material is more effective than simply giving out a brochure. Reviewing food labels and having an individual describe the amount of sodium, sugar, or fat in the food product is another exercise that can be very effective to foster compliance. Even the Internet is increasingly being used in providing health care. It appears that the general public will use an Internet-based weight loss program that involves physical activity and dietary behavioral interventions (McCoy and colleagues, 2005).

Through identifying individual or group goals and objectives, messages can be kept to a few key points. Prioritizing messages and offering sequential information needed to elicit health and eating changes are important. Simple concepts can later be built on with more complex concepts. For example, decision-making skills regarding meal planning are advanced concepts and need to be stressed after there is a general understanding of the rationale for change.

Messages given should offer positive reinforcement for behavioral change and should be based on individual needs. Asking what changes have previously been tried in attempts to improve health is important in order to build on the skills already achieved.

Scare tactics can cause inappropriate behaviors for health improvement, such as denial or tuning out the message. Follow-up reinforcement or referral to other appropriate services can be helpful to continue the development of more positive health habits (Table 1-8).

Knowledge of how to eat correctly was demonstrated to result in improved health outcomes, such as increased levels of the good cholesterol, high-density lipoprotein (HDL) (see Chapter 7), and lowered blood pressure. Those subjects who were not competent in eating were five to seven times more likely to have elevated levels of LDL cholesterol (the bad cholesterol) and triglycerides (another form of blood cholesterol). Nutrition education can serve as a form of MNT (Psota, Lohse, and West, 2007). Another study found that a 4-week educational course delivered as lectures resulted in 20 positive physical activity and dietary behavior changes by the 6-week mark, and most healthy behaviors did not return to baseline levels even after 18 months (Merrill and colleagues, 2008).

EVALUATION STRATEGIES

The final step of evaluation should be considered during the planning and intervention phases. The effectiveness of the plan in terms of the person's progress must then be documented and evaluated. This is based on information and skills gained and by the outcomes of laboratory blood tests or other measures. Examples might be achieving a 5% weight loss, an LDL cholesterol level less than 100 mg/dL (see Chapter 7), or normalized blood glucose level for a person with diabetes (see Chapter 8). The evaluation process can help the health care professional determine if further intervention is needed.

Many forms of evaluation may be performed. Measuring health outcomes might be done with ongoing, informal evaluation through observation (such as at mealtimes in an institutional setting) or through informal conversation (for example, a

Table 1-8 Common Family Nutrition Problems and Possible Solutions

PROBLEM	REFERRALS TO OR SOURCES OF SOLUTIONS
Inadequate economic resources for purchasing food	The Food Stamp Program The Women, Infants, and Children (WIC) Supplemental Food Program—a program for lower-income families that includes food coupons and nutrition education Food pantries and soup kitchens The Expanded Food and Nutrition Education Program (EFNEP)—a program of the Cooperative Extension Service that can be referred to for budgeting assistance Use food models to determine if excess intake in one food group (such as meat) can be reduced to allow for increase in other foods
Physical constraints to obtaining food	Nutrition Program for the Elderly for meal delivery for homebound older adults Local grocery stores with delivery service Public Health Nursing for professional home-based assessment
Inadequate cooking equipment or storage facilities	EFNEP for recipes and meal ideas
Food dislikes	A qualified nutritionist (or registered dietitian [RD]) for food alternatives Explain that tastes are learned; suggest the one-taste approach to facilitate acceptance
Inadequate time to prepare food	Suggest use of nutritious, but convenient, food ideas Vitamin A ideas: carrot sticks, apricots, cantaloupe, watermelon Protein ideas: cheese (low-fat or moderate amounts of natural cheese), peanut butter, eggs, or egg whites
Too much sodium in diet	The local American Heart Association, an organization promoting heart health, for recipe ideas An RD for individualized meal plans and behavioral change strategies Suggest use of frozen or fresh vegetables, Swiss cheese instead of high-sodium processed cheese; spices and herbs or jelly to enhance the natural flavor of food Explain that our taste for salt is both learned and unlearned Explain that salt substitutes should be used only on the advice of a physician because of potential harm from the potassium content
Too much sugar in diet	Encourage gradual sugar reduction while tastes change: use of one half or three fourths of usual amount in baking or at the table; suggest use of fresh fruit or fruit canned in light syrup Explain that spices such as cinnamon or nutmeg can enhance the natural flavor without added sugar Encourage the use of ice water, flavored waters, iced tea, or diet soda as a replacement for soft drinks
Too much cholesterol, fat, and saturated fat	The American Heart Association for recipe ideas Suggest a gradual change from 4% (whole milk) to 2% (reduced-fat) to 1% (low-fat) or skim milk (fat-free) while tastes change
Negative effects of commercials on food-buying practices	Suggest use of less butter, margarine, mayonnaise, and oil Explain that although cholesterol is found only in animal foods, saturated fats should be mainly avoided; food products with ingredient labels that say *liquid oil* are better than those that say *hydrogenated oil* (see Chapters 2 and 7 for more details) Explain that advertisements are meant to sell products; they generally are not concerned with healthy dietary habits Explain to children that many foods they see advertised help them to grow outward, not upward (a representation with your hands can be helpful to children)

Nutrition Assessment and Care Plan

Name: _____ Date: _____
D.O.B.: _____ Age: _____ Diagnoses: _____

Subjective Data

Food habits: _____
_____
_____
Fluid intake: _____
Activity level: _____

Objective Data

Diet order: _____
Consistency: _____
Medications: _____
_____
Supplements: _____
_____
Bowel/bladder functions: _____
_____
Laboratory values: _____
_____
_____
_____

Meal pattern: _____

Breakfast	Lunch	Supper

Male/Female: _____
Weight HX: _____
_____
Weight: _____ Height: _____
Physical indicators: _____
_____
_____

Meal observations: _____
_____
Skin intact: Yes_____ No_____ Pressure ulcer: Yes_____ No_____ Stage:_____
Medical factors affecting nutritional status: _____
_____
_____
_____
Physical limitations: _____
_____
_____

Problem	Goal	Intervention

Recommendations: _____
_____

Signature: _____

FIGURE 1-10 Sample nutrition assessment and care plan.

discussion of food likes and dislikes). More formal evaluation may involve monitoring laboratory values.

Monitoring the growth in children and weight changes in adults is a simple but effective means of measuring nutritional status. Evaluation may also focus on knowledge gained through verbal or written questions. Before-and-after tests can evaluate the outcome of a planned intervention but should be used with caution because many adults do not like to be quizzed.

The nutrition care plan (Figure 1-10) should always be incorporated into the total health care plan. This plan should be formulated by the health care team as soon as

possible. In summary, the nutrition care planning process includes making a nutrition assessment, identifying nutritional needs, planning how to meet nutritional needs using goals and objectives, carrying out the plan of care, and evaluating nutritional care.

What Is Your Nutrition IQ as You Begin the Study of Nutrition?

Some of the following statements are true, and some are false. Read each question, and then write your answer in the blank before you consult the list of correct answers below. Relevant chapter numbers are provided for further information.

____ **1.** Weight loss is mainly due to ingesting less kcalories than the body needs rather than amounts of protein, carbohydrates, fat, vitamins, or minerals (Chapter 6).
____ **2.** Margarine and butter contain the same number of calories (Chapter 2).
____ **3.** There may be a genetic predisposition to the risk of diabetes (Chapters 5 and 8).
____ **4.** A well person who eats the right kinds and amounts of foods every day generally does not need to take vitamin pills to meet the Dietary Reference Intake (Chapter 3).
____ **5.** Not eating bread and potatoes is the best way to lose weight safely (Chapter 6).
____ **6.** Children should not have dessert unless they clean their plates (Fact & Fallacy, Chapter 1, p. 27).
____ **7.** Calcium supplements are the best way to increase calcium intake if the individual does not like milk (Chapter 3).
____ **8.** The risk of heart disease can best be reduced with a low–saturated fat and high-fiber diet than one that is low in total fat intake only (Chapter 7).
____ **9.** White bread is the same nutrition content as wheat bread (Chapter 2).
____ **10.** Olives, olive oil, avocados, and most nuts are low in saturated fat, and moderate amounts are fine for a low-cholesterol and weight loss diet (Chapter 2).
____ **11.** A person with a milk allergy can safely consume lactose-free milk (Chapter 4).
____ **12.** An obese woman should lose weight if she becomes pregnant (Chapter 11).
____ **13.** Children should be forced to eat vegetables for their own good (Chapter 12).
____ **14.** High blood pressure can lead to kidney damage (Chapter 9).
____ **15.** The sense of thirst diminishes with older age (Chapter 13).
____ **16.** Food poisoning occurs more frequently than the common cold (Chapter 14).
____ **17.** A high-glycemic-load diet may lead to certain forms of cancer in persons with insulin resistance (Chapter 10).
____ **18.** Natural sweets such as honey may be eaten freely by people with diabetes (Chapter 8).
____ **19.** A person can drink too much water (Chapters 4 and 13).
____ **20.** Following a vegan diet may be a symptom of anorexia nervosa (Chapter 12).

ANSWERS

1. T
2. T
3. T
4. T
5. F
6. F
7. F
8. T
9. T
10. T
11. F
12. F
13. F
14. T
15. T
16. T
17. T
18. F
19. T
20. T

Number correct answers _____
Number incorrect answers _____
How good do you think your Nutrition Score is? _____

Chapter Challenge Questions & Classroom Activities

1. Explain what is meant by the following statement: "Good meal planning is both a science and an art."
2. Discuss why family eating at the table contributes to good nutritional status.
3. Analyze food advertisements in magazines. To whom are the ads appealing? How?
4. Become familiar with the ethnic, religious, or regional diet assigned to you by the instructor, and summarize information about it to present to the class. Be prepared to discuss this ethnic diet in terms of the food groups of the MyPyramid and Dietary Guidelines for Americans. What are the good points? How could the diet be improved? Use the following chart to record important information about each diet presented in class.

ETHNIC DIETARY HABITS

Regional or ethnic diet (list foods):
Characteristics and main dish:
Good nutritional features:
Desirable nutritional improvements:

5. Students might tell about the food customs and dietary habits of their country or countries of heritage and possibly demonstrate the ethnic dishes popular in their personal family meals. Markets of a city, ethnic food sections of large grocery stores, and ethnic restaurants afford good opportunities for learning about foods used by families with different ethnic backgrounds. The class might prepare a traditional Italian or Mediterranean meal or determine if any traditional Italian foods (such as bean-based dishes) can be found on local menus.
6. Brainstorm examples of biologic, psychologic, and social influences on food choices.
7. Discuss reasons why a person may not want to change food habits, and list assessment questions that may be used to reveal such concerns.

Case Study

Rita and her second husband, Sean, were having their morning cup of coffee, decaf for him and his son Royce, who would be along shortly for his daily visit, but espresso for her as she'd had all her life. Royce couldn't handle the caffeine with his history of heart disease. They were talking about all the health problems and eating habits of their several generations of children. Although the two of them were very healthy, they attributed this to their sparse eating as children growing up during the Great Depression of the 1930s. Sean's family ate lots and lots of cabbage, and although they didn't refer to themselves as vegetarians, they mostly were because they had little money to purchase meat. Rita grew up in a culture from Italy of having meat only once weekly. Rita's son Tony grew up eating all the traditional Italian foods such as pasta fagioli and lots of beans and greens. However, since his first marriage many years ago Sean had regularly eaten red meat because his wife preferred many meat and potato meals as a result of her mother's family being German Catholic. Rita's grandchildren and great-grandchildren loved their burgers and fries and she commented, "way too many sugary drinks." Sean's children and grandchildren weren't much different, although they were limiting sweets because his youngest granddaughter was diagnosed with diabetes this past year. They looked up to find Royce with a box of donuts in his hands and tried hard not to roll their eyes.

Critical Thinking Applications

1. How might have Rita and Sean's diets as children fit into the Dietary Guidelines?
2. As children, what might Rita and Sean have had too little of to meet their health needs?
3. What advice might you provide as a nurse or other health care professional to their children and grandchildren to stay healthy?
4. Describe how a Mediterranean type of eating pattern fits into the MyPyramid and Dietary Guidelines.

My Food and Nutrition Experience Diary

To help make yourself food and nutrition minded as you study nutrition, (1) jot down in the space provided any food and nutrition comments, questions, or experiences you encounter in discussions with individuals out of a classroom setting and later as you give nutritional care to patients (checking menus, setting up or observing and serving trays, feeding patients, and so on) and (2) assemble in a notebook (preferable), folder, or file box any available food and nutrition booklets, clippings, or other printed materials.

DATE	FOOD AND NUTRITION EXPERIENCE	COMMENTS

REFERENCES

Ahluwalia IB, Ford ES, Link M, Bolen JC: Acculturation, weight, and weight-related behaviors among Mexican Americans in the United States, *Ethn Dis* 17(4):643-649, 2007.

Antecol H, Bedard K: Unhealthy assimilation: why do immigrants converge to American health status, *Demography* 43(2):337-360, 2006.

Britten P, Haven J, Davis C: Consumer research for development of educational messages for the MyPyramid Food Guidance System, *J Nutr Educ Behav* 38(6 Suppl):S108-S123, 2006.

Cassady D, Jetter KM, Culp J: Is price a barrier to eating more fruits and vegetables for low-income families? *J Am Diet Assoc* 107(11):1909-1915, 2007.

Deshmukh-Taskar P, Nicklas TA, Yang SJ, Berenson GS: Does food group consumption vary by differences in socioeconomic, demographic, and lifestyle factors in young adults? The Bogalusa Heart Study, *J Am Diet Assoc* 107(2):223-234, 2007.

Duffey KJ, Popkin BM: Shifts in patterns and consumption of beverages between 1965 and 2002, *Obesity* 15(11):2739-2747, 2007.

Elzinga BM, Bakker A, Bremner JD: Stress-induced cortisol elevations are associated with impaired delayed, but not immediate recall, *Psychiatry Res* 134(3):211-223, 2005.

Guenther PM, Dodd KW, Reedy J, Krebs-Smith SM: Most Americans eat much less than recommended amounts of fruits and vegetables, *J Am Diet Assoc* 106(9):1371-1379, 2006.

Havlicek J, Lenochova P: The effect of meat consumption on body odor attractiveness, *Chem Senses* 31(8):747-752, 2006.

Howard KR: Childhood overweight: parental perceptions and readiness for change, *J Sch Nurs* 23(2):73-79, 2007.

Krebs-Smith SM, Kris-Etherton P: How does MyPyramid compare to other population-based recommendations for controlling chronic disease? *J Am Diet Assoc* 107(5):830-837, 2007.

Kussmann M, Raymond F, Affolter M: OMICS-driven biomarker discovery in nutrition and health, *J Biotechnol* 124(4):758-787, 2006.

Liese AD, Weis KE, Pluto D, Smith E, Lawson A: Food store types, availability, and cost of foods in a rural environment, *J Am Diet Assoc* 107(11):1916-1923, 2007.

McCoy MR, Couch D, Duncan ND, Lynch GS: Evaluating an internet weight loss program for diabetes prevention, *Health Promot Int* 20(3):221-228, 2005.

Merrill RM, Aldana SG, Greenlaw RL, Diehl HA, Salberg A, Englert H: Can newly acquired healthy behaviors persist? An analysis of health behavior decay, *Prev Chronic Dis* 5(1):A13, 2008.

Neuhauser L, Rothschild R, Rodríguez FM: MyPyramid.gov: assessment of literacy, cultural and linguistic factors in the USDA food pyramid web site, *J Nutr Educ Behav* 39(4): 219-225, 2007.

Nitzke S, Freeland-Graves J: Position of the American Dietetic Association: total diet approach to communicating food and nutrition information, *J Am Diet Assoc* 107(7):1224-1232, 2007.

Nowjack-Raymer RE, Sheiham A: Numbers of natural teeth, diet, and nutritional status in US adults, *J Dent Res* 86(12):1171-1175, 2007.

O'Connor TM, Yang SJ, Nicklas TA: Beverage intake among preschool children and its effect on weight, *Pediatrics* 118(4):e1010-e1018, 2006.

Psota TL, Lohse B, West SG: Associations between eating competence and cardiovascular disease biomarkers, *J Nutr Educ Behav* 39(5 Suppl):S171-178, 2007.

Spencer EH, Elon LK, Frank E: Personal and professional correlates of US medical students' vegetarianism, *J Am Diet Assoc* 107(1):72-78, 2007.

Spencer EH, Frank E, Elon LK, Hertzberg VS, Serdula MK, Galuska DA: Predictors of nutrition counseling behaviors and attitudes in US medical students, *Am J Clin Nutr* 84(3):655-662, 2006.

chapter

2

Carbohydrates, Proteins, and Fats:
The Energy Macronutrients of Balanced Meals

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Chapter Topics

Introduction
Macronutrients and Their Common Food Sources
Carbohydrates: Functions and Recommended Intake
Proteins: Functions and Recommended Intake
Fats and Cholesterol: Functions and Recommended Intake
Calculation of Percentages of Macronutrients in the Diet
Role of the Nurse and Other Health Care Professionals in Educating the Public About Carbohydrates, Proteins, and Fats

Objectives

After completing this chapter, you should be able to:

- Describe the macronutrient content of various foods and meal items.
- Describe the function and general recommendations for carbohydrate, protein, and fat in health prevention and disease management.
- Describe the role of the nurse or other health care professional in promoting an appropriate carbohydrate, protein, and fat intake in a meal context.

Terms to Identify

Alpha-linolenic acid (ALA)
Amino acids
Arachidonic acid
Available carbohydrates
Biologic value
Bipolar disorder
Carbohydrate bioavailability
Casein
Cholesterol
Complete protein
Dietary fiber
Diglycerides
Disaccharide
Docosahexaenoic acid (DHA)
Eicosanoids
Eicosapentaenoic acid (EPA)
Ergosterol
Essential amino acids
Essential fatty acids
Fructose
Glucose
Gluconeogenesis
Glycemic index
Glycemic load
Glycerol
High–biologic value protein
Homocysteine
Hydrogenated
Incomplete protein
Insoluble fiber
Ketosis
Kwashiorkor
Lactalbumin
Lactose
Linoleic acid
Lipids

Lipogenesis
Macronutrients
Maple syrup urine disease (MSUD)
Marasmus
Modified starch
Monoglycerides
Monosaccharide
Monounsaturated fats
Nitrogen balance
Nonglycemic carbohydrates
Oligosaccharides
Omega-3 fatty acid
Peptides
Phenylketonuria (PKU)
Phospholipids
Polyols
Polysaccharide
Postprandial
Prostaglandin
Protein Digestibility–Corrected Amino Acid Score (PDCAAS)
Protein-energy malnutrition
Resistant carbohydrates
Satiety
Saturated fats
Second-meal effect
Soluble fiber
Starch
Sterols
Sugar alcohols
Taurine
Trans fatty acids
Whey

INTRODUCTION

The topic of ideal intake of macronutrients continues to be debated. The consumer knows of the debate as to whether to follow a low-fat diet or a low-carbohydrate diet. Athletes are concerned with optimal protein intake and often feel protein supplements are necessary. Health care professionals can help dispel the public's confusion about how to eat appropriately. Individual guidance needs to be tailored to health needs and goals as discussed throughout the textbook. A basic understanding of macronutrients and their sources is needed first.

WHAT ARE MACRONUTRIENTS, AND WHERE ARE THEY FOUND?

The energy (measured in kilocalories [kcalories or kcal]) in the food we eat comes from carbohydrates, proteins, and fats, otherwise called **macronutrients** (Figure 2-1). Balanced meals contain all three macronutrients. The macronutrients provide the fuel for body functioning (although of the three, proteins serve this function the least efficiently). All three macronutrients contain the elements carbon, hydrogen, and oxygen. Proteins differ from carbohydrates and fats in that proteins also contain nitrogen. Carbohydrates and proteins provide 4 kcal/g of weight, and fats provide 9 kcal/g, as noted on many food labels (see Figure 1-4). Alcohol provides 7 kcal/g. Although alcohol is produced from a source of carbohydrate, the body uses it differently once the carbohydrates are fermented into alcohol.

There are only two dietary sources of carbohydrates: plant material and milk. Proteins are naturally found in all foods but are present in negligible amounts in fruit. There are no proteins in fats and sugars. The highest sources of protein include meat, or the muscle of animals, including poultry and fish; eggs, nuts, seeds, and

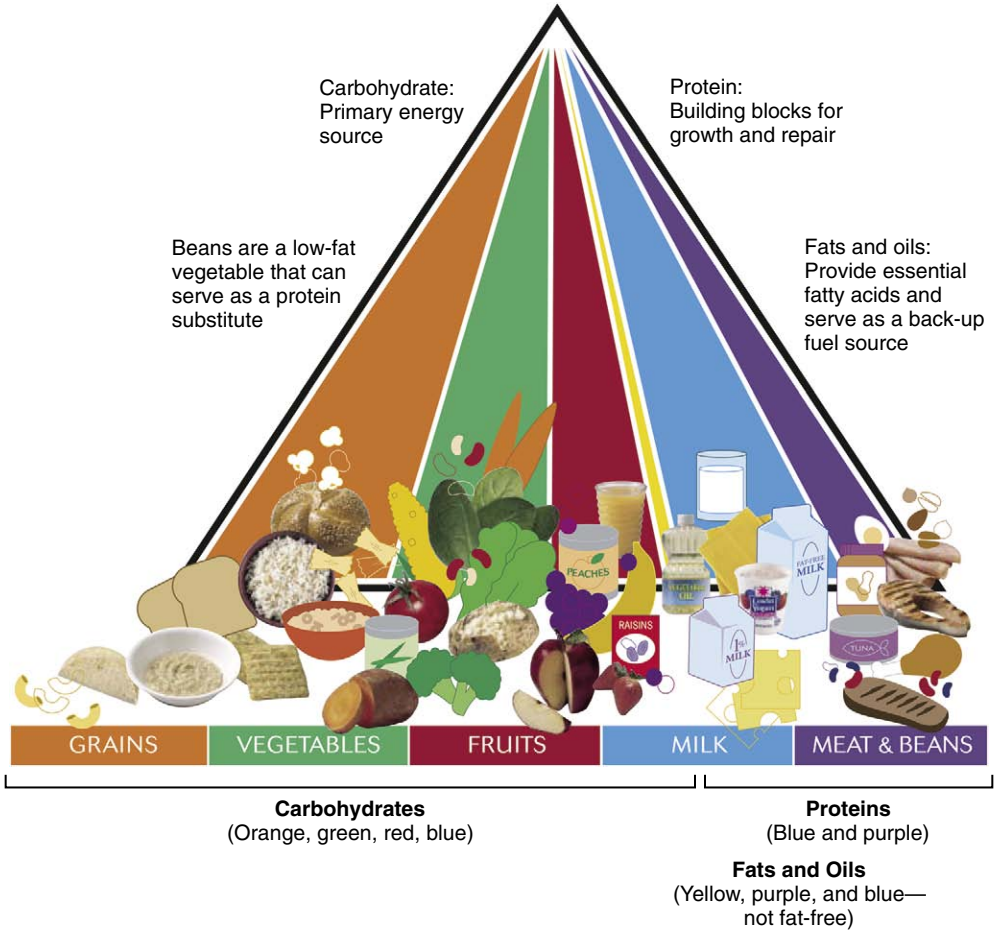


FIGURE 2-1 Carbohydrate, protein, and fat content of the MyPyramid Food Guidance System.

milk are also high in protein content. Legumes contain significant amounts of both carbohydrates (as a plant source) and proteins (because of their ability to pull nitrogen from the air). Fats are naturally found within all protein foods and some fruits, but only in trace amounts in vegetables. Whole milk contains all three types of macronutrients. Through processing, food products can have altered content of macronutrients, either higher or lower.

EMPTY CALORIES

Both fats (see section below) and sugars are referred to as empty calories, meaning they contain a high amount of energy but few vitamins or minerals (see Chapter 3). Ordinary table sugar (available from a variety of sources such as beets or sugar cane), molasses, maple syrup, corn syrup, and honey are concentrated sources of carbohydrates but have virtually no vitamins or minerals. Blackstrap molasses is the one

exception, in that it is relatively high in some nutrients such as iron, calcium, and potassium and it also contributes some B vitamins. Sugar can be noted on food labels as sugar, syrup, or any word that ends in *-ose* (except cellulose, which is a type of fiber). One teaspoon of sugar contains 4 g of carbohydrates (and therefore 16 kcal). When sugar is naturally found in foods, such as fruit and milk, it is not a source of empty kcalories.

WHAT ARE CARBOHYDRATES AND THEIR FUNCTIONS AND RECOMMENDATIONS?

Carbohydrates are made through the process of photosynthesis (in which the sun's energy allows plant leaves to take in carbon dioxide [CO_2] from the air and water [H_2O] through the roots). Carbon (*carbo-*) and water (*-hydrate*) are formed into carbohydrates, and the plant gives off oxygen as a result. Hence carbohydrates are mainly found in foods of plant origin. Although we do not think of sugar as growing out of the ground, it does come from a plant. Even honey comes ultimately from plant matter, being produced from the nectar of flowers by honeybees. The only nonplant dietary sources of carbohydrates are milk and milk products. Cheese is negligible in carbohydrate because of the way it is produced, with the liquid whey being drained away.

BASIC FORMS OF CARBOHYDRATES

The current terminology of forms of carbohydrates used in the United States falls into three broad categories, which are used on food labels. However, there is controversy on how best to classify carbohydrates based on impact on nutritional status. To begin this discussion, it is helpful to recognize the basic categorization currently used.

1. Sugars, or simple carbohydrates, include a single or double molecule made up of carbon, hydrogen, and oxygen ($C_6H_{12}O_6$) and may also be referred to as a **monosaccharide** (single units) or **disaccharide** (double units or double sugars). There are two types of monosaccharide molecules: **glucose** (blood sugar) and **fructose** (fruit sugar). Disaccharides are found only in food and must break apart, through digestion, into monosaccharide molecules before they can be absorbed into the bloodstream. **Lactose** (milk sugar) is an example of a disaccharide. The inability to digest lactose into single monosaccharide molecules is a common digestive problem (see Chapter 4). Sucrose, common table sugar, is a combination of glucose and fructose (Table 2-1).
2. **Starch**, in the past called a complex carbohydrate, is a chain of at least three sugar links and is referred to as a **polysaccharide** (multiple units). It is now known that starch is digested as rapidly as sugar, with digestion completed within 1 hour. It was once believed that digestion of starch occurred through removal of sugar links off each end of the polysaccharide chain. It is now recognized that the chemical bonds holding each single sugar link together in a chain break apart simultaneously through digestion. Consequently starch and sugar have similar effects on blood glucose levels.
3. **Dietary fiber** is the most complex form of carbohydrate. Although it is a polysaccharide like starch, the complexity of the polysaccharide chain in fiber makes digestion by humans nearly impossible. For this reason, at least some of the fiber

Table 2-1 Types and Sources of Carbohydrates

TYPE	DESCRIPTION	SOURCES
Monosaccharides (Simple Sugars)		
Glucose (blood sugar)	The end product of most carbohydrate digestion. One form in which carbohydrates are absorbed, resulting from its being the only fuel the central nervous system can use.	Found in fruits, certain roots, corn, and honey. Also found in blood as the product of starch digestion.
Fructose (fruit sugar)	Gives honey its characteristic flavor. Combined with glucose in table sugar.	Found in fruit, honey, and vegetables.
Galactose	A byproduct of lactose digestion.	Naturally found only in mammalian milk.
Disaccharides (Double Sugars)		
Sucrose (table sugar)	Composed of glucose and fructose. Commonly known as table sugar, which is made from sugar cane.	Found in sugar cane, sugar beets, molasses, maple sugar, maple syrup, many fruits and vegetables, and added to foods as table sugar.
Lactose (milk sugar)	Produced only by mammals. It is less soluble and less sweet than cane sugar and is digested more slowly. Composed of glucose and galactose.	Found in milk and unfermented milk products.
Maltose (malt sugar)	Formed when starch is changed to sugar during digestion. Composed of two glucose molecules.	Found in malt and malt products; not free in nature.
Polysaccharides (Starch, Complex Carbohydrates)		
Complex carbohydrate (starch)	The reserve store of carbohydrates in plants; changed to glucose during digestion (through intermediate steps of dextrin and maltose).	Found in grains and grain products, seeds, roots, potatoes, green bananas, and other plants.
Dextrin	Formed from starch breakdown.	Cooked starch (toast).
Dietary fiber	Indigestible; provides bulk and stimulation for the intestines and helps prevent or manage many chronic illnesses.	Insoluble found in skins and seeds of fruits, vegetables, and grains. Soluble found in large amounts in legumes, greens, citrus fruits, oatmeal, and barley.
Glycogen	The reserve store of carbohydrates in animals; changed to glucose as needed.	Stored in small amounts in the liver and muscles.

may be subtracted from the total carbohydrate content as listed on food labels (see below).

There are two broad groupings of fiber based on their solubility in water. **Insoluble fiber** (generally found in the skin and seeds of plant foods) tends to be crunchy, whereas **soluble fiber** (generally found in the pulp of plant foods) tends to be gummy. Insoluble fibers include cellulose and hemicellulose. Soluble fibers include

Box 2-1 Food Sources of Various Fiber Components

CELLULOSE
Whole-wheat flour
Bran
Cabbage family
Peas and beans
Apples
Root vegetables

HEMICELLULOSE
Bran
Cereals
Whole grains

GUMS
Oatmeal
Dried beans
Brown rice
Barley
Pectin
Apples
Citrus fruits
Strawberries

LIGNIN
Mature vegetables
Wheat

gums, lignins, and pectins. Plant foods contain both soluble and insoluble fiber, but proportions vary depending on the food source. See Box 2-1 for a general listing of fiber content of various plant foods.

The basic classification of carbohydrates has to do with chemical structure in terms of the number of glucose molecules and the form of digestibility. There is growing debate that this classification is inadequate based on nutritional impact. The Food and Agriculture Organization/World Health Organization Expert Consultation in 1997 divided carbohydrates into three main groups: sugars (with 1 or 2 glucose molecules: monosaccharides and disaccharides), **oligosaccharides** (short-chain carbohydrates with 3 to 9 glucose molecules), and polysaccharides (10 or more glucose molecules). Additional terms used include **polyols** (sugar alcohols), **modified starch** (altered food starches used as a thickener, stabilizer, binder, or emulsifier), nonstarch polysaccharides (as found in plant cell walls), and total carbohydrate (the sum of total carbohydrate grams). Beyond the basic chemistry, physical properties affect how individual forms of carbohydrate impact nutritional status. This includes factors such as water solubility, gel formation, crystal formation, and association with other molecules such as proteins and lipids.

One nutritional classification includes a main group of **available carbohydrates,** meaning they are digested and absorbed in the small intestine for subsequent cellular metabolism (see Chapter 4), whereas **resistant carbohydrates** are those that resist digestion in the small intestine or are poorly absorbed/metabolized. The available carbohydrates are commonly referred to as starch and sugars. Resistant carbohydrates are commonly referred to as fiber. One definition and measurement proposed for dietary fiber is "intrinsic plant cell-wall polysaccharides" rather than simply determining indigestibility in the small intestine. Further characterization of carbohydrate forms has implications for nutrition claims and food labeling (Englyst, Liu, and Englyst, 2007).

Carbohydrate bioavailability is a term that has been coined to describe both the chemical identity and physical form of food taken into consideration. One proposed classification and measurement scheme divides dietary carbohydrates into glycemic

carbohydrates (those having impact on blood glucose through being digested and absorbed in the small intestine) and **nonglycemic carbohydrates** (those that enter the large intestine undigested, examples being fiber or plant cell-wall nonstarch polysaccharides, resistant starch, and nondigestible oligosaccharides) (Englyst and Englyst, 2005). Three food energy systems are in use in food tables and for food labeling in different world regions based on selective interpretation of the digestive physiology and metabolism of food carbohydrates (Elia and Cummings, 2007).

Consequently there is confusion among the general public and among health care professionals on how best to utilize food labels for carbohydrates in the goal of meeting optimal health and blood glucose goals. The American Dietetic Association advocates that the total carbohydrate available for blood glucose is the sum of all sugars and starches, but only half of the fiber over 5 g and half of sugar alcohols. The outcomes of the Diabetes Control and Complications Trial (see Chapter 8) advised that total carbohydrate is the sum minus all of the fiber if it is over 5 g in a serving. Another method involves subtracting resistant starch from total starch (Granfeldt, Wu, and Björck, 2006). Available carbohydrate intake is a confounding factor in assessing impact from health changes in different levels of glycemic load. The role of fiber is not completely understood, and its impact on health remains to be determined (Livesey and colleagues, 2008).

On a practical level, it is generally agreed that intrinsic sugar content as found in fruit is beneficial to health and that the foundation of a person's diet should include fruit, vegetables, whole grains to meet fiber goals, and milk, with minimal amounts of added sugars (extrinsic sources).

Teaching Pearl

An analogy for fiber is that it is like a twisted gold chain necklace. Just as it is difficult to unravel a gold chain necklace, the human digestive system cannot unravel a polysaccharide chain. Cows can digest fiber because they have the equivalent of four stomachs. ■

GLYCEMIC INDEX

Glycemic index refers to the effect of foods on blood glucose (sugar) levels. Carbohydrates have the primary impact on blood glucose. Of carbohydrates, those that are in liquid form, such as in fruit juice, carbonated soft drinks (soda pop), or milk, have a higher glycemic index than those that are in solid form, especially those high in fiber, such as legumes and vegetables. Whole grains have a lower glycemic index than white-flour food products. Whole fruits have a lower glycemic index than the equivalent fruit juices. **Glycemic load** is a relatively newer term that includes both how rapidly a food raises blood glucose and the total amount of carbohydrate.

A low glycemic index, by reducing the impact of a meal-related rise in blood glucose, called **postprandial** blood glucose, has been shown to have health benefits. High-fiber diets have been shown to lower postprandial glucose and insulin responses and improve blood lipid (see Chapter 7). They may also manage diabetes (see Chapter 8) by facilitating the cells' use of insulin (Riccardi, Rivellese, and Giacco,

2008). The postprandial effect of one meal can affect the blood glucose outcome of a subsequent meal. This is referred to as the **second-meal effect.** This may be due to high-fiber foods causing fermentation in the colon (Brighenti and colleagues, 2006).

FUNCTIONS OF CARBOHYDRATES

Carbohydrates, in the form of sugars and starch, are generally easily converted to energy needed for physical activity and basic life processes (Table 2-1). The human body prefers carbohydrates for fuel. One gram weight of carbohydrates yields 4 kcal of physical energy.

Humans use carbon in carbohydrates as fuel, just as carbon is used for fuel in automotive vehicles and furnaces. The human body is made up of millions of microscopic body cells that act as small furnaces (specifically the mitochondria within the cells) to essentially burn our food energy. Each 1 g of carbohydrates in food can be considered like one nugget of coal. The higher the carbohydrate amount in a food or a meal, the more nuggets of coal, or the more fuel, available to the body cells.

Carbohydrates have the following functions, as well:

- Spare the burning of protein for energy (proteins have more important functions, such as building and repairing body structures).
- Allow for more efficient and complete oxidation (burning) of fats for energy.
- As sugar, can have a laxative effect.
- As starch, provide an economical and abundant source of energy after being digested into glucose. Sugar and starch are both digested quickly (in less than 1 hour).
- As lactose, aid in the absorption of calcium.
- As dietary fiber (insoluble and indigestible), promote normal functioning of the intestines by adding bulk. Soluble forms, in significant amounts, lower serum cholesterol levels (see Chapter 7). Fiber slows down the time of digestion, which helps promote satiety (the feeling of fullness or satisfaction after eating) and is related to low glycemic index (the rate at which blood glucose levels rise). Fiber is not considered part of a meal's high glycemic load (a meal that is high in total carbohydrates and with a high glycemic index).

Teaching Pearl

To describe the difference between soluble and insoluble fiber, you can say, "If you put the peel of an apple in a glass of water, it will sit there day after day. That is insoluble fiber, or roughage. But if you put the pulp part of the apple into water, it will dissolve into little particles. This is soluble fiber, known as pectin, and it is used to thicken fruit juice into jam." ■

RECOMMENDATIONS FOR INTAKE OF CARBOHYDRATES

Most persons should derive at least 60% of their kcalories from carbohydrates. This recommendation is found with the Daily Values on food labels. Based on 2000 kcal, 300 g of carbohydrate is the recommended amount for most adults, as found on food labels. The minimum quantity of fruits, vegetables, grains, and milk in the 2005 Dietary Guidelines provides about 200 g of carbohydrates. With an emphasis on

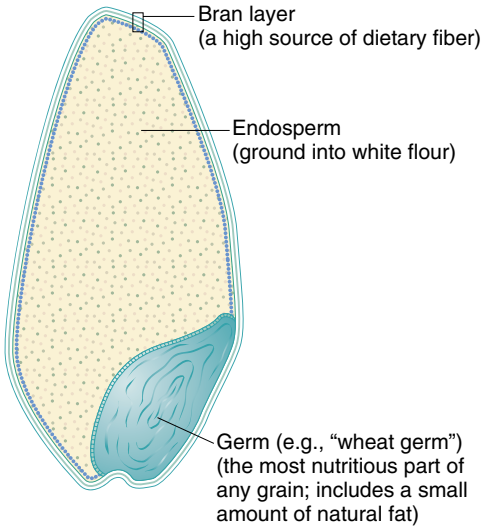


FIGURE 2-2 Anatomy of a grain. Whole grains include all three portions of the grain.

high-fiber foods, this level can safely be included for the vast majority of individuals, especially if consumed in small, frequent meals.

Some individuals benefit from a lower amount of carbohydrates, but everyone needs at least 100 g daily to prevent **ketosis** (rapid breakdown of body fat leading to ketone formation and a lowered pH, or increased acidity level of the blood). With ketosis, reduced ability to remove CO_2 occurs. However, the optimal minimum of carbohydrate intake was set nationally at 130 g/day (see the back of the book).

Sugar is now considered appropriate as part of total carbohydrate intake as long as the minimum nutritional needs are being met (consumption of the minimum number of food servings in the Dietary Guidelines) and weight and level of health allow for added sugar. Infants, however, should not consume honey because of the possible presence of botulism spores.

The recommended amount of fiber is 20 to 35 g, or 14 g of fiber per 1000 kcal. This goal can be met by including the daily recommended number of food servings found in the 2005 Dietary Guidelines, which include three servings of whole grains and 4½ cups of vegetables and fruits, including ½ cup of legumes on most days. The fiber in grains is found in the germ and the bran layer, where most of the overall nutritional value in whole grains is found (Figure 2-2). With any increase in fiber intake, an increase in water intake is needed to prevent fecal impaction.

DETERMINATION OF CARBOHYDRATE CONTENT OF FOODS WITHOUT FOOD LABELS

In the primary source of carbohydrates, plants, an easy method to determine the carbohydrate content is by assessing three tactile factors:

- Water content
- Level of sweetness
- Density (Box 2-2)

Box 2-2 Carbohydrate Counting

GRAINS AND STARCHY VEGETABLES (15 g OF CARBOHYDRATES)

3 c popcorn
1 c puffed cereals
½ c pasta, dry vegetable (potato, beans), or sweet vegetable (corn, peas, winter squash)
1 slice bread or 1 oz equivalent (½ c)
⅓ c rice
¼ c dry and sweet vegetable (yams or "sweet potato")

FRUITS (15 g OF CARBOHYDRATES)

1 c high water-content fruits (melon and berries)
½ c most fruits
¼ c most dried fruits
½ banana
⅛ c dry and sweet fruits (raisins or dried banana chips)

MILK (~15 g OF CARBOHYDRATES)

1 c milk or yogurt (unsweetened)

LOW-CARBOHYDRATE VEGETABLES (5 g OF CARBOHYDRATES)

1 c raw vegetables (high in water and low in sweetness)
½ c cooked vegetables (high in water and low in sweetness) (Do not count carbohydrates unless they total 15 g or more.)

CONCENTRATED CARBOHYDRATE SOURCES

1 tsp sugar = 4 g of carbohydrates
½ c sugar = 95 g of carbohydrates
1 tbsp flour = 5 g of carbohydrates
½ c flour = 45 g of carbohydrates

Generally speaking, there are approximately 15 g of carbohydrates for every ½ cup of most plant-based foods. This is true of most grains, fruits, and vegetables that are relatively dry or sweet. One slice of bread weighs 1 oz and is ½ cup in volume. Most vegetables provide 5 g of carbohydrates per ½ cup when cooked or per 1 cup when raw. This is because most vegetables are not dry or sweet; rather, they are high in water content and not sweet like fruit. Sweet potatoes (yams) are dry, like white potatoes, and are also sweet. The fact that sweet potatoes are both dry and sweet doubles the carbohydrate value to 30 g per ½ cup.

Further, a slice of bread provides a good size analogy for estimating carbohydrate values—for example, a piece of pizza that is the size of one slice of bread contains one serving of starch (about 15 g of carbohydrate). A plate of pasta that is about the same size as four slices of bread is 4 oz of pasta or 60 g of carbohydrates.

Grains that have low density (are high in air content) allow a larger volume for the same amount of carbohydrates (for example, 3 cups of popcorn or 1 cup of puffed cereal contains 15 g of carbohydrates). Grains that are dense, such as bagels, can be misleading in their carbohydrate content. A typical deli-size bagel is 4 oz and contains 60 g of carbohydrates.

There is generally 15 g of carbohydrates for every ½-cup serving of fruit. However, fruits that are very watery (such as watermelon or cantaloupe, which require that you lean forward or hold them over a plate when you eat them) contain less carbohydrate per volume because the water takes up space. Thus to equal 15 g of carbohydrates in watery fruits it takes 1 cup. When the water content is lower than usual, such as with bananas and dried fruits, it takes only ¼ cup to equal 15 g

of carbohydrates. For dried fruit that also is very sweet, such as raisins and dried banana chips, ⅛ cup contains the same 15 g carbohydrates (see Box 2-2).

Vegetables that are higher in carbohydrates are the dry potato and legumes or the sweet ones such as "sweet corn" and "sweet peas." This is why they are often referred to as starchy vegetables (remember, they have the same 15 g of carbohydrates for a ½-cup serving as the other starchy foods such as bread and pasta). Carrots and beets are higher in water content than peas, corn, and potatoes. They are mildly sweet and contain 10 g of carbohydrates for 1 cup raw or ½ cup cooked. Examples of low-carbohydrate vegetables are those that are watery and not sweet. An easy way to determine this is to try to say the word *sweet* with the name of the vegetable. For example, it sounds correct to say, "sweet corn," but it sounds ridiculous to say "sweet spinach," "sweet cabbage," or "sweet cucumber," all of which are low in carbohydrates (5 g per ½-cup cooked or 1-cup raw serving). There are always exceptions to every rule. In this case, although you would say, "sweet peppers," the *sweet* is used to distinguish them from hot peppers. The same holds true for the sweet Vidalia onions, which have a mild flavor rather than a strong flavor. Thus sweet peppers and sweet onions are still low in carbohydrate content.

Based on water content, it can easily be determined that flour has more carbohydrates than bread, as it is extremely dry. You can swallow bread, but you cannot swallow flour. Flour has 45 g of carbohydrates per ½-cup serving. Sugar, being both extremely dry and extremely sweet, has almost 100 g of carbohydrates per ½-cup serving. A ½-cup piece of cake has to contain over 15 g of carbohydrates because it is sweeter than bread, but less than 100 g, because it is not pure sugar. A typical ½-cup serving of unfrosted cake contains about 30 g of carbohydrates and about 50 g if topped with mildly sweet frosting.

Teaching Pearl

To determine a person's understanding of how to estimate carbohydrate in foods based on the tactile aspects of water content, level of sweetness, and density, you might ask, "Can you determine the carbohydrate content of a ½-cup piece of cake?" and then follow with the above discussion. ■

SUGAR SUBSTITUTES

Sugar substitutes come in two main forms: nutritive (providing a source of carbohydrates) and nonnutritive (containing insignificant amounts of carbohydrates). **Sugar alcohols** are nutritive and are easy to recognize by their names, which all end in *-ol* and sound like *alcohol.* The main sugar alcohols are sorbitol, mannitol, and xylitol. Sugar alcohols do not contribute to dental decay but otherwise have little advantage over sugar. One problem with sugar alcohols is that they can induce diarrhea with as little as 8 g, as noted on food labels. One half of the quantity of sugar alcohols listed on food labels counts toward the total carbohydrate intake. Saccharin, aspartame (NutraSweet or Equal), acesulfame-K (Sunett or Sweet One), and sucralose (Splenda) are all nonnutritive sweeteners.

Fact & Fallacy

FALLACY Potatoes and bread are fattening.

FACT Excess kcalories in relation to physical energy needs causes weight gain. Excess carbohydrate and fat kcalories can lead to obesity. Aiming for the minimum recommended carbohydrate intake of 130 g allows for the inclusion of 4 cups of potatoes or eight slices of bread daily if no other carbohydrate source is consumed. The goal of a balanced diet with 3 cups of milk and at least three servings of whole grains still allows for 1 cup of potatoes daily. For individuals needing this lower carbohydrate goal, additional low-carbohydrate vegetables should be included rather than fruits, or the fruit can be alternated with potatoes. ■

ALCOHOL

Alcohol is an additional fuel source for the human body because it is a source of kcalories. It provides 7 kcal/g. The caloric content of alcohol is close to that of fat, which provides 9 kcal/g. Alcohol is derived from a carbohydrate source, such as barley for beer and grapes for wine. However, once the carbohydrates are fermented into alcohol, they are no longer used in the same fashion. The carbohydrate source that is not fully fermented into alcohol remains an available source of carbohydrate for cellular use such as in sweet wines, liquors, and regular beer. Hard liquor and dry wines have virtually no available carbohydrates for metabolism. The impact of alcohol on metabolism, however, tends to increase the body's ability to utilize insulin and can contribute to blood glucose problems (see Chapter 8).

WHAT ARE PROTEINS AND THEIR FUNCTIONS AND RECOMMENDATIONS?

Proteins are the basic element of all life. Whether in animal or plant sources, proteins will be found. Proteins are made from a combination of **amino acids** and always contain nitrogen. Through the process of digestion, proteins in food are broken down into amino acids; then they are reassembled into proteins by the liver, regulated by our genetic makeup. Proteins are in a constant flux, along with the amino acids, as body needs demand and metabolism allows. The field of molecular biology will continue to identify metabolic pathways of amino acids and proteins and their functions. The implications of dietary choices will continue to be unraveled.

The highest concentration of proteins is found in muscle. All forms of muscle are high in proteins (red and white meat and fish). Legumes (beans) and nuts are plant material and therefore contain carbohydrates (as do all plant-based foods), but legumes also have the ability to draw nitrogen from the air, making them high in protein. Nuts contain the material needed to grow new trees (peanuts are actually a legume) and are consequently another good source of proteins. Therefore legumes and nuts are included in the meat group of the MyPyramid. Other rich sources of proteins are eggs, milk, and cheese. The proteins in milk are referred to as **casein, lactalbumin,** and **whey** and often are part of nutritional supplements used in nutritional support (see Chapter 15).

Whole grains and vegetables also provide protein, but in lower amounts. The proteins in plant- based foods typically are not complete proteins (see section below).

FUNCTIONS OF PROTEINS

The nitrogen found in proteins is what sets protein apart from the other macronutrients. Nitrogen gives proteins their unique function of building and repairing all of the various body tissues, allowing for the production of hormones and digestive enzymes, and a strong immune system. Although this is protein's primary role, it also can be broken down and stripped of its nitrogen to be used as an energy source. Unless adequate carbohydrates and fats are provided, some of the proteins ingested will be used for energy needs rather than for building and repairing body tissues. Proteins have numerous functions:

- Repairing or replacing worn-out tissues
- Supplying material for growth and tissue building
- Providing some energy (4 kcal/g)
- Constructing and properly maintaining important body compounds (enzymes, hormones, hemoglobin, antibodies, other blood proteins, and glandular secretions)
- Helping to prevent edema through their role in maintaining vascular osmotic pressure

TYPES OF PROTEINS

The term **biologic value** describes how well a particular protein food approximates the amount and combination of essential amino acids in the body. **Essential amino acids** cannot be produced by the body and hence need to be included in the diet. A **complete protein** is said to contain all of the essential amino acids, whereas an **incomplete protein** has some of the essential amino acids but is lacking others. Food sources that are complete proteins are also referred to as having **high–biologic value protein.**

Generally speaking, animal sources of proteins such as meat, fish, poultry, and dairy products (Figure 2-3) contain complete proteins of high biologic value. Incomplete yet good sources of protein foods that are lacking one or more of the essential amino acids include whole grains, legumes, nuts, and seeds. Combining a variety of

FIGURE 2-3 High-protein foods.

Table 2-2 Food Pyramid Servings for Needs of the Vegan Diet of the Limiting Amino Acids: Lysine, Methionine, and Tryptophan, Based on 175-lb Adult; Approximate Minimum Content Available From Variety of Foods

FOOD GROUP	LYSINE (RDA GOAL: >3000 mg)	METHIONINE/CYSTEINE (RDA GOAL: >1500 mg)	TRYPTOPHAN (RDA GOAL: >400 mg)
6 oz grains; half whole grain	≥420 mg	≥535 mg	≥195 mg
3 c soy milk	≥1300 mg	≥640 mg	≥315 mg
1 c nuts	≥500 mg	≥550 mg	≥200 mg
1 c legumes	≥1000 mg	≥400 mg	≥180 mg
2½ c vegetables	≥150 mg	≥30 mg	≥10 mg
2 c fruits	≥50 mg	≥5 mg	≥2 mg
TOTAL	**3420 mg**	**2160 mg**	**902 mg**

incomplete protein foods over the course of the day can give the body all of the essential amino acids needed for adequate protein levels. Therefore vegetarians can receive adequate proteins without eating meat if they combine foods in such a way that the minimum requirement for the essential amino acids is consumed over the course of 24 hours (Table 2-2).

Because proteins are made up of varying amounts of amino acids, they can have different health implications. Even though protein has a limited impact on blood glucose levels, one study found that meals with similar nutrient composition (33% protein, 41% carbohydrate) but different types of protein (cod, cottage cheese, or soy protein isolate) had different effects on postprandial blood glucose responses. Variation of effect was dependent on the length of time after intake (von Post-Skagegård, Vessby, and Karlström, 2006). However, meal composition with varying types of fat in a meal can also have an impact. The fat content of cottage cheese is primarily of a saturated form (see section below).

AMINO ACIDS IN FOODS

Protein, necessary for building and repairing body tissues in humans and for the formation of enzymes, is made up of 20 basic amino acids. Amino acids are called the building blocks of protein because they are the foundation for the synthesis of a large number of proteins. They can be found in varying amounts and combinations in the food we eat, and the human body can synthesize most of them. By definition protein consists of long chains of amino acids connected together. The exact number that constitutes protein is debatable, but all concur that a chain with over 100 individual amino acids in the chain is a protein. Short chains of amino acids are referred to as **peptides.**

The following amino acids are essential, or indispensable, which means they cannot be synthesized and must therefore be obtained from the diet:

Histidine (required for children)	Lysine	Threonine
Isoleucine	Methionine	Tryptophan
Leucine	Phenylalanine	Valine

There are 12 basic nonessential amino acids important for health—that is, they can be synthesized by the body if there are adequate quantities of essential amino acids and the genetic ability for metabolism is viable:

Alanine	Cysteine	Glycine
Arginine	Cystine	Proline
Asparagine	Glutamic acid	Serine
Aspartic acid	Glutamine	Tyrosine

The following is a brief review of roles of the essential amino acids.

Histidine is an essential amino acid for children because it is required for growth. For adults it is not necessary to maintain nitrogen balance, and consequently it is not considered essential for adults.

Isoleucine is called a branched-chain amino acid, along with leucine and valine, because of its physical structure. There is evidence that isoleucine helps regulate blood glucose levels. As shown in a rat study, intake promotes use of glucose in muscles and inhibits liver production of glucose (Doi and colleagues, 2007). A severe and rare autosomal recessive metabolic disorder related to the branched-chain amino acids and caused by an enzyme defect is **maple syrup urine disease (MSUD).** Brain and neurologic damage occur because of the buildup of these branched-chain amino acids. Early screening in infancy is needed to alter the diet to prevent neurologic damage. Liver transplantation has been found helpful in correcting MSUD with evidence of normalization of the branched-chain amino acid levels within hours of surgery despite unrestricted protein intake (Strauss and colleagues, 2006).

Leucine, another branched-chain amino acid related to MSUD, needs to be limited to prevent neurologic damage. One study found that optimal levels need to be maintained below 300 μmol/L in order to prevent neurologic damage found with MSUD (Couce Pico and colleagues, 2006). On a positive note, for persons without MSUD, intake may have a role in weight management. In a study with mice, increases in dietary leucine intake allowed a 25% loss in body fat with resulting improved glucose and serum cholesterol levels despite having a high-fat diet. Weight loss was attributed to increased metabolism, not a reduction in kcalorie intake (Y Zhang and colleagues, 2007).

Lysine is a particularly important essential amino acid to include as part of a vegetarian diet due to its limited quantity in plant-based foods. A vegan diet needs to include nuts and/or soybean-based foods to best meet lysine requirements (see Table 2-2). Although adequate intake is imperative, avoiding excess intake of lysine has been implicated in reduced heart disease and lower cancer risk through complex metabolic actions related to altered metabolism. This favorable outcome is further enhanced with higher intake of several of the nonessential amino acids: alanine, arginine, glycine, and serine through reduction in enzymes required for **lipogenesis** (creation of fat), production of cholesterol, and enhanced action of the low-density lipoprotein (LDL) receptors (see Chapter 7) along with a decrease in insulin-like growth factor (IGF; see Chapter 10) (Krajcovicova-Kudlackova, Babinska, and Valachovicova, 2005).

Methionine is a sulfur-containing amino acid and is synthesized into the amino acids **taurine** and **homocysteine.** It is often the most limiting amino acid in the diets of vegetarians and those who have low intakes of meat because of its low levels in

grain products (see Table 2-2). Metabolism of the sulfur amino acids, methionine, cysteine, and cystine, has been receiving increased attention because of the link to chronic diseases such as cardiovascular disease, Alzheimer's disease, and diabetes. (See sections below on homocysteine and taurine.) There is some evidence of a negative impact of excess intake of the sulfur-containing proteins on loss of calcium with the resultant risk of bone loss. One study did find lower bone mineral density of the lumbar spine with excess intake (Thorpe and colleagues, 2008).

Phenylalanine is referred to as an aromatic amino acid because of its molecular structure. It is listed as a warning on food products containing the sugar substitute aspartame, or NutraSweet. The warning applies only to persons having an inability to metabolize phenylalanine into tyrosine. This is known as **phenylketonuria (PKU)** and is linked with mental retardation. At birth, infants are now screened for PKU, and if it is found to be present, there is a restriction of excess intake of this amino acid for life in order to maintain brain and neurologic health. The amount of phenylalanine required in the diet has recently received attention. It was found that in the absence of tyrosine in the diet, the mean phenylalanine requirement is higher than the current Food and Agriculture Organization (FAO)/World Health Organization (WHO)/United Nations University (UNU) (1985) and Dietary Reference Intakes (2002) recommendations (Hsu and colleagues, 2006).

Threonine is an essential amino acid that is found in a protein in the intestinal tract. It has been noted that in preterm infants, the intestines, pancreas, and spleen have a high uptake of dietary threonine, suggesting an increased need in these tissues (van der Schoor and colleagues, 2007).

Tryptophan is needed for the production of serotonin, the good-feeling hormone, and the hormone needed to induce sleep. Turkey is high in tryptophan and is well known as an inducer of sleep. Milk is another good source of tryptophan, which is likely why the old adage of warm milk before bedtime helps with sleep. Acute tryptophan depletion was found to induce a specific depressive response. The effects were more pronounced in females than in males (Booij and colleagues, 2005). A vegan diet requires alternative sources of tryptophan (see Table 2-2).

Valine, along with the other branched-chain amino acids, is found in low amounts in the condition, liver cirrhosis. Valine appears important to maintaining the functions of dendritic cells of neurons, especially in patients with liver cirrhosis (Kakazu and colleagues, 2007).

Nutritionally dispensable or nonessential amino acids can be synthesized in the body. They still play critical roles in health and well-being.

Alanine is part of a liver enzyme known as alanine transaminase (ALT). In **gluconeogenesis** (the creation of glucose from protein breakdown), the carbon of alanine becomes available as a glucose source. Alanine is derived from the metabolism of the branched-chain amino acids (isoleucine, leucine, and valine) through the intermediary form of pyruvate. Alanine can also be produced from metabolism of glutamine, glutamic acid, and aspartic acid.

Arginine serves as a precursor for the amino acids proline and glutamate, along with other substances such as creatine, nitric oxide, and urea. Arginine is metabolized through a complex and highly regulated set of pathways that remain incompletely understood (Morris, 2007). Arginine has been used as a supplement for critically ill patients, but not without controversy. Along with glutamine, it appears to promote

immunity, although by different actions (Vermeulen and colleagues, 2007). One study found that low levels of arginine were found with increased indications of inflammation and during the acute phase of critical illness and trauma, but levels normalized during the recovery phase (van Waardenburg and colleagues, 2007).

Asparagine serves as a precursor related to the metabolism of energy. Due to this there has been some discussion that supplementation, along with a similar substance, aspartate, would be helpful with athletes. However, supplementation was not found to significantly affect physical performance with high-intensity exercise or to spare muscle glycogen (Parisi and colleagues, 2007). Asparagine is part of a placental hormone, human chorionic gonadotropin (see Chapter 11).

Aspartic acid is the amino acid that is combined with phenylalanine to develop the sweet taste found in the sugar substitute NutraSweet. It is also part of an enzyme, aspartate transaminase (AST) and can be metabolized into alanine.

Cysteine contains the element sulfur. Intake of this nonessential amino acid has been implicated in lowering the requirement for methionine (Ball, Courtney-Martin, and Pencharz, 2006). In a rat study, cysteine, along with methionine and vitamin C, was shown to reduce adverse effects on the lining of the stomach associated with chronic consumption of alcohol (Amanvermez and colleagues, 2008). One study found a relative increase of free homocystine as total cysteine concentrations fell below 170 µmol/L. Increased intake of cysteine may help treat homocystinuria, the buildup of homocystine in the urine (Lee and Briddon, 2007). However, caution is needed in supplementing the diet with the sulfur amino acids because they are well established as being toxic. Cysteine is more toxic than cystine when administered orally at a pharmacologic dose (Baker, 2006).

Cystine also contains sulfur and is metabolized from cysteine. Excess intake of cystine in conjunction with a low methionine intake has resulted in skin breakdown in animal studies (Strieker and colleagues, 2006). Genetic metabolic problems related to cystine result in accumulation in all tissues. This has been related to kidney damage. Some cancer cells are dependent on cystine for growth. Medication-induced deficiency of cystine/cysteine resulted in inhibition of prostate cancer (Doxsee and colleagues, 2007). On a positive note, cystine is involved in protection of nerve health through the intermediary production of glutathione, an important cellular antioxidant (Shih and colleagues, 2006).

Glutamic acid can be extensively metabolized into alanine through the intermediary of pyruvate; lesser amounts are metabolized into proline.

Glutamine can be formed from aspartate during times of glucose deprivation, allowing an alternate source of energy for neurons (Peng and colleagues, 2007). Glutamate and urinary ammonia are formed from plasma glutamine through enzymatic action. Glutamine can be metabolized into alanine and a smaller amount into proline.

Glycine, along with arginine, is metabolized into creatine, the commonly used substance of many athletes (see Chapter 13).

Proline can be synthesized into arginine and metabolized from glutamic acid and glutamine.

Serine deficiency can occur from defects in metabolism and leads to severe neurologic symptoms, including congenital microcephaly and psychomotor retardation (Furuya and colleagues, 2008).

Tyrosine is metabolized from the essential amino acid phenylalanine and is also an aromatic amino acid. It is part of an enzyme required for insulin to be used at the cell level, called tyrosine kinase. Other benefits include adaptation to cold temperatures with improved cognition noted (Mahoney and colleagues, 2007). This may be due to the role of tyrosine in maintaining adequate levels of special hormones called catecholamines (norepinephrine, epinephrine, and dopamine; see Chapter 4). The benefits of tyrosine under cold temperature conditions have also been related to improved psychomotor tasks such as with marksmanship (O'Brien and colleagues, 2007).

Peptides also play a role in health. Some of the common ones are discussed below:

Carnosine is a dipeptide found in skeletal muscles and therefore meat. It is produced from alanine and histidine. It possesses antioxidant properties and reduces inflammation. In a study of mice treated with carnosine there was reduced lung damage and inflammation. It has been suggested as possible treatment for fibrotic disorders of the lung in which oxidative stress plays a role (Cuzzocrea and colleagues, 2007). It also protects against radiation damage, and it promotes wound healing. Cancer patients receiving radiation therapy may benefit from carnosine (Guney and colleagues, 2006).

Homocysteine, a sulfur amino acid, is produced from the metabolism of methionine. Elevation of serum levels has been implicated in the development of heart disease (see Chapter 7) known as hyperhomocysteinemia. An increase of 5 μmol/L of plasma homocysteine levels increases the risk of heart disease up to an equivalent 20 mg/dL elevation of cholesterol levels (Hashimoto, Shinohara, and Hasegawa 2007).

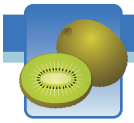
Taurine is another sulfur amino acid, being metabolized from methionine, and is one of the brain's most abundant amino acids. Persons following a vegan diet have been observed to have low plasma taurine levels. This is likely a result, in part, of low intake of methionine, which is found with animal protein sources.

Fetal Down syndrome has been linked with low levels of taurine, which is important for brain development (Whittle and colleagues, 2007). It is considered the most abundant free amino acid in breast milk. Taurine appears to help visual and hearing development of preterm and low-birth-weight infants. Current standard practice is to supplement formula milk and parenteral nutrition solutions with taurine (Verner, Craig, and McGuire, 2007).

Taurine appears to protect against oxidative stress (see Chapter 4), promotes a healthy nervous system, and protects against heart disease (Bouckenooghe, Remacle, and Reusens, 2006). Taurine deficiency, along with excess intake of dietary sodium, has been implicated in development of hypertension and loss of protein in the urine (Mozaffari and colleagues, 2006). Taurine is highly abundant in seafood and may be the link to reduced heart disease found among persons who consume fish. One study found a supplement containing both the omega-3 fatty acids and taurine was superior to omega-3 fats alone in protection against heart disease (Elvevoll and colleagues, 2008).

Taurine may further inhibit epilepsy through its role in the central nervous system (Li and colleagues, 2005). It has also been shown to reduce insulin resistance at the cellular level (Nandhini and colleagues, 2005) (see Chapter 5). There is

evidence to suggest taurine helps block the transfer of diabetes from diabetic mother to offspring (Kim and colleagues, 2007).



Cultural Considerations

Vegetarians are a diverse group. However, many individuals who practice vegan diets generally distrust Western medicine and may adhere to the advice of alternative health care providers. Although this may be a positive practice, the potential for harmful practices does exist. Great sensitivity in assessing food, herbal, and supplement practices can help ensure positive health behaviors are being followed. ■

Fact & Fallacy

FALLACY Phenylalanine, as found in the sugar substitute aspartame, is a poison.

FACT Phenylalanine is an essential amino acid needed in the formation of protein. Some persons are born with a metabolic defect in which excess phenylalanine can cause mental retardation (see Chapter 4). A routine test is performed at birth to determine whether infants have this metabolic disorder, called phenylketonuria (PKU). Such persons need to avoid excess phenylalanine throughout life. Cautions about aspartame (Equal, NutraSweet), which contains phenylalanine, are provided to help protect persons with PKU. Persons without PKU are generally not harmed by increased consumption of this essential amino acid. ■

RECOMMENDATIONS FOR PROTEIN INTAKE

Nitrogen balance is the current standard to set the goal of protein intake. It refers to a condition in which the nitrogen consumed in the form of proteins is equal to the nitrogen lost daily in the urine and other body secretions. At this point, intake is considered to be meeting the body's needs. The requirement is then increased to account for the mixed-protein diet (protein from a variety of foods). The Recommended Dietary Allowance (see Chapter 3) is 0.8 g of proteins for each kilogram of body weight. (Weight in kilograms is calculated by dividing weight in pounds by approximately 2.2.) This translates into 63 g of proteins for a man weighing 79 kg and 50 g for a woman weighing 63 kg.

Alternative approaches to estimating protein requirements suggest a more optimal goal ranging from at least 0.9 to 1.2 g/kg of body weight (Humayun and colleagues, 2007). Part of the debate on optimal protein intake has to do with digestibility of the food component and the amount of essential amino acids. A high protein intake that comes only from a plant-based diet may actually be insufficient if the minimum requirement for all essential amino acids is not met. This is referred to as the Protein Digestibility–Corrected Amino Acid Score method (see following section).

Kcalorie need may also be used to set protein goals based on percentage of intake. Protein intake should generally be about 10% to 15% of kcalorie intake, up to a maximum of 35%. (See the later section on converting grams of protein into percentages of total kcalories.) In regard to kcalories, adequate intake is essential in

Table 2-3 Daily Protein Needs Based on Age and Weight for a Typical Mixed Diet

AT BIRTH	6 MONTHS	≥18 YEARS	ELDERS
2.24 g/kgBW/day	1.5 g/kgBW/day	0.8 g/kgBW/day	1.0 g/kgBW/day

BW, Body weight.

meeting protein needs. Without sufficient kcalories, some protein is converted into glucose through the process of gluconeogenesis.

For infants, protein allowances are based on the amount of proteins provided by the quantity of milk required to ensure a satisfactory rate of growth. There is a greater need for protein, based on weight, during infancy than at later ages (Table 2-3). This is due to growth needs. The need from birth slowly declines until age 18, when need remains steady through midlife. During the adolescent growth spurt, increased intake of kcalories is needed to ensure proteins are used for growth needs. During pregnancy, an intake of at least 60 g of proteins is recommended daily. Some authorities advocate as much as 100 g in the pregnant woman's daily diet. The dietary protein allowance for a lactating woman is about the same as that for a pregnant woman. Older adults generally benefit from more protein, and this need is believed to be due to decline in liver function and overall reduced efficiency in digestion, absorption, and metabolism. The Dietary Reference Intake for protein may be found at the end of the textbook.

Need for protein may be further altered as a result of disease states. The protein requirement is increased for any condition in which body proteins are broken down or for increased needs with healing, such as with hemorrhages, burns, poor protein nutrition, previous surgery, wounds, and long convalescence. Athletes need a higher protein intake of 1.0 to 1.5 g/kg of body weight because of the stress on the body tissues of the increased physical activity.

Albumin is a measure of serum protein status. An albumin level less than 3.5 mg/dL is generally an indication of mild protein deficiency (see Chapter 15). This value does not always correctly reflect protein status. The albumin level may be high due to dehydration or low due to edema. Blood loss and inflammation will cause the value to be lower. For this reason prealbumin may better reflect protein requirements. Protein deficiency over a long period results in muscle loss, reduced resistance to disease, skin and blood changes, slow wound healing, and a condition known as nutritional edema.

QUANTITIES OF FOOD NEEDED TO MEET THE PROTEIN RECOMMENDATIONS

With a varied diet, including meat or other animal protein source, meeting the minimum requirements for the essential amino acids is an easy task. The minimum number of food servings in the MyPyramid provides at least 60 g of proteins, more than enough for most people.

- One serving of grains (½ cup or 1 oz weight) provides on average 2 g of proteins
- One serving of vegetables (1 cup raw or ½ cup cooked) provides 2 g of proteins
- 1 cup of milk or equivalent provides 8 g of proteins

Table 2-4 PDCAAS Scores of Common Foods (Maximum Score 1.0 Means Optimal Complete Protein Availability)

Milk and egg white	1.0
Soy	0.9-1.0 (based on form)
Other legumes	0.52-0.68
Whole wheat	0.54

PDCAAS, Protein Digestibility–Corrected Amino Acid Score.

- 1 oz (¼ cup) of meat, cheese, or nuts provides about 7 g of proteins. One egg (¼-cup volume) or ½ cup of beans also equates to 1 oz of meat. Three ounces of meat is the size of a deck of cards or the size of an average palm of the hand.

PROBLEMS ASSOCIATED WITH INADEQUATE PROTEIN INTAKE

The term **kwashiorkor** refers to a condition in which the individual may have an adequate caloric intake but lacks adequate dietary proteins. However, protein deficiency is frequently associated with a deficiency in calories as well. When the diet is low in calories, proteins are used as a source of energy, leaving little of this nutrient to build and repair tissues and maintain immune function. Such a condition is termed **protein-energy malnutrition** (also called **marasmus**) and is prevalent in most developing countries. (See Chapter 12 for its impact on growth.) This condition often occurs during physiologic stress in hospitalized patients (see Chapter 15).

The advent of nutritional supplements has led to a newer method of determining protein content (Table 2-4; see Chapter 15). **Protein Digestibility–Corrected Amino Acid Score (PDCAAS)** is a scoring method with the highest number being 1, based on the contents and availability of all essential amino acids within a food or a commercial protein or nutritional supplement. This system is based on the recognition that the one essential amino acid that is most deficient in a given food limits the body's ability to produce the many proteins required for life processes regardless of total grams of protein that are consumed. PDCAAS has not been applied to a total diet.

WHAT ARE FATS AND CHOLESTEROL AND THEIR FUNCTION AND RECOMMENDATIONS?

Fats are similar to carbohydrates and proteins in that they contain carbon, hydrogen, and oxygen. Fats are higher in kcalories than carbohydrates and proteins due to having more carbon in their structure. Cholesterol is a *fatlike* substance but is not used as a kcalorie source.

Fats are described by the number of carbon units in the chain, followed by the number of double bonds; the more double bonds, the less hydrogen within the molecule of fat. For example, oleic acid (C18:1) has 18 carbons in each chain with one double bond, meaning one less hydrogen molecule in its composition. Oleic acid is a monounsaturated fat. A saturated fat, palmitic acid (C16:0) has 16 carbons and no double bonds, making it a saturated fat. Erucic acid (C22:1) is found in the oil of

Table 2-5 Fatty Acids and Their Common Food Sources

FATTY ACIDS	COMMON FOOD SOURCES
Saturated	
Lauric	Coconut, palm kernel oil
Myristic	Coconut
Palmitic	Palm oil, beef
Stearic	Cocoa butter, beef
Monounsaturated Fatty Acid	
Oleic	Olive oil, rapeseed (canola) oil, beef
Polyunsaturated Fatty Acids	
Linoleic	Corn oil, cottonseed oil, safflower oil, sunflower oil
Linolenic	Green leafy vegetables, soybean oil, soybean products (tofu), canola oil, flaxseed
Eicosapentaenoic	Mackerel, sardines, lake trout
Docosahexaenoic	Salmon, tuna, bluefish, halibut

mustard and is another monounsaturated fat, as can be determined by its having one double bond. Polyunsaturated fats contain multiple double bonds. Another descriptor that is used has to do with where the double bond is found in the carbon chain. For example, gamma-linolenic acid (18:3n-6) is an 18-carbon chain with three double bonds; the first double bond is at the sixth carbon along a section of the fat molecule. This is referred to as an omega-6 fat.

Fats that have a liquid consistency at room temperature are usually called oils. Oils are composed predominantly of the unsaturated fatty acids; the solid fats are the saturated forms. Saturated fats (e.g., stearic and butyric fatty acids) are typically found in products containing animal fats, such as milk, butter, and red meat. Tropical fat sources, such as palm and coconut oils and Brazil nuts, are also high in saturated fat (Table 2-5).

The most unsaturated form of fats is simply called omega-3 fatty acid. The specific names of omega-3 fatty acids are **eicosapentaenoic acid (EPA)** and **docosahexaenoic acid (DHA).** Fish from cold-water regions are high in this kind of highly unsaturated fat. Polyunsaturated fats will stay in liquid form at cold temperatures, monounsaturated fats will become viscous, and saturated fats will become so hard that you have to cut them (Figure 2-4).

Teaching Pearl

A tip for explaining saturated fats and hydrogen content is to say, "Hydrogen is found in water. When clothes are hanging on the clothesline and soaking wet, we could say they are saturated with water (or hydrogen). The more hydrogen in fat, the more saturated it is." ■

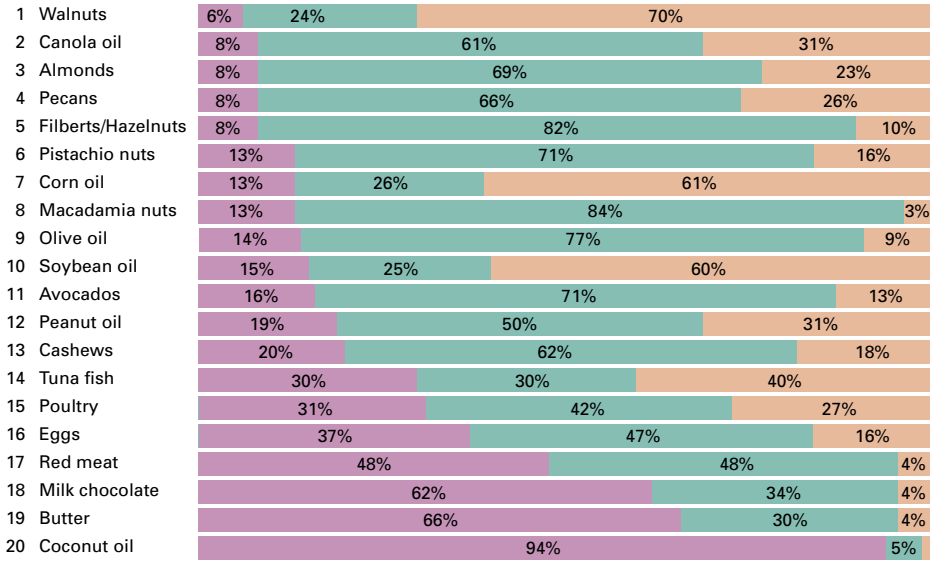


FIGURE 2-4 Degree of saturation in common foods (in percentages). Percentages are based on the total amount of saturated, monounsaturated, and polyunsaturated fats. *Purple*, saturated fat; *green*, monounsaturated fat; *orange*, polyunsaturated fat. (Reference for fat content modified from U.S. Department of Agriculture, Agricultural Research Service: USDA National Nutrient Database for Standard Reference, release 18, 2007.)

FUNCTIONS OF DIETARY FATS

The primary function of fats is to serve as a concentrated source of heat and energy. Body cells, with the exception of the cells of the nervous system and erythrocytes, can use fatty acids directly as a source of energy. In addition, fats perform the following functions:

- Furnishing **essential fatty acids** (see Table 2-5)
- Sparing burning of protein for energy
- Adding flavor and palatability to the diet
- Giving **satiety** value to the diet (fat slows the digestive process up to 4 hours and thereby promotes satisfaction or satiation)
- Promoting absorption of fat-soluble vitamins
- Providing a structural component of cell membranes, digestive secretions, and hormones
- In the form of body fat, insulating and controlling body temperature; protecting body organs

Animal fats and fortified margarines not only contain some of the fat-soluble vitamins (A, D, E, and K), but also aid in their absorption. They also play a role in the absorption of fatty acids. Excess fat stored in the body as adipose tissue insulates and protects organs and nerves. Fats also lubricate the intestinal tract. Fatlike substances that have important roles in the body include **phospholipids** (fat plus the mineral phosphorus is the basis of cell membrane structure) and **sterols** (**ergosterol** in plants and **cholesterol** in animal fat).

Monounsaturated fats are favored over both saturated and polyunsaturated fats for a variety of reasons that will be discussed throughout the textbook. Table 2-5 shows

FIGURE 2-5 General amounts of saturated fats, monounsaturated fats, and polyunsaturated fats can be determined by appearance when fats are chilled. Note that solids are on the bottom of avocado and olive oils.

how food fats break down in saturated, monounsaturated, and polyunsaturated fat percentages; note that you can visually determine this based on degree of solidity versus liquidity after a food fat has been exposed to cold temperatures (Figure 2-5).

FUNCTIONS AND SOURCES OF ESSENTIAL FATTY ACIDS

Essential fatty acids have multiple purposes, including maintenance of the functioning and integrity of cellular membranes, cellular membrane fluidity, and enzyme activities, and they serve as carriers and membrane receptors. They further affect cholesterol metabolism and act as the precursor of a group of hormonelike compounds called **eicosanoids**. **Prostaglandin** is an example of an eicosanoid that has been shown to stimulate muscle and uterine contractions and is involved in control of inflammation.

Essential fatty acids are necessary for the nutritional well-being of all animals and must be supplied in the diet. The two principal essential fatty acids for humans are **linoleic acid**, an omega-6 fatty acid (see section below), and **alpha-linolenic acid (ALA)**, which is a plant form of **omega-3 fatty acid**. **Arachidonic acid** is an essential fatty acid, but the body can usually produce it if adequate linoleic acid is consumed.

Omega-6 (or n-6) fatty acids are found in vegetable and seed oils and are forms of polyunsaturated fatty acids (PUFAs). The omega-3 fatty acids are a form of polyunsaturated fat, sometimes called a highly unsaturated fatty acid. Omega-3 (or n-3) fatty acids are found in fatty fish, and the ALA form is found in walnuts, flaxseed, canola oil, and soybean oil. Flaxseed is one of the richest known sources of ALA and is a good source of soluble fiber. Flaxseed can help reduce serum cholesterol levels (see Chapter 7) and normalize meal-related glucose levels. One study indicated this was due to other attributes beyond fatty acid content (W Zhang and colleagues, 2007).

At least among adults with diabetes, dietary intake of linolenic acid appears to lower the risk of peripheral neuropathy (Tao and colleagues, 2008). A balanced intake of both n-6 and n-3 PUFAs is essential for good health.

SOURCES OF FATS AND CHOLESTEROL

Fats are found in many foods containing proteins and are added through cooking or flavoring foods. The amount of fats found in grains, vegetables, and most fruits is generally insignificant. The exceptions are coconuts, avocados, and olives. Fats extracted from vegetable sources (such as corn, safflowers, soybeans, and olives) are usually found in liquid form and generally are not harmful to health unless they are hydrogenated (i.e., hydrogen has been added to liquid oils in order to make solid fats—also called **trans fatty acids** or **trans fats**). Fats that are solid (naturally found mostly in animal products such as butter and red meat) are referred to as **saturated fats**.

Lipids include all types of fats and fat-related compounds. Cholesterol is a fat-related compound that is not a kcalorie source. Cholesterol is found only in animal fats because it is made in the liver of animals. Fats from plant sources do not contain cholesterol. It is important to note that mineral oil is not considered a food fat because it cannot be digested and used by the body. If used as a laxative, it should never be taken near mealtime because it can negatively affect fat-soluble vitamin absorption.

Fact & Fallacy

FALLACY Castor oil should be used as a laxative.

FACT Castor oil can cause malabsorption of important nutrients and should not be used as a laxative. Topically, it has been found to be toxic to the conjunctival cells of the eye, causing cell death (Said and colleagues, 2007). ■

Teaching Pearl

The fats in cold-water fish are mainly of the most unsaturated form, called omega-3 fatty acids, and do not solidify in the cold arctic waters. Imagine what would happen to these fish if their body fat consisted of saturated fat—they would solidify and sink. Therefore fish from cold arctic waters have to be high in omega-3 fatty acids to survive. ■

TRANS FATS

The difference in degree of saturation relates to the amount of hydrogen in the fat molecule. Hydrogen atoms can be added to unsaturated liquid oils to make them more solid. When hydrogen is added, the oil becomes a spread, or margarine. Such fats are called **hydrogenated** fats. This form of fat contains trans fatty acid, which is related to the chemical structure of the fat, with hydrogen found on both sides of the double bond of the carbon chain. Trans fatty acids are harder, like saturated fats, and have been linked with heart disease and adverse effects on other conditions related to the metabolic syndrome (see Chapter 5), including inflammation, body weight, insulin resistance, and cancer (Gebauer, Psota, and Kris-Etherton, 2007).

Trans fatty acids were added to food labels in 2006 (see Figure 1-4). Solid stick margarines have the most hydrogen added, with tub margarines having less and liquid margarines having the least.

Fact & Fallacy

FALLACY Trans fat–free foods are never hydrogenated.

FACT Foods that have not been hydrogenated essentially have no trans fats. This includes all unprocessed foods such as fruits and vegetables and natural vegetable oils. Hydrogenated food products that are labeled as having no trans fats either have too little to measure in the stated portion or are made in such a way that the hydrogen is found on only one side of the carbon chain. Thus it is possible to have a product that was hydrogenated but has nearly zero trans fats. Although this is currently presumed to be safe, time will tell if hydrogenated fats that are trans fat free are free of health hazards. ■

Both fats and oils are composed principally of triglycerides and various fatty acids in various proportions. These differences contribute to flavor and other properties of food and have health implications. Triglycerides consist of a base of **glycerol** (a form of carbohydrate) with three fatty acids and are the main type of fat circulating in the bloodstream. **Diglycerides** have two fatty acids, whereas **monoglycerides** have one fatty acid attached to the glycerol base.

Fats are insoluble in water. Glycerol is a small, water-soluble carbohydrate. The addition of glycerol to fatty acids allows the transport of fats through the water-based bloodstream. This contributes insignificant amounts of carbohydrate to the diet.

Fact & Fallacy

FALLACY It is better to use butter because we now know margarine also contributes to heart disease.

FACT Although margarine is hydrogenated and contains trans fatty acids, which promote cardiovascular disease, butter is no better. Butter contains both saturated fat and cholesterol, increasing the risk of heart disease. Liquid margarines contain insignificant amounts of hydrogen when compared with the harder margarines and therefore contain less trans fatty acids. We might adopt the practice of Italian cuisine, in which bread is dipped in olive oil rather than butter or margarine, thereby avoiding saturated and hydrogenated fats. Traditional Italian restaurants offer olive oil on the table for use with dipping bread, often with the addition of seasonings such as basil, garlic, red pepper flakes, and/or balsamic vinegar. ■

THE ROLE OF UNSATURATED FATS IN DISEASE STATES

The chief active components of olive oil include oleic acid, a monounsaturated fat, antioxidant factors, and substances that have anticancer and antibacterial components. Olive oil, and presumably olives (in moderate amounts to account for the salt content of olives), is associated with lowered blood pressure and LDL cholesterol

(see Chapter 7) and reduced risk of colon and breast cancer (Waterman and Lockwood, 2007).

Nerve function is influenced by the type of fats, or lipids, in cell membranes. The neuronal portion of the brain has a high level of unsaturated essential fatty acids. An optimal balance of omega-3 to omega-6 fatty acids is necessary for optimal neurodevelopment and cognitive function. Reduced levels of omega-3 fatty acids in the membranes of red blood cells have been noted in persons with central nervous system and mental disorders (Assisi and colleagues, 2006). DHA may be more effective than EPA in alleviating inflammatory processes (Weldon and colleagues, 2007).

Vegetarians may elect to include flaxseed as an alternative form of omega-3; however, the form it is in, ALA, requires conversion in the body to EPA. This is inefficient, and there is very limited production of DHA from ALA sources. The marine form of EPA/DHA is produced from the fish consuming algae. Clinical trials with DHA-rich microalgae oil indicate comparable effects in lowering plasma triglycerides (see Chapter 7) and oxidative stress (see Chapter 4) (Doughman, Krupanidhi, and Sanjeevi, 2007). The phytoestrogen content of flaxseed is similar to that of sesame. One study found that sesame intake benefits blood lipids, antioxidant status, and possibly sex hormone status among postmenopausal women (Wu and colleagues, 2006).

Arachidonic acid is converted into eicosanoids, which regulate nerve function and inflammatory responses. Schizophrenia has been linked with environmental causes, such as low arachidonic acid intake. There is evidence of a link between poor folate (a B vitamin—see Chapter 3) status in utero, lack of arachidonic acid as found in meat, and omega-3 fatty acids found in fatty fish with neural tube defects (related to deficiency of folate) and schizophrenia during historical episodes of famine. Five out of six randomized controlled trials with eicosapentaenoic acid (fish) have shown positive effects in schizophrenia, and four out of six showed favorable results in depression and **bipolar disorder,** formerly known as manic-depression (Muskiet and Kemperman, 2006). There is evidence to suggest that omega-3 PUFAs reduce symptoms of depression (Ross, Seguin, and Sieswerda, 2007). However, other research suggests the use of omega-3 PUFAs, at least in supplement form, for treatment of schizophrenia still remains experimental (Joy, Mumby-Croft, and Joy, 2006).

DHA is essential to brain development, whereas EPA seems more influential on behavior and mood. Both help to maintain neurologic health. DHA and EPA combinations have been shown to benefit cognition and a variety of learning disabilities (Kidd, 2007).

Cardioprotective benefits have been observed with daily consumption of as little as 1 to 2 oz average daily intake of fatty fish with long-chain fatty acids (greater than or equal to 20 carbon units). Greater intakes further decrease risk of cardiovascular disease in a dose-dependent manner, up to about five servings per week (Psota, Gebauer, and Kris-Etherton, 2006).

A dietary recommendation of approximately 500 mg/day of EPA and DHA (6 oz fatty fish per week) for cardiovascular disease risk reduction is advised. For treatment of existing cardiovascular disease, 1 g/day is recommended. Foods enriched with EPA and DHA or fish oil supplements are a suitable alternative to achieve recommended intakes and may be necessary to achieve intakes of 1 g per day (Gebauer and colleagues, 2006).

FUNCTIONS OF CHOLESTEROL

Cholesterol has an essential role in the structure of adrenal and sex hormones and in increasing the body's production of vitamin D through the exposure of the skin to ultraviolet light. It is made and stored in the liver and also occurs in the form of a lipoprotein (lipid combined with protein) in the blood. There is growing evidence that cholesterol in food is not as harmful to health as was once believed (see Chapter 7).

RECOMMENDATIONS FOR INTAKE OF FATS AND CHOLESTEROL

There are no specific requirements for fats other than the body's need for the essential fatty acids, which is usually met through a diet that contains appropriate food fats. A minimum of 20 g of fat in the diet can meet the body's need for essential fatty acids if the appropriate fats are consumed. An intake of 30 g of fat is more likely to ensure adequate intake of the essential fatty acids. Intake of polyunsaturated and saturated fats should each not exceed 10% of kcalories. The balance of fats should come from monounsaturated fats, with many advocates recommending that these fats should account for up to 20% of kcalories. Most authorities recommend a maximum of 30% of total caloric intake from fats, with equal distribution of polyunsaturated, monounsaturated, and saturated fats. Some individuals may benefit from a higher fat intake—up to 35%—as long as monounsaturated or omega-3 fatty acids predominate (see Chapters 5 and 7). The upper limit of 300 mg of cholesterol per day is recommended on food labels with the percent Daily Values. A diet low in both saturated fatty acids and trans fatty acids should be promoted.

Teaching Pearl

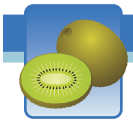
You might explain that peanuts are cholesterol free because they grow in the ground. You can add to this by saying that cholesterol is found only in animal fats because of the production by the liver. Most nuts can be safely eaten when a higher intake of monounsaturated fat is acceptable. Nuts that contain mainly monounsaturated fats are grown in the temperate climate zones. The tropical Brazil nut contains relatively high amounts of saturated fat, whereas the nut of the coldest climate regions (the walnut) contains mainly polyunsaturated fat (see Figure 2-4. All other nuts are primarily monounsaturated fats, including peanuts (a legume). ■

QUANTITIES OF FOOD NEEDED TO MEET THE FAT RECOMMENDATIONS

The fat content of the recommended servings in the MyPyramid ranges from a low of about 20 g (if the minimum number of food servings is consumed using fat-free milk, lean meat, and unprocessed grain products) to 80 g if whole milk and high-fat meats are used. It is not unusual for Americans to consume 100 to 150 g of fat per day.

There are 5 g of fat in each teaspoon of added fat or oils. On average there are 5 g for every ounce of red meat (but only 1 to 2 g for white meat, fish, and legumes; see Appendix 3 on the Evolve website). Steak contains 8 g of fat per ounce (which is why it is so tender and juicy), whereas stew beef has only 3 g per ounce (which is why you have to cook it in liquid for a long time to tenderize the meat). Therefore a person eating a pound of white-meat chicken (without the skin) will consume only 16 g of fat (with about 5 g of saturated fat—about 30% of the total fats—see Figure

2-4), whereas someone eating the same amount of steak will consume 128 g of fat—literally ½ cup of lard (and 64 g of saturated fat—3 days' worth—or about half of the total fats). A food containing 3 g or less of fat per serving is considered a low-fat food. This includes grains that do not have significant amounts of fats added, such as sliced bread used to make sandwiches, pasta, vegetables, most cereals, and most fruits (except coconuts, avocados, and olives, which do contain high amounts of fat). Also low in fat is low-fat (1%) milk because it contains less than 3 g of fat per cup.



Cultural Considerations

Paczki, pronounced *punch key*, is a traditional Polish treat consumed before the advent of Lent. There is a high fat and sugar content in these grain-based delicacies, which are fried and filled with a variety of fruit or other sweet fillings. This custom has spread to other cultures, where the pastry is available in traditional Polish enclaves. ■

HOW ARE PERCENTAGES OF THE MACRONUTRIENTS IN THE DIET CALCULATED?

The percentage of kcalories from proteins in relationship to the total dietary intake is calculated by first multiplying the number of grams of protein in the diet by 4 (to find the number of kcalories), then dividing that number by the total caloric intake from all foods consumed in 1 day. For example, the percentage of kcalories from protein in a 2000-kcal diet containing both animal and vegetable sources of proteins in the form of 3 cups of milk (24 g of protein), six slices of bread (12 g of protein), three vegetables (6 g of protein), and 4 oz of meat (28 g of protein) for a total of 70 g of protein would be calculated as follows:

$$70 \quad 4 = 280 \text{ kcal}$$

$$280 \text{ kcal} \quad 2000 \text{ kcal} = 0.14 \quad 100 = 14\% \text{ protein}$$

The same calculation can be used to find the carbohydrate percentage (excluding fiber content, because fiber is not digestible and therefore provides no significant amount of kcalories). For calculating the fat percentage, the number of fat grams should be multiplied by 9 because fats yield 9 kcal/g.

WHAT IS THE ROLE OF THE NURSE OR OTHER HEALTH CARE PROFESSIONAL IN EDUCATING THE PUBLIC ABOUT INTAKE OF CARBOHYDRATES, PROTEINS, AND FATS?

The goal of a nurse or other health care professional should be to educate about the positive role of carbohydrates, proteins, and fats and to promote appropriate intake of different types of foods, as based on the MyPyramid. The health care professional should use good interviewing skills (see Figure 1-6) in determining a person's current dietary habits and the reasons such practices are being followed (for example, adherence to physician advice, which may have been given years ago; dental problems; or health beliefs). Some individuals may be receptive to dietary change when given a reason, whereas others may resist strongly. The nurse or other health care provider should never argue or give the impression of arguing, but rather should indicate respect for a person's food choices and health beliefs when introducing new ideas about healthy diets.

Promoting consumption of a variety of high-fiber plant-based foods sources (with adequate fluids), along with protein foods and essential fatty acids, is an appropriate role for the health care professional. The health care professional can help reeducate the public about how much protein in the daily diet the body really needs. The amount of protein we consume can generally be safely decreased, but an assessment of an individual's usual dietary intake should be made before automatically recommending a reduced amount. In the past the emphasis in meal planning was to have meat as the main part of the meal, with side dishes such as starchy foods and vegetables. It is now recommended that we view meat as the side dish and emphasize high-fiber plant-based foods (whole grains, legumes, vegetables, and fruits).

Many individuals are now aware that controlling the macronutrient content of the diet plays a key role in the prevention and management of a variety of chronic diseases and health conditions. However, health care professionals can help the public recognize that some fats are healthy and that too little fat intake can have adverse health implications. The same applies to carbohydrate sources. Beyond this awareness, individuals need to learn what foods are low in saturated fats and high in fiber; these foods should be promoted in a way that makes them practical and appealing to consume. Alternatives to meat, such as legumes, can be promoted simply by indicating verbally that they can be a delicious part of a meal (as bean burritos or baked beans, for example).

Chapter Challenge Questions & Classroom Activities

1. What are the three different kinds of carbohydrates?
2. What is the difference between soluble and insoluble fibers? Provide examples of foods with the two types of fibers.
3. Write a healthy day's menu that provides 20 to 30 g of fiber.
4. How do proteins differ from carbohydrates and fats?
5. What does the term *high–biologic value protein* mean? What are sources?
6. What is the problem with inadequate intake of proteins?
7. Describe the texture of saturated versus unsaturated fats.
8. If a food label states that one bagel contains 60 g of carbohydrate, how many servings of grain would the bagel contain?
9. *Class activity.* Show food models of portions equating to 15 g of carbohydrates, 1 oz and 3 oz of meat, the number of teaspoons of fat found in lean versus high-fat meats, and whole versus low-fat milk.
10. Using the chart in Box 2-3, calculate the total carbohydrates, proteins, fats, and kcalories for the minimum number of servings of the MyPyramid.

Case Study

Anna had stopped counting the "points" of her meals because she had met her goal weight. She was trying instead to simply watch her carbohydrates to maintain her weight loss. This was, in part, to support her daughter, who was using food labels for total carbohydrates in meals. As a family they decided not to worry as much about fats because the children needed the kcalories,

but they emphasized the "healthy fats." Her grandmother liked that idea because she had always used olive oil generously in her cooking. It was also helpful for Patrick, even though he didn't have diabetes like his daughter.

Critical Thinking Applications

1. How much fat is appropriate for a 2000-kcal diet (refer back to Chapter 1), and how does this equate to food amounts? Give examples referring to Box 2-3.
2. What does *total carbohydrates* on food labels mean?
3. What are the two primary sources (not examples) of carbohydrates?
4. What are some other healthy fats besides olive oil?
5. What are some lean meats that can easily be included within a low–saturated fat diet?
6. How can meals be planned to provide the greatest level of satiety?

Box 2-3 Chart for Determining Meal Calculations of the Macronutrients (See Appendix 3 on the Evolve website)

FOOD GROUP	NO. SERVINGS	CHO (g)	PRO (g)	FAT (g)	BREAKFAST	AM SNACK	LUNCH	PM SNACK	DINNER	BEDTIME SNACK
Grains										
Fruits										
Milk										
Vegetables										
Meat										
Fats										
Sugar										
Total grams										
Total kcal										
% kcal										

CHO, Carbohydrates; *PRO*, protein.

REFERENCES

Amanvermez R, Tunçel OK, Demir S, Kefeli M, Bek Y, Celik C: Protective effects of cysteine, methionine and vitamin C on the stomach in chronically alcohol treated rats, *J Appl Toxicol* 28(5):591-598, 2008.

Assisi A, Banzi R, Buonocore C, Capasso F, Di Muzio V, Michelacci F, Renzo D, Tafuri G, Trotta F, Vitocolonna M, Garattini S: Fish oil and mental health: the role of n-3 long-chain polyunsaturated fatty acids in cognitive development and neurological disorders, *Int Clin Psychopharmacol* 21(6):319-336, 2006.

Baker DH: Comparative species utilization and toxicity of sulfur amino acids, *J Nutr* 136(6 Suppl):1670S-1675S, 2006.

Ball RO, Courtney-Martin G, Pencharz PB: The in vivo sparing of methionine by cysteine in sulfur amino acid requirements in animal models and adult humans, *J Nutr* 136(Suppl 6):1682S-1693S, 2006.

Booij L, van der Does AJ, Haffmans PM, Spinhoven P, McNally RJ: Acute tryptophan depletion as a model of depressive relapse: behavioural\specificity and ethical considerations, *Br J Psychiatry* 187:148-154, 2005.

Bouckenooghe T, Remacle C, Reusens B: Is taurine a functional nutrient? *Curr Opin Clin Nutr Metab Care* 9(6):728-733, 2006.

Brighenti F, Benini L, Del Rio D, Casiraghi C, Pellegrini N, Scazzina F, Jenkins DJ, Vantini I: Colonic fermentation of indigestible carbohydrates contributes to the second-meal effect, *Am J Clin Nutr* 83(4):817-822, 2006.

Couce Pico ML, Castiñeiras Ramos DE, Bóveda Fontán MD, Iglesias Rodríguez AJ, Cocho de Juan JA, Fraga Bermúdez JM: Advances in the diagnosis and treatment of maple syrup urine disease: experience in Galicia (Spain), *J Inherit Metab Dis* 29(4):532-537, 2006.

Cuzzocrea S, Genovese T, Failla M, Vecchio G, Fruciano M, Mazzon E, Di Paola R, Muià C, La Rosa C, Crimi N, Rizzarelli E, Vancheri C: Protective effect of orally administered carnosine on bleomycin-induced lung injury, *Am J Physiol Lung Cell Mol Physiol* 292(5):L1095-L1104, 2007.

Doi M, Yamaoka I, Nakayama M, Sugahara K, Yoshizawa F: Hypoglycemic effect of isoleucine involves increased muscle glucose uptake and whole body glucose oxidation and decreased hepatic gluconeogenesis, *Am J Physiol Endocrinol Metab* 292(6):E1683-E1693, 2007.

Doughman SD, Krupanidhi S, Sanjeevi CB: Omega-3 fatty acids for nutrition and medicine: considering microalgae oil as a vegetarian source of EPA and DHA, *Curr Diabetes Rev* 3(3):198-203, 2007.

Doxsee DW, Gout PW, Kurita T, Lo M, Buckley AR, Wang Y, Xue H, Karp CM, Cutz JC, Cunha GR, Wang YZ: Sulfasalazine-induced cystine starvation: potential use for prostate cancer, *Prostate* 67(2):162-171, 2007.

Elia M, Cummings JH: Physiological aspects of energy metabolism and gastrointestinal effects of carbohydrates, *Eur J Clin Nutr* 61(Suppl 1):S40-S74, 2007.

Elvevoll EO, Eilertsen KE, Brox J, Dragnes BT, Falkenberg P, Olsen JO, Kirkhus B, Lamglait A, Osterud B: Seafood diets: hypolipidemic and antiatherogenic effects of taurine and n-3 fatty acids, *Atherosclerosis* 200(2):396-402, 2008.

Englyst KN, Englyst HN: Carbohydrate bioavailability, *Br J Nutr* 94(1):1-11, 2005.

Englyst KN, Liu S, Englyst HN: Nutritional characterization and measurement of dietary carbohydrates, *Eur J Clin Nutr* 61(Suppl 1):S19-S39, 2007.

Furuya S, Yoshida K, Kawakami Y, Yang JH, Sayano T, Azuma N, Tanaka H, Kuhara S, Hirabayashi Y: Inactivation of the 3-phosphoglycerate dehydrogenase gene in mice: changes in gene expression and associated regulatory networks resulting from serine deficiency, *Funct Integr Genomics* 8(3):235-249, 2008.

Gebauer SK, Psota TL, Harris WS, Kris-Etherton PM: n-3 Fatty acid dietary recommendations and food sources to achieve essentiality and cardiovascular benefits, *Am J Clin Nutr* 83(Suppl 6):1526S-1535S, 2006.

Gebauer SK, Psota TL, Kris-Etherton PM: The diversity of health effects of individual trans fatty acid isomers, *Lipids* 42(9):787-799, 2007.

Granfeldt Y, Wu X, Björck I: Determination of glycaemic index: some methodological aspects related to the analysis of carbohydrate load and characteristics of the previous evening meal, *Eur J Clin Nutr* 60(1):104-112, 2006.

Guney Y, Turkcu UO, Hicsonmez A, Andrieu MN, Guney HZ, Bilgihan A, Kurtman C: Carnosine may reduce lung injury caused by radiation therapy, *Med Hypotheses* 66(5):957-959, 2006.

Hashimoto T, Shinohara Y, Hasegawa H: [Homocysteine metabolism], *Yakugaku Zasshi* 127(10):1579-1592, 2007.

Hsu JW, Goonewardene LA, Rafii M, Ball RO, Pencharz PB: Aromatic amino acid requirements in healthy men measured by indicator amino acid oxidation, *Am J Clin Nutr* 83(1):82-88, 2006.

Humayun MA, Elango R, Ball RO, Pencharz PB: Reevaluation of the protein requirement in young men with the indicator amino acid oxidation technique, *Am J Clin Nutr* 86(4):995-1002, 2007.

Joy CB, Mumby-Croft R, Joy LA: Polyunsaturated fatty acid supplementation for schizophrenia, *Cochrane Database Syst Rev* 3:CD001257, 2006.

Kakazu E, Kanno N, Ueno Y, Shimosegawa T: Extracellular branched-chain amino acids, especially valine, regulate maturation and function of monocyte-derived dendritic cells, *J Immunol* 179(10):7137-7146, 2007.

Kidd PM: Omega-3 DHA and EPA for cognition, behavior, and mood: clinical findings and structural-functional synergies with cell membrane phospholipids, *Altern Med Rev* 12(3):207-227, 2007.

Kim SJ, Ramesh C, Gupta H, Lee W: Taurine-diabetes interaction: from involvement to protection, *J Biol Regul Homeost Agents* 21(3-4):63-77, 2007.

Krajcovicova-Kudlackova M, Babinska K, Valachovicova M: Health benefits and risks of plant proteins, *Bratisl Lek Listy* 106(6-7):231-234, 2005.

Lee PJ, Briddon A: A rationale for cystine supplementation in severe homocystinuria, *J Inherit Metab Dis* 30(1):35-38, 2007.

Li Q, Guo JC, Jin HB, Cheng JS, Yang R: Involvement of taurine in penicillin-induced epilepsy and anti-convulsion of acupuncture: a preliminary report, *Acupunct Electrother Res* 30(1-2):1-14, 2005.

Livesey G, Taylor R, Hulshof T, Howlett J: Glycemic response and health a systematic review and meta-analysis: the database, study characteristics, and macronutrient intakes, *Am J Clin Nutr* 87(1):223S-236S, 2008.

Mahoney CR, Castellani J, Kramer FM, Young A, Lieberman HR: Tyrosine supplementation mitigates working memory decrements during cold exposure, *Physiol Behav* 92(4):575-582, 2007.

Morris SM Jr: Arginine metabolism: boundaries of our knowledge, *J Nutr* 137(6 Suppl 2):1602S-1609S, 2007.

Mozaffari MS, Patel C, Abdelsayed R, Schaffer SW: Accelerated NaCl-induced hypertension in taurine-deficient rat: role of renal function, *Kidney Int* 70(2):329-337, 2006.

Muskiet FA, Kemperman RF: Folate and long-chain polyunsaturated fatty acids in psychiatric disease, *J Nutr Biochem* 17(11):717-727, 2006.

Nandhini AT, Thirunavukkarasu V, Ravichandran MK, Anuradha CV: Effect of taurine on biomarkers of oxidative stress in tissues of fructose-fed insulin-resistant rats, *Singapore Med J* 46(2):82-87, 2005.

O'Brien C, Mahoney C, Tharion WJ, Sils IV, Castellani JW: Dietary tyrosine benefits cognitive and psychomotor performance during body cooling, *Physiol Behav* 90(2-3): 301-307, 2007.

Parisi A, Quaranta F, Masala D, Fagnani F, Di Salvo V, Casasco M, Pigozzi F: Do aspartate and asparagine acute supplementation influence the onset of fatigue in intense exercise? *J Sports Med Phys Fitness* 47(4):422-426, 2007.

Peng L, Gu L, Zhang H, Huang X, Hertz E, Hertz L: Glutamine as an energy substrate in cultured neurons during glucose deprivation, *J Neurosci Res* 85(15):3480-3486, 2007.

Psota TL, Gebauer SK, Kris-Etherton P: Dietary omega-3 fatty acid intake and cardiovascular risk, *Am J Cardiol* 98(4A):3i-18i, 2006.

Riccardi G, Rivellese AA, Giacco R: Role of glycemic index and glycemic load in the healthy state, in prediabetes, and in diabetes, *Am J Clin Nutr* 87(1):269S-274S, 2008.

Ross BM, Seguin J, Sieswerda LE: Omega-3 fatty acids as treatments for mental illness: which disorder and which fatty acid? *Lipids Health Dis* 6:21, 2007.

Said T, Dutot M, Christon R, Beaudeux JL, Martin C, Warnet JM, Rat P: Benefits and side effects of different vegetable oil vectors on apoptosis, oxidative stress, and P2X7 cell death receptor activation, *Invest Ophthalmol Vis Sci* 48(11):5000-5006, 2007.

Shih AY, Erb H, Sun X, Toda S, Kalivas PW, Murphy TH: Cystine/glutamate exchange modulates glutathione supply for neuroprotection from oxidative stress and cell proliferation, *J Neurosci* 26(41):10514-10523, 2006.

Strauss KA, Mazariegos GV, Sindhi R, Squires R, Finegold DN, Vockley G, Robinson DL, Hendrickson C, Virji M, Cropcho L, Puffenberger EG, McGhee W, Seward LM, Morton DH: Elective liver transplantation for the treatment of classical maple syrup urine disease, *Am J Transplant* 6(3):557-564, 2006.

Strieker MJ, Werner A, Morris JG, Rogers QR: Excess dietary cystine intensifies the adverse effect of a methionine deficiency in the cat, *J Anim Physiol Anim Nutr* 90(11-12):440-445, 2006.

Tao M, McDowell MA, Saydah SH, Eberhardt MS: Relationship of polyunsaturated fatty acid intake to peripheral neuropathy among adults with diabetes in the National Health and Nutrition Examination Survey (NHANES) 1999-2004, *Diabetes Care* 31(1):93-95, 2008.

Thorpe M, Mojtahedi MC, Chapman-Novakofski K, McAuley E, Evans EM: A positive association of lumbar spine bone mineral density with dietary protein is suppressed by a negative association with protein sulfur, *J Nutr* 138(1):80-85, 2008.

van der Schoor SR, Wattimena DL, Huijmans J, Vermes A, van Goudoever JB: The gut takes nearly all: threonine kinetics in infants, *Am J Clin Nutr* 86(4):1132-1138, 2007.

van Waardenburg DA, de Betue CT, Luiking YC, Engel M, Deutz NE: Plasma arginine and citrulline concentrations in critically ill children: strong relation with inflammation, *Am J Clin Nutr* 86(5):1438-1444, 2007.

Vermeulen MA, van de Poll MC, Ligthart-Melis GC, Dejong CH, van den Tol MP, Boelens PG, van Leeuwen PA: Specific amino acids in the critically ill patient–exogenous glutamine/arginine: a common denominator? *Crit Care Med* 35(Suppl 9):S568-S576, 2007.

Verner A, Craig S, McGuire W: Effect of taurine supplementation on growth and development in preterm or low birth weight infants, *Cochrane Database Syst Rev* (4):CD006072, 2007.

von Post-Skagegård M, Vessby B, Karlström B: Glucose and insulin responses in healthy women after intake of composite meals containing cod-, milk-, and soy protein, *Eur J Clin Nutr* 60(8):949-954, 2006.

Waterman E, Lockwood B: Active components and clinical applications of olive oil, *Altern Med Rev* 12(4):331-342, 2007.

Weldon SM, Mullen AC, Loscher CE, Hurley LA, Roche HM: Docosahexaenoic acid induces an anti-inflammatory profile in lipopolysaccharide-stimulated human THP-1 macrophages more effectively than eicosapentaenoic acid, *J Nutr Biochem* 18(4):250-258, 2007.

Whittle N, Sartori SB, Dierssen M, Lubec G, Singewald N: Fetal Down syndrome brains exhibit aberrant levels of neurotransmitters critical for normal brain development, *Pediatrics* 120(6):e1465-1471, 2007.

Wu WH, Kang YP, Wang NH, Jou HJ, Wang TA: Sesame ingestion affects sex hormones, antioxidant status, and blood lipids in postmenopausal women. *J Nutr* 136(5):1270-1275, 2006.

Zhang W, Wang X, Liu Y, Tian H, Flickinger B, Empie MW, Sun SZ: Dietary flaxseed lignan extract lowers plasma cholesterol and glucose concentrations in hypercholesterolaemic subjects, *Br J Nutr* 1-9, 2007.

Zhang Y, Guo K, LeBlanc RE, Loh D, Schwartz GJ, Yu YH: Increasing dietary leucine intake reduces diet-induced obesity and improves glucose and cholesterol metabolism in mice via multimechanisms, *Diabetes* 56(6):1647-1654, 2007.

chapter 3

The Micronutrients of Balanced Meals: *Vitamins, Minerals, and Phytochemicals*

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Chapter Topics

Introduction
Dietary Reference Intakes
Inclusion of Vitamins and Minerals in the Diet
The Role of Vitamins in Nutrition
Difference Between Fat-Soluble and Water-Soluble Vitamins
The Role of Minerals in Nutrition
Mineral Classification
Harmful Minerals
The Role of Phytochemicals in Nutrition
Food Preparation for Preservation of Vitamins and Minerals
Food Fortification
Regulation of Vitamin and Other Dietary Supplements
Use of Herbal Products in Achieving Health
The Role of the Nurse or Other Health Care Professional in Educating the Public About Vitamins and Minerals

Objectives

After completing this chapter, you should be able to:

- Describe the main difference between the fat-soluble and water-soluble vitamins.
- Recognize at least one known function of each of the vitamins and minerals.
- List foods high in the various vitamins and minerals.
- Recognize phytochemicals and their potential role in health.
- Describe the potential concerns regarding supplements of vitamins and minerals and herbal products.
- Describe how the nurse or other health care professional can most appropriately promote the intake of vitamins, minerals, phytochemicals, and supplements.

Terms to Identify

Acetylcholine
Acid-base balance
Acrodermatitis enteropathica
Adequate Intake (AI)
Alopecia
Anemia
Antioxidant
Arthralgias
Ascites
Ataxia
Beriberi
Calcium channel blocker
Cardiomyopathy
Carotene
Catecholamines
Cheilosis
Cofactor
Cretinism
Deoxyribonucleic acid (DNA)
Dietary Reference Intake (DRI)

Dual-energy x-ray absorptiometry (DXA or DEXA) scan
Diuretics
Dyslipidemia
Electrolyte
Elemental
Encephalopathy
Endothelial
Enrichment
Epithelial tissue
Estimated Average Requirement (EAR)
Fat-soluble vitamins
Ferritin
Fortification
Free radicals
Gluconeogenesis
Goiter
Heme iron
Hemochromatosis
Hemoglobin
Hypercalcemia
Hyperosmotic diarrhea
Hypocalcemia
Hypocupremia
Hyponatremia
Hypoparathyroidism
Hypovitaminosis D
International units (IU)
Intrinsic factor
Iron overload
Lactic acidosis
Macular degeneration
Megaloblastic anemia
Metabolic acidosis
Metabolic enzymes
Mitochondria
Multiple sclerosis (MS)
Myoclonus
Neuropathy
Neutropenia
Nicotinamide
Nystagmus
Ophthalmoplegia
Osteomalacia
Pancytopenia
Pellagra
Pernicious anemia
Phytochemicals
Polyuria
Precursor
Prothrombin
Psoriasis
Reactive oxygen species (ROS)
Rebound scurvy
Recommended Dietary Allowance (RDA)
Retinoids
Retinol-binding protein (RBP)
Retinol equivalents (RE)
Rickets
Scurvy
Sickle cell disease
Spina bifida
Tardive dyskinesia
Tetany
Tocopherol
Tolerable Upper Intake Level (UL)
Transferrin
Vitamin B complex
Water-soluble vitamins
Wernicke-Korsakoff syndrome
Wilson's disease

INTRODUCTION

As we become more knowledgeable about our vitamin and mineral needs, it is helpful to keep the history of that knowledge in perspective. Initially, food was recognized as the important element in health. One of the first major discoveries about the role of vitamins was that the use of lemons/limes offered protection against the dreaded **scurvy** that plagued ocean voyagers. Before this revelation, sailors often developed this severe vitamin C deficiency, which resulted in internal bleeding and death. The effect of toxic vitamin levels was noted when Arctic explorers died from ingesting polar bear liver, which has a high level of vitamin A.

It was not until the twentieth century that vitamins were chemically identified. Vitamins are now known to be organic substances that are genetically produced by plants, and many are also found in animal products. One retired scientist recalled being one of the first people asked to put vitamin C into pill form during the 1920s. He and his colleagues laughed at the foolishness of this idea at the time. We may no longer laugh about the importance of vitamins, but we cannot expect that all has been learned in one lifetime about the complexity of the body's need for vitamins.

Minerals, the seeming equivalent of vitamins in the consumer's eye, are inorganic substances that have some similarities to vitamins but also have many differences. The most notable difference is that minerals are **elemental**, which means that they do not break down. This characteristic of minerals prevents their destruction by heat and air—destruction to which vitamins are susceptible. All minerals are elements found in the chemical periodic table. In the saying "Ashes to ashes, dust to dust," the ashes are the minerals found in the body.

Vitamins and minerals become available to body cells from foods we eat after the processes of digestion and absorption. Vitamins and minerals are integral to the function of **metabolic enzymes** at the cellular level for basic life processes (see Chapter 4).

Food is the ideal medium for intake of vitamins and minerals. For example, it has been found that individuals consuming salads and other raw vegetables tend to have improved serum levels of vitamin E and the water-soluble vitamins C and folic acid along with a form of vitamin A called carotenoid (Su and Arab, 2006). Nuts are another source of many nutrients needed by the body and have been noted to improve health status. They contain a variety of compounds that can lower risk of heart disease: phytosterols that interfere with intestinal cholesterol absorption, healthy fats and fiber that lower the body's production of cholesterol, folate that lowers homocysteine levels (see Chapter 7), and magnesium and potassium with naturally low levels of sodium related to lowered blood pressure (see Dietary Approaches to Stop Hypertension [DASH] diet, Chapter 7). These nutrients and other trace minerals found in nuts contribute to healthy bones and lower insulin resistance and the risk of diabetes (see Chapter 5). Nuts are also a good source of protein, and are vital to a healthy vegetarian diet. No vitamin and mineral supplement can include all of the healthy nutrients found in nuts and other unprocessed foods.

A variety of foods best allows inclusion of all known nutrients for health. Plant-based foods are also a source of **phytochemicals** (substances in foods that are beneficial to health but are not vitamins or minerals). It is believed there are at least 100 phytochemicals yet to be identified in food. Low-processed foods in balanced meals with an emphasis on variety will likely meet all known requirements of the many nutrients needed for health. Inadequate intake of calcium and vitamin D from limited intake of milk is common. However, persons needing or electing to take additional amounts of vitamins and minerals through supplements need to do so with caution for two main reasons. One is the concern of excess or unintentionally inadequate intake of vitamins and minerals. Excess intake can easily occur with calcium from supplements. Health providers who recommend calcium supplementation need to first assess dietary intake. This is especially true if other sources of calcium are included in a person's intake, such as with calcium-based antacids and calcium-fortified foods. Along this line, a person taking a multivitamin and mineral supple-

ment may be under the illusion that good nutritional intake from foods is not important. For example, the magnesium and calcium content of common multivitamin preparations do not meet the **Dietary Reference Intake (DRI)** for these minerals. Actually, there are a variety of minerals that will not be found at 100% of the DRI in basic multivitamin-mineral supplements. This is due, in part, to the fact that minerals are bulky and cannot all fit into a pill that can be swallowed easily.

The other major concern with vitamin and mineral supplementation is the concern of potency and truth in advertising. Since the Dietary Supplement Health and Education Act of 1995 (DSHEA—pronounced *D-shay*) dietary supplements have been distinguished from drugs or food additives and have minimal regulation on quality. Vitamin and mineral supplements are not legally bound to provide the stated amounts listed on the labels unless a statement of potency guarantee is made (see later section). Furthermore, it is potentially very easy to take toxic doses from supplements, which is virtually impossible from food. An excess of one vitamin or mineral can compete with another; for example, zinc competes with copper, and vitamin E can inhibit the activity of vitamin K.

When vitamin and mineral supplements are used, they should usually be within 100% to 200% of the recommended amounts (see the table at the end of this book). Exceptions to these guidelines should be made only with a warranted medical condition and on the advice of a health care provider or registered dietitian. Many health conditions associated with the need for vitamins and minerals are better resolved through food because the human body is extremely complex and the nutrient composition of food best matches this need. Health care professionals are in a unique position to positively influence an individual's nutrient intake. This chapter is aimed at increasing appreciation for the micronutrients in food that our bodies require.

WHAT ARE THE DIETARY REFERENCE INTAKES?

The U.S. Recommended Dietary Allowances (RDAs) and Canadian Recommended Nutrient Intake (RNIs) have been replaced with the Dietary Reference Intakes (DRIs), the term used collectively to describe four primary measures of recommended dietary intake. The updated DRIs are now used by both the United States and Canada. Nutrient intake amounting to less than the lower end of the range of the DRIs may lead to nutrient deficiency. Intake amounting to more than the upper limit may give rise to toxic effects, especially with trace minerals (Figure 3-1). The DRIs should not be confused with requirements for a specific individual because requirements vary considerably. Problems such as premature birth, inherited metabolic disorders, infections, chronic diseases, and the use of medications may require special dietary modifications. The specific reference values that constitute the DRIs are as follows:

Estimated Average Requirement (EAR): the amount of a nutrient estimated to meet half of healthy individuals' needs based on life stage and gender.

Recommended Dietary Allowance (RDA): the average daily dietary intake level that meets the nutrient requirement of more than 97% of the healthy population in a particular life stage and gender group.

Adequate Intake (AI): a recommended intake of vitamins and minerals based on observations of nutrient intake by a group of healthy persons that is assumed to be adequate (when an RDA cannot be determined). The AI level is generally between the RDA level and the maximum safe amount.

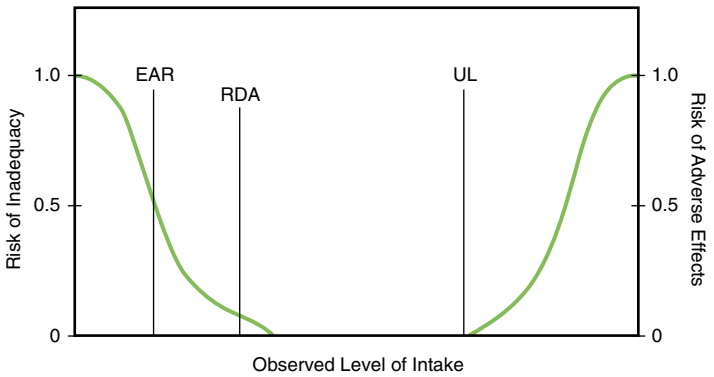


FIGURE 3-1 Dietary Reference Intakes. This figure shows that the Estimated Average Requirement (EAR) is the intake at which the risk of inadequacy to an individual is 50%. The Recommended Dietary Allowance (RDA) is the intake at which the risk of inadequacy is very small (2% to 3%). The Adequate Intake (AI) does not bear a consistent relationship to the EAR or the RDA because it is set without being able to estimate the average requirement. It is assumed the AI is above the RDA if it could be calculated. At intakes between the RDA and Tolerable Upper Intake Level (UL), the risks of inadequacy and of excess are both close to 0. At intakes above the UL, the risk of adverse effects increases.

Tolerable Upper Intake Level (UL): the highest level of daily nutrient intake that is likely to pose no risk of adverse health effects in almost all individuals in the general population. Intakes above the UL are associated with increased risk of adverse reactions. Derived from UL are two newer methods described as the Observed Safe Level (OSL) and Highest Observed Intake (HOI).

HOW ARE VITAMINS AND MINERALS BEST INCLUDED IN THE DIET?

Reliance on nonfortified (see section below) food sources for vitamins and minerals offers little risk of ingesting toxic amounts and provides a good balance of vitamins and minerals. The MyPyramid Food Guidance System (see Chapter 1) is a strategy to plan healthy meals. Although there is debate about how best to portray recommended intake for the majority of the population through MyPyramid, the general goals are still sound. The 2005 Dietary Guidelines were updated to specifically recommend three whole-grain servings or half of the daily grain intake, along with increased quantities of fruits and vegetables to the equivalent of 4½ cups, and a minimum of 3 cups of milk daily; MyPyramid has been altered to better portray these guidelines for food choices.

The B vitamins (especially thiamin and niacin) are naturally found in whole grains and legumes. These foods also provide a wide array of minerals such as chromium and zinc. Vegetables and fruits supply a variety of vitamins, such as vitamin C, and minerals, such as potassium. The dark green, leafy vegetables are especially high in potassium, magnesium, and vitamins A (in the **carotene** form) and C, as well as the B vitamin, folate. Deep orange fruits and vegetables such as sweet potatoes, carrots, cantaloupe, and mango are very high in carotene. Citrus fruits (oranges, grapefruits, lemons, and limes) are very high in vitamin C. Milk and milk products are high in calcium and also provide the primary source of riboflavin. The addition of meat or other protein-rich foods further rounds out the nutritional needs, providing B vitamins and many minerals.

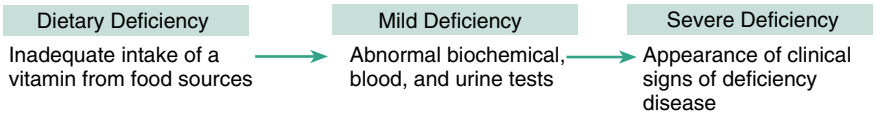


FIGURE 3-2 The progression of the development of vitamin deficiencies.

WHAT IS THE ROLE OF VITAMINS IN NUTRITION?

The body requires vitamins only in minute amounts, but proper growth and development and optimal health are impossible without them. Some vitamins may be synthesized by the body, but for the most part they must be supplied in the daily diet of normal healthy persons. Early attention was paid to the clear-cut manifestations of diseases caused by vitamin deficiencies (Figure 3-2).

Vitamins, although organic in nature, do not provide energy (kilocalories [kcalories or kcal]) However, they do help in the metabolism of the kcalorie-containing macronutrients: carbohydrate, protein, and fat. In this role, vitamins are thought to act as catalysts.

Vitamins are classified as body regulators because of the following functions:

- Regulating the synthesis of many body tissues (bones, skin, glands, nerves, brain, and blood)
- Participating in the cellular metabolism of macronutrients through their function with metabolic enzymes (chemicals the body produces to allow for basic life processes) as coenzymes and cofactors
- Preventing nutritional deficiency diseases and allowing for optimal health at all ages
- Serving as antioxidants to reduce damage at the cellular level from the process of oxidation (see Chapter 4)

WHAT IS THE DIFFERENCE BETWEEN FAT-SOLUBLE AND WATER-SOLUBLE VITAMINS?

Generally vitamins are classified into two groups: **fat-soluble vitamins** (vitamins A, D, E, and K) and **water-soluble vitamins** (B-complex vitamins and vitamin C). However, there are water-soluble forms of these vitamins that can be supplemented for persons with fat malabsorption, as found with cystic fibrosis, such as vitamin D_3 and vitamin K_3. The fat-soluble vitamins are stored in body fat and can reach toxic levels. This is why intake of fat-soluble vitamins should not exceed the Upper Limit of Safety (may be found at the back of the book). The one exception to this is vitamin D as currently stated; an updated DRI and Upper Limit of Safety is being reviewed and is expected to be at much higher levels than currently advised in the DRIs. Water-soluble vitamins are generally not stored in any significant amounts in the body, which means that they need to be included in the diet on a daily basis. Fat-soluble vitamins are generally more stable than water-soluble vitamins and are less prone to destruction by heat, air, and light. Deficiencies of fat-soluble vitamins in healthy individuals are less likely to occur than deficiencies of water-soluble vitamins.

The absorption of fat-soluble vitamins is enhanced by dietary fat. Individuals who are afflicted with malabsorption of fat or who consume an extremely small

amount of fat are at higher risk for development of fat-soluble vitamin deficiencies. The same applies to use of a weight loss medication, orlistat, that is now available for over-the-counter sale. This medication interferes with the digestion of fat (see Chapter 4) and has the potential to contribute to deficiency of fat-soluble vitamins (Filippatos and colleagues, 2008).

FAT-SOLUBLE VITAMINS

Vitamin A

Vitamin A can be obtained in two forms. The **precursor** form is beta-carotene, simply referred to as carotene, which is turned into vitamin A in the liver. Carotene is found in abundance in dark green, leafy vegetables and deep-orange vegetables and fruits (except oranges—there are exceptions to every rule). The color of carotene is orange, which is why those foods high in carotene are of similar color and why a person's skin can turn orange when these foods are eaten in abundance. This is usually innocuous, and orange skin color fades away once carotene foods are decreased in the diet. There are a variety of carotenoids, including lycopene, lutein, and zeaxanthin (also referred to as phytochemicals; see later section). Colorful fruits and vegetables contain a variety of carotenoids. Egg yolk is a highly bioavailable source of lutein and zeaxanthin.

The other form of vitamin A is the preformed version (retinol and retinyl palmitate as used in food fortification). Preformed vitamin A is found in animal products such as liver; milk fat as in whole milk, cream, and butter; and egg yolks. See Table 3-1 and Figure 3-3 for other specific food sources. Vitamin A is often added to foods in a process called **fortification** (see section below) and is found in supplements. Vitamin A in the preformed version is able to produce toxicity if ingested in large amounts, especially because it is readily stored in the body for up to 2 years. Some acne creams contain preformed vitamin A, which has been linked with birth defects; caution is advised for use of these creams among women of childbearing years.

Retinol can be found in oil-based or water-based forms (water-miscible), emulsified, and in solid preparations. The non–oil-based forms of retinol are approximately 10 times as toxic as are oil-based preparations. This is due to increased absorption. The safe upper single dose of retinol in oil or liver seems to be approximately 4 to 6 mg/kg body weight. Chronic intake of 2 mg retinol per kilogram in oil-based preparations results in hypervitaminosis A, regardless of age (Myhre and colleagues, 2003). Food fortification with retinyl palmitate can lead to toxic levels of vitamin A in the body, called hypervitaminosis A.

Retinoids (vitamin A and its derivatives) circulate in the body predominantly attached to **retinol-binding protein (RBP)**. This allows transport of retinol from liver stores to body tissues. There are wide variations in carotenoid usage from one person to another due to a variety of factors such as absorption differences from specific foods consumed, certain medicines used, genetic and physiologic factors, and nutritional status. Conversion of provitamin A carotenoids into vitamin A is not 100% efficient, and good protein status is needed (Borel and colleagues, 2005).

Vitamin A is important for healthy **epithelial tissue** (external skin and internal lining of the respiratory and gastrointestinal [GI] tract). Deficiency of vitamin A has long been known to increase the risk of infection and is associated with night blindness, as well as total blindness in many countries (see Chapter 14). It is now known

Table 3-1 Fat-Soluble Vitamins*

FUNCTIONS	GOOD SOURCES	SYMPTOMS OF DEFICIENCY	SYMPTOMS OF TOXICITY
Vitamin A (Nomenclature: Preformed—Retinol, Retinal, Retinoic Acid; Precursor—Carotene)			
Maintenance of epithelial cells and mucous membranes Constituent of visual purple, important for night vision Necessary for normal growth, development, and reproduction Necessary for adequate immune response	Preformed vitamin A: **100% DRI:** 2 oz chicken liver 1¼ tsp cod-liver oil Carotene: **100% DRI:** ¼ average sweet potato ¼ c carrots ¼ c canned pumpkin ¼ c spinach ⅓ c collards/kale1 c cantaloupe **25% DRI:** ½ papaya ½c romaine lettuce ½ c broccoli 1 mango 1 c tomato 1½ c watermelon	Nyctalopia (night blindness) Keratinized skin (rough, dry skin) Dry mucous membranes Xerophthalmia (an eye disease)	Appetite loss Hair loss Dry skin Bone and joint pain Enlarged liver and spleen Fetal malformations Headache Weakness Vomiting Irritability Hydrocephalus (children) Brittle nails Gingivitis Cheilosis Ascites Hypercalcemia
Vitamin D (Nomenclature: Ergocalciferol [Vitamin D_2], Cholecalciferol [Vitamin D_3]; Precursors—Ergosterol [Plants], 7-Dehydrocholesterol [in Skin])			
Aids in absorption of calcium and phosphorus Regulates blood levels of calcium Promotes bone and teeth mineralization	**100% DRI:** 1 tsp cod-liver oil 1½ oz herring 3 oz salmon 5 oz sardines **25% DRI:** 1 c fortified milk 3½ oz shrimp	Rickets (children) Osteomalacia (adults) Impaired neuromuscular function Possible multiple sclerosis Inflammatory bowel diseases Hypertension Certain forms of cancer	Calcification of soft tissues Hypercalcemia Renal stones Appetite and weight loss Nausea and fatigue Growth failure in children
Vitamin E (Nomenclature: Tocopherol)			
Prevents oxidative destruction of vitamin A in the intestine Protects red blood cells from rupture (hemolysis) Helps maintain normal cell membranes by reducing the oxidation of polyunsaturated fatty acids	**100% DRI:** 3 tbsp sunflower oil ½ c sunflower seeds 2 oz almonds **25% DRI:** 2 tbsp canola/olive/peanut oils 3 tbsp wheat germ 1 oz hazelnuts/filberts and peanuts 12 oz soy milk 1 c turnip greens	Breakdown of red blood cells Neurologic disorders Problems with muscle coordination (ataxia)	Decreased thyroid hormone level Modest increases in triglycerides

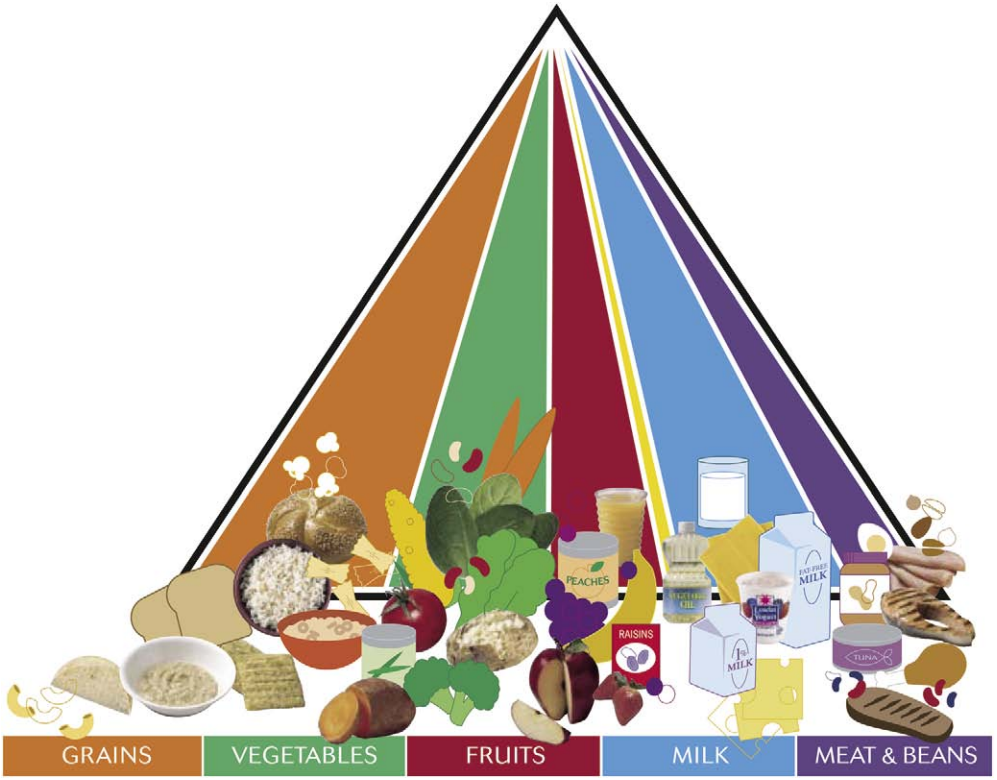
Table 3-1 Fat-Soluble Vitamins*—cont'd

FUNCTIONS	GOOD SOURCES	SYMPTOMS OF DEFICIENCY	SYMPTOMS OF TOXICITY
Vitamin K (Nomenclature: Menadione [Vitamin K_3], Phylloquinone [Vitamin K_1])			
Necessary for formation of prothrombin and other factors necessary for blood clotting Promotion of strong bones	**100% DRI:** ⅛ c kale ¼ c spinach ⅓ c mustard greens ¾ c broccoli **25% DRI:** ½ c cabbage ¾ c blueberries 1 c Brussels sprouts Synthesis by intestinal bacteria	Hemorrhage Osteoporosis	No toxicity known

Data from *USDA Composition of Foods*, Handbook No. 8 Series, Washington, DC, 1976-1986, Agricultural Research Service, USDA; U.S. Department of Agriculture, Agricultural Research Service: USDA National Nutrient Database for Standard Reference, release 17; Davis J, Sherer K: *Applied nutrition and diet therapy for nurses,* ed 2, Philadelphia, 1994, Saunders; and Mahan KL, Escott-Stump S: *Krause's food, nutrition, and diet therapy,* ed 12, Philadelphia, 2008, Saunders.
DRI, Dietary Reference Intake.
*Amounts of foods listed meet the Dietary Reference Intake for adults ages 31 to 50 (largest amount used as reference) as rounded off to the nearest portion size to meet the DRI.

that a good intake of vitamin A helps with bone growth, a healthy immune system, improved vision, and reproduction. Marginal vitamin A deficiency is common and can result in a form of iron deficiency. Marginal vitamin A intake by a breastfeeding mother can put the nursing offspring at risk for iron deficiency (Kelleher and Lonnerdal, 2005). It is beneficial for individuals with marginal vitamin A status to consume carotene-rich orange and green leafy vegetables with a low-fat diet. It has been shown this can normalize the body pool of vitamin A through increased absorption (Ribaya-Mercado and colleagues, 2007).

Toxicity of vitamin A has been linked with **cheilosis** (see Figure 3-4), altered lipids, and **hypercalcemia** (excess calcium in the blood). Although vitamin A deficiency impairs bone growth, hypervitaminosis A causes bones to lose their calcium and can lead to osteoporosis (see Chapter 13). It can also cause severe liver damage (Castaño, Etchart, and Sookoian, 2006). In one situation after ingestion of large doses of vitamin A, the symptoms included muscle soreness, hair loss, nail disorder, and **ascites** (fluid accumulation in the peritoneal cavity of the abdomen), and with deteriorating health, the person further developed renal insufficiency, **encephalopathy** (brain degeneration), failure to thrive, and ultimately required liver transplantation (Cheruvattath and colleagues, 2006). Hypervitaminosis A caused hypercalcemia to develop in a toddler who had been treated for autism with massive doses of vitamin A, 100,000 IU daily for 3 months followed by a daily dose of 150,000 IU the 3 following months. His symptoms included vomiting, headache, fever, and skin abnormalities (Kimmoun and colleagues, 2008). Cases of children overdosing on vitamin A via excess intake of chewable vitamins has been reported and found to take months to normalize serum levels (Lam and colleagues, 2006). Treatment of hypervitaminosis A may be helped by use of vitamin E supplementation. This was found in a study



WHOLE GRAINS
Vitamins E, B_1, B_3, B_6, Fol, Panto, Mg, P, Fe^+, Cr, Cu, Mn, Mo, Se, Zn

WHITE, ENRICHED, AND FORTIFIED GRAIN PRODUCTS
Vitamins B_1, B_3, Fol, Fe^+

DARK GREEN LEAFY VEGETABLES
Vitamins A (carotene), C, K, Fol, Ca^{2+}, Mg, Fe^+, Co

DARK ORANGE FRUITS AND VEGETABLES
Vitamins A (carotene), C (melons, berries, and tomatoes), K^+, P, and Mg (found in apricots)

OTHER VEGETABLES AND FRUITS
Vitamin C, P, K^+, Na^+, Cl^-, Mn, Co, I (vegetables grown in iodine-rich soil)

FATS/OILS
Chocolate: Cu
Butter: vitamins A and D
Soybean oil: vitamin K
Vegetable oils: vitamin E
Cod-liver oil: vitamins A and D

MILK
Vitamins A and D (fort), B_2, B_{12}, Bio, Na^+, P, Ca^{2+}, Mg, Se, S

LEGUMES
Vitamins B_1, B_3, B_{12} (fort soy prod), Fol, Panto, K^+, P, Mg, Ca^{2+}, Cu, S, Mo, Fe^+

EGGS
Vitamins A, D, B_2, B_{12}, Bio, Chol, Mn, Se, Fe^+

ORGAN MEAT
Vitamins A, B_1, B_2, B_6, B_{12}, Chol, Fol, P, Fe^+, Zn, Cr, Cu, Se, Mo

RED AND WHITE MEAT
Vitamins B_3, B_{12}, Bio, Panto, K^+, P, Cr, S, Fe^+

FISH
Vitamins D (liver), E, B_3, B_{12}, C^{2+} (bones), Cl^-, Mg, Fl, Cu, Se, Fe^+, I (salt-water fish)

FIGURE 3-3 Vitamin and mineral content of the MyPyramid (listed in the following order: fat-soluble vitamins, water-soluble vitamins, major minerals, and trace minerals). *Bio,* biotin; *Ca^{2+},* calcium; *Chol,* choline; *Cl^-,* chloride; *Co,* cobalt; *Cr,* chromium; *Cu,* copper; *Fe^+,* iron; *Fl,* fluorine; *Fol,* folate; *I,* iodine; *K^+,* potassium; *Mg,* magnesium; *Mn,* manganese; *Mo,* molybdenum; *Na^+,* sodium; *P,* phosphorus; *Panto,* pantothenic acid; *S,* sulfur; *Se,* selenium; *Zn,* zinc.

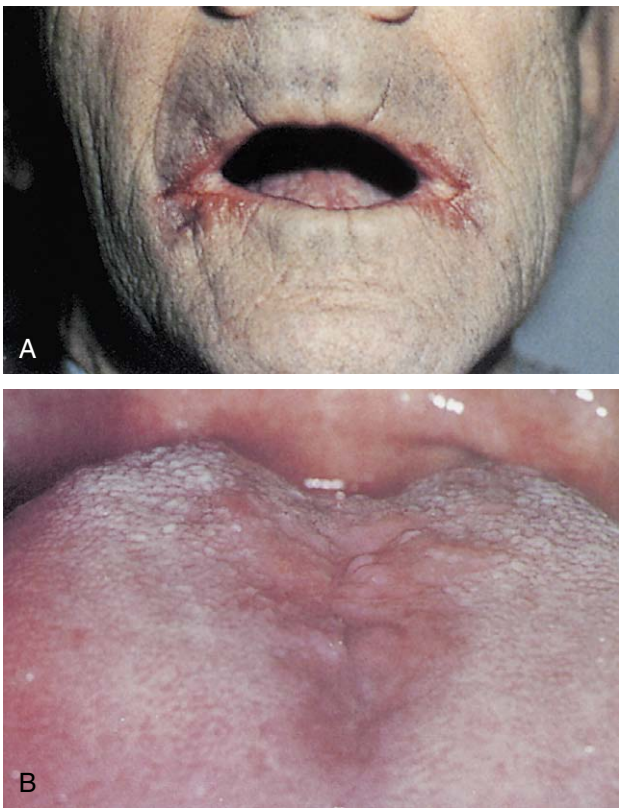


FIGURE 3-4 Vitamin B deficiencies. **A,** Angular cheilosis caused by vitamin B–complex deficiency, as well as vitamin A toxicity. **B,** Depapillation of the tongue from B vitamin deficiency. (**A** from Callen JP, Greer KE, Hood AF, Paller AS, Swinyer LJ: *Color atlas of dermatology,* Philadelphia, 1993, Saunders; **B** from Murphy GF, Herzberg AJ: *Atlas of dermatopathology,* Philadelphia, 1996, Saunders.)

of rabbits, with 2 weeks of supplementation effectively lowering the serum vitamin A levels (St Claire, Kennett, and Besch-Williford, 2004).

Persons with cystic fibrosis and impaired pancreatic function are at risk of vitamin A deficiency because of fat malabsorption. However, avoidance of excess vitamin A intake is still important. One study of individuals with cystic fibrosis found that total preformed vitamin A intake exceeded the UL in the majority studied. Despite the fat malabsorption, the serum levels of vitamin A were found to be at levels for potential toxicity (Graham-Maar and colleagues, 2006).

Vitamin A in foods is measured in **retinol equivalents (RE)** or **international units (IU)**. The use of international units indicates that both preformed vitamin A and carotenoids are measured; this is still a common method used in food composition tables and diet planning. Because the biologic activities of carotenoids and vitamin A are different, however, retinol equivalents began to be used. Simply put, numbers used in the IU system are about three times those expressed in the RE system. The DRI for vitamin A is expressed as micrograms (mcg), with 1 mcg being equal to 3.3 IU.

FIGURE 3-5 Rickets. (From Shah BR, Laude TA: *Atlas of pediatric clinical diagnosis,* Philadelphia, 2000, Saunders.)

Vitamin D

With the advent of industrialization in the late nineteenth century and the resulting long hours of working in factories endured by many children, **rickets** (bowing of the legs caused by body weight on soft leg bones) (Figure 3-5) became common enough that public health measures for its prevention began. The preventive measure used was the practice of giving children cod-liver oil. After vitamin D was chemically isolated in 1935, it was eventually added to milk, which ultimately replaced cod-liver oil as a means of preventing rickets (1 teaspoon of cod-liver oil provides about 100% of the DRI for vitamin D and vitamin A). Milk is an appropriate food to fortify with vitamin D because this vitamin greatly enhances the absorption of calcium, of which milk is one of the best sources. Rickets is again on the upsurge because of reduced intakes of fortified milk, decreased exposure to ultraviolet B sunlight in urban settings, and children increasingly spending their time indoors.

Sunlight contributes to vitamin D levels by starting the conversion of a cholesterol-related vitamin D precursor in the skin to an active form. This conversion varies according to the length and intensity of sun exposure and the color of the skin, with lighter skin color increasing the production of vitamin D. Institutionalized elderly persons are at high risk for vitamin D deficiency because of negligible exposure to the sun and likely will benefit from supplementation. With aging, the ability of the body to produce vitamin D from sunlight exposure becomes impaired, and thus even community-dwelling elder persons require more vitamin D as reflected in a higher DRI after age 70.

Factors that influence vitamin D production in the skin include sunscreen use, skin pigmentation, time of day, season of the year, latitude, and aging. A total of 100 IU of vitamin D raises the blood level of 25-hydroxyvitamin D (25[OH]D) by 1 to 2 nmol/L (Cranney and colleagues, 2007). Thus children and adults who do not receive adequate vitamin D from sun exposure need at least 1000 IU/day vitamin D.

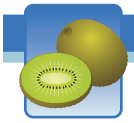
There are different forms of vitamin D, including 1,25-dihydroxyvitamin D_3 (1,25[OH][2]D], simply known as vitamin D_2, which is generally the form of vitamin D in vitamin supplements. The biomarker for vitamin D stores is the serum level of 25(OH)D, with the minimum goal of 80 nmol/L or 32 ng/mL for optimal health. The evidence now appears strong enough to advise a higher vitamin D intake than the current DRI guidelines (see back of book). Based on a study in Nebraska, it was found that to achieve optimal vitamin D status an expected intake would be almost 2000 IU/day (Lappe and colleagues, 2006). Evidence is growing that a minimum of 800 IU of vitamin D is required to meet goals of optimal vitamin D status.

However, the recognition of increased needs for vitamin D comes at a time when there is concern about the growing number of persons who do not even meet the minimum recommended vitamin D intake because of decreased intake of milk and fish. One microgram of vitamin D equals 40 IU in the diet.

Vitamin D has many physiologic roles beyond those related to bones, including regulating blood pressure and acting as a tumor suppressant. A study using data from the National Health and Nutrition Examination Survey (NHANES) found that although the mean levels of 25(OH)D were above the minimum goal, vitamin D levels were lower in women, persons 60 years of age and older, minorities, and persons with obesity, hypertension, diabetes mellitus, and elevated triglycerides. This was particularly true at the lowest levels of 25(OH)D (Martins and colleagues, 2007). There is evidence from a variety of studies that shows a 50% lower incidence of colon cancer with an intake of 1000 IU/day vitamin D or serum 25(OH)D levels greater than 33 ng/mL (82 nmol/L) and that this level of serum vitamin D is associated with reduced risk for a number of other cancers, including breast, lung, ovarian, prostate, and non-Hodgkin's lymphoma. There is further evidence that vitamin D reduces the risk of autoimmune diseases, including **multiple sclerosis (MS)**, a disease of the central nervous that is more prevalent in regions farther from the equator, and type 1 diabetes mellitus (see Chapter 8). Olympic skiers have noted a high rate of MS in their sport. Exposure to sunlight during early life or vitamin D supplementation has been related to reduced incidence of this condition. There also appears to be benefit for the primary forms of arthritis, type 2 diabetes mellitus, hypertension, and stroke (Grant, 2006).

Vitamin D deficiency leads to secondary hyperparathyroidism, increased bone turnover, bone loss, and when severe, **osteomalacia** (softening of the bones). **Hypovitaminosis D** (a condition of low vitamin D status) is associated with impaired neuromuscular function. All persons with persistent, nonspecific musculoskeletal pain are at high risk for severe hypovitaminosis D (the condition of vitamin D deficiency). Hypovitaminosis D is prevalent even in southern latitudes and should be taken into account in the evaluation of postmenopausal and male osteoporosis (Levis and colleagues, 2005).

Persons with renal (kidney) disease usually require supplementation because of impairment of the final steps of vitamin D synthesis (see Chapter 9). There is an increased risk of vitamin D deficiency in conditions of malabsorption of fat, such as with cystic fibrosis. In one study of this condition, despite a mean intake of 800 IU daily, optimal goals of 25(OH)D were not met (Rovner and colleagues, 2007). Prevalence of vitamin D deficiency in persons treated with medication for epilepsy has been found, especially with use of multiple medications, with indicators of adverse impact on bone health. Routine monitoring of serum 25(OH)D and vitamin D supplementation should be considered for individuals with epilepsy treated with medication (Nettekoven and colleagues, 2008).



Cultural Considerations

Fear of rickets led one Turkish family to administer massive daily quantities of vitamin D to their infant son. This practice was facilitated through purchase of a high-dosage form of vitamin D via the Internet. Severe hypercalcemia developed, leading to loss of appetite, weakness with lethargy, hypotonia, and constipation. Physical examination also indicated signs of moderate intracellular dehydration, **polyuria** (excess urination), and leukocytes in the urine; worsening neurologic decline led ultimately to dialysis and medical management to normalize calcium levels (Chambellan-Tison and colleagues, 2007). ■

Vitamin E

Vitamin E, also known as **tocopherol**, was initially recognized as essential for reproduction in rats. Vitamin E is transported in triglyceride (TG)-rich lipoproteins (see Chapter 7). One case of type 2 diabetes was found with both high levels of triglycerides and vitamin E (Girona and colleagues, 2008).

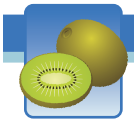
Vitamin E acts as an **antioxidant** (preventing cell damage from oxidation). In relatively recent years, vitamin E was routinely advised at the 400 IU level in medical practices for the goal of reduced cardiovascular disease related to the oxidative damage. However, no evidence was found for this expected protection, and instead there was evidence of increased incidence of disease and mortality. Consequently, vitamin E supplementation is no longer routinely advised. However, a genetic subgroup of persons with diabetes were found to benefit with 400 IU vitamin E supplementation significantly reducing cardiovascular events (Milman and colleagues, 2008).

Vitamin E is still important for overall health, when it comes from food sources in particular. Nuts and vegetable oils are rich in vitamin E and are protective against heart disease (see Chapter 7). A mere ¼ cup of almonds provides 100% of the RDA for vitamin E.

Maternal intake of vitamin E during pregnancy is beneficial for growth and development of the fetus. One study found that infants whose mothers had low plasma alpha-tocopherol concentrations weighed less and had smaller head circumference. Higher levels of both maternal alpha-tocopherol and cord retinol concentrations were associated with improved growth (Masters and colleagues, 2007). There is some evidence that asthma among children may be also related to maternal diet during pregnancy due to inadequate vitamin E intake (Seaton, 2008). One form of

vitamin E, gamma-tocopherol, has been shown to be more effective than alpha-tocopherol in reducing systemic inflammation. In a rat study large doses of the gamma form was found to inhibit inflammatory pathways that are related to allergic rhinitis and asthma (Wagner and colleagues, 2008). However, in another rat study large doses of vitamin E were associated with changes in the small intestine and inflammation (Gianello and colleagues, 2007). Thus too little or excess intake of vitamin E appears to be related to inflammation.

Known toxic effects from excess ingestion of vitamin E are limited primarily to premature infants and persons receiving anticoagulant medications such as Coumadin. This is due to potential complications of inadequate clotting of blood.



Cultural Considerations

About 70% of Latino children living in rural Nebraska, who were not taking supplements, were found to have low serum levels of vitamin E, and about 60% had intakes of vitamin E less than the EAR goal (as described above). Vitamin C and selenium intakes were above the RDA (Kim and colleagues, 2006). ■

Vitamin K

Vitamin K is also known as phylloquinone. Recommendations for dietary vitamin K intake have been made on the basis of blood coagulation factors. Vitamin K was first recognized as an antihemorrhagic factor. Because vitamin K is essential for the formation of **prothrombin** (a clotting factor), defective blood coagulation is the main symptom of vitamin K deficiency. Vitamin K is also involved in other physiologic processes, including vascular function and bone metabolism. There are three forms of dietary vitamin K, known as K_1, K_2, and K_3. Vitamin K is found in dietary sources such as dark green, leafy vegetables (see Table 3-1), and it is also synthesized by bacteria in the jejunum and ileum of the small intestine (see Chapter 4).

Vitamin K has a key function in the synthesis of at least two proteins involved in calcium and bone metabolism. Good vitamin K status has been found to increase bone mass in healthy peripubertal children (van Summeren and colleagues, 2008).

Vitamin K deficiency is most likely to occur in individuals receiving antibiotics over an extended period who are not able to absorb fat and who have a low intake of foods containing vitamin K. Persons receiving antibiotic therapy should be considered for vitamin K supplementation. Persons who take Coumadin to reduce the risk of blood clot formation need a consistent intake of vitamin K to maintain stable prothrombin rates. The combined use of Coumadin and gram-negative antibiotics results in high risk of hemorrhage; such treatment requires monitoring of the individual's blood coagulation.

Deficiency of vitamin K is common among young infants. This is because of low levels of the vitamin K–synthesizing bacteria in the intestinal tract at birth. A parenteral vitamin K injection is recommended for newborn infants. Infant formulas are now routinely supplemented with this vitamin. Intracranial hemorrhage (ICH) is one outcome of vitamin K deficiency in early infancy. Signs of ICH related to vitamin K deficiency can occur at 1 to 2 months of age. This condition can cause convulsion, vomiting, and irritability with coma, fontanel bulging, and absence of pupil reaction.

Infants with ICH are at high risk for developmental delay, epilepsy, blindness, and mortality.

Poor vitamin K status has been associated with a greater risk for hip fracture in older men and women. Oral anticoagulants, such as Coumadin, block the use of vitamin K. The vitamin K in spinach and broccoli (high vitamin K sources) appears to have poor bioavailability with a short-lived effect on blood clotting. Moderate intake is generally tolerated in conjunction with use of Coumadin.

WATER-SOLUBLE VITAMINS

The B vitamins are water-soluble vitamins required as coenzymes for enzymes essential for cell function. They have an essential role in maintaining function of the **mitochondria** (the furnaces of the cell); mitochondria are compromised by a deficiency of any B vitamin (Depeint and colleagues, 2006). Water-soluble vitamins are required in the diet because they cannot be synthesized by humans. The **vitamin B complex** refers to all water-soluble vitamins except ascorbic acid, also known as vitamin C (Table 3-2). Thiamin, or vitamin B_1, is a water-soluble B complex vitamin that was first discovered in 1910 in the process of exploring how rice bran cured patients of **beriberi** (a condition involving inflammation of the nerves). Beriberi is classified as "dry" (neurologic) or "wet" (cardiovascular) and may include both forms in the same person.

With further study, vitamin B was shown to be not a single substance but a combination of substances, each one of which was given a letter or a descriptive term, or later a chemical designation as its chemical nature became known. Several factors in the vitamin B complex are recognized today.

The B vitamins are as follows (see the DRI table at the back of the book):

- Thiamin (vitamin B_1)
- Riboflavin (B_2)
- Niacin (B_3)
- Pantothenic acid (sometimes referred to as B_5)
- Pyridoxine and related substances (collectively known as vitamin B_6)
- Biotin (sometimes referred to as B_8)
- Folate (sometimes referred to as B_9)
- Cobalamin (B_{12})
- Choline

A lack of B-complex vitamins is one of the most widespread forms of malnutrition. Because of the similar distribution of these vitamins in foods, a deficiency of several is observed more often than is a deficiency of a single one. The interrelationship of many of these vitamins in life processes means that signs of dietary deficiency are often similar when the diet lacks any one of several factors (Figure 3-4). Many physiologic and pathologic stresses influence the need for the B vitamins.

Hyperhomocysteinemia, a condition related to deficiency of multiple B vitamins, has been linked to neurodegenerative diseases and dementia. Treatment with folate, B_{12}, and B_6 has been found to improve cerebral function among persons with hyperhomocysteinemia and dementia. Other population groups that may benefit with increased intake of the B vitamins to lower hyperhomocysteinemia include those with neuropsychiatric disease, risk of stroke, treatment of Parkinson's disease who

Table 3-2 Water-Soluble Vitamins*

FUNCTIONS	GOOD SOURCES	SYMPTOMS OF DEFICIENCY	SYMPTOMS OF TOXICITY
Vitamin B_1 (Nomenclature: Thiamin)			
Plays a role in carbohydrate metabolism Helps the nervous system, heart, muscles, and tissues to function properly Promotes a good appetite and good functioning of the digestive tract	**100% DRI:** 1¼ c rice (enriched) 4 oz pork 6 oz ham **25% DRI** ¼ c wheat germ ¾ c black-eyed peas/ black beans 3 oz tuna 2½ slices whole-grain bread 3 slices white bread (enriched) 6 oz liver	Polyneuritis Beriberi Fatigue Depression Poor appetite Poor functioning of intestinal tract Nervous instability Edema Spastic muscle contractions Wernicke's encephalopathy Korsakoff's psychosis Mental confusion Metabolic acidosis	Rare with IV thiamin
Vitamin B_2 (Nomenclature: Riboflavin)			
Essential for certain enzyme systems that aid in the metabolism of carbohydrates, proteins, and fats Needed for healthy skin, lips, tongue, and the eye surface	**100% DRI:** 2 oz beef liver **25% DRI:** 6 oz yogurt/milk 6 slices whole-grain bread (enriched) ¾ c soybeans 2 hard-cooked eggs 1 c spinach	Tongue inflammation Cheilosis (see Figure 3-5) Scaling and burning skin Sensitive eyes Angular stomatitis and cheilosis Cataracts Anemia	Inhibits zinc absorption
Vitamin B_3 (Nomenclature: Niacin, Nicotinic Acid)			
Part of two important enzymes that regulate energy metabolism Promotes good physical and mental health and helps maintain the health of the skin, tongue, and digestive system	**100% DRI:** 4 oz beef liver 5 oz chicken **25% DRI:** 2 oz tuna/halibut ¾ c whole-wheat flour ¾ c mushrooms ¾ c rice (enriched) 3 oz turkey/beef	Pellagra (rare) with severe deficiency characterized by the four Ds: diarrhea, dermatitis, dementia, death Photosensitive dermatitis Depressive psychosis	Flushing caused by vasodilation Nausea and vomiting Abnormal glucose metabolism Abnormal plasma uric acid levels Abnormal liver function tests Gastric ulceration Anaphylaxis (swelling, pain, fever, or asthmatic symptoms caused by physical sensitivity) Circulatory collapse

Table 3-2 Water-Soluble Vitamins*—cont'd

FUNCTIONS	GOOD SOURCES	SYMPTOMS OF DEFICIENCY	SYMPTOMS OF TOXICITY
Vitamin B_6 (Nomenclature: Pyridoxine, Pyridoxal, Pyridoxamine)			
Important in metabolism of proteins and amino acids, carbohydrates, and fats Essential for normal cell membrane function and growth	**100% DRI:** 5 oz beef liver 8 oz turkey 1¼ c chickpeas 1 baked potato **25% DRI:** 2 oz tuna 3 oz pork ¾ c sweet potato 1 c plantain 1 c lentils 1¼ c broccoli 1¼ c okra	Not fully established, but believed to lead to convulsions, peripheral neuropathy, secondary pellagra, possible depression, oral lesions	Sensory nerve damage Numbness of extremities Ataxia Bone pain Muscle weakness
Vitamin B_{12} (Nomenclature: Cobalamin)			
Aids in hemoglobin synthesis Essential for normal functioning of all cells, especially nervous system, bone marrow, and gastrointestinal tract Important in energy metabolism, especially folic acid metabolism	Foods of animal origin **100% DRI:** 3 clams/month 3 oz beef liver/month 1 oz sardines 3 oz beef **25% DRI:** 4 oz yogurt 6 oz milk 1 large egg	Pernicious (megaloblastic) anemia Subacute combined degeneration of the spinal cord Various psychiatric disorders May cause anorexia Contributes to osteoporosis	No toxicity known
Folacin (Nomenclature: Folic Acid)			
Functions in the formation of red blood cells and in normal functioning of gastrointestinal tract Essential for the metabolism of protein and DNA	**100% DRI:** ~1 oz enriched cereals ½ c enriched rice 1¼ c lentils **25% DRI:** 2 oz liver 3 tbsp wheat germ ½ c chickpeas, black beans, and kidney beans ½ c spinach and okra ¾ c broccoli and collard greens 10 oz orange juice 3-4 slices bread	Impaired cell division Alterations of protein synthesis with possible neural tube defect (i.e., spina bifida) Various psychiatric disorders Megaloblastic anemia Supplements mask the symptoms of pernicious anemia but not the neurologic manifestations	No toxicity known

Continued

Table 3-2 Water-Soluble Vitamins*—cont'd

FUNCTIONS	GOOD SOURCES	SYMPTOMS OF DEFICIENCY	SYMPTOMS OF TOXICITY
Choline			
A constituent of several compounds necessary for certain aspects of nerve function and lipid metabolism Required in utero for lifelong memory	Synthesized from methionine (an amino acid) **100% DRI:** 4 oz beef liver **25% DRI:** 2 eggs 1½ oz chicken liver	Occurs only when protein intake (methylamine) is low	No toxicity known in humans
Pantothenic Acid			
Essential part of complex enzymes involved in fatty acid metabolism	**100% DRI:** 3 oz beef liver 1 c shitake mushrooms 1½ c mushrooms **25% DRI:** 1 chicken liver ⅓ c sunflower seeds ¾ c enriched rice 8 oz yogurt 1 c potato, peas, and sweet potato 12 oz milk 2 eggs 2 c legumes	Nutritional melalgia (burning foot syndrome) Headache Fatigue Poor muscle coordination Nausea Cramps	Possible diarrhea
Biotin†			
Essential for activity of many enzyme systems Plays a central role in fatty acid synthesis and in the metabolism of carbohydrates and protein Essential for growth and development and healthy skin	Liver Meats Milk Soy flour Brewer's yeast Egg yolk (raw egg white destroys biotin) Bacteria in the intestinal tract also produce biotin	Rare, but includes certain types of anemia, depression, insomnia, muscle pain, dermatitis	No toxicity known in humans
Vitamin C (Nomenclature: Ascorbic Acid, Dehydroascorbic Acid)			
Helps protect the body against infections and helps in wound healing and recovery from operations Is important for tooth dentin, bones, cartilage, connective tissue, and blood vessels	**100% DRI:** ⅓ c red peppers ½ c peaches ½ papaya 6 oz apricot nectar and orange juice ¾ c green pepper 1 c strawberries 1 c broccoli **25% DRI:** ⅓ c kohlrabi 3 oz grapefruit juice ½ kiwi	Anemia Swollen and bleeding gums Loose teeth Ruptures of small blood vessels (bruises) Scurvy (rebound scurvy can occur when large doses, or megadoses, are suddenly stopped)	Urinary stones Diarrhea Hypoglycemia Inhibits zinc absorption Interferes with tests for fecal and urinary occult blood Will provide a false positive test for glucosuria

Data from U.S. Department of Agriculture, Agricultural Research Service: USDA National Nutrient Database for Standard Reference, release 17; Davis J, Sherer K: *Applied nutrition and diet therapy for nurses,* ed 2, Philadelphia, 1994, Saunders; and Mahan KL, Escott-Stump S: *Krause's food, nutrition, and diet therapy,* ed 12, Philadelphia, 2008, Saunders.

DRI, Dietary Reference Intake; *IV,* intravenous.

*Amounts of foods listed meet the Dietary Reference Intake for adults ages 31 to 50 (largest amount used as reference) as rounded off to the nearest portion size to meet the DRI.

†Amounts of foods not listed due to lack of consistent and available data.

receive levodopa, multiple sclerosis, depression, and epilepsy with certain antiepileptic drugs. B vitamin deficiency should be suspected in children with development disorders, failure to thrive, and unexplained neurologic manifestations (Herrmann, Lorenzl, and Obeid, 2007).

Thiamin (Vitamin B_1)

Thiamin is a **cofactor** (an organic molecule that connects with another element or enzyme to allow metabolic processes to occur). Thiamin is required by at least three enzymes to allow for carbohydrate metabolism. Metabolic products related to thiamin use are needed for protein synthesis, **deoxyribonucleic acid (DNA)** or the substance of our genetic material, and brain chemicals. Thiamin deficiency can lead to serious brain disorders. **Neuropathy** (nerve damage) is associated with deficiency of thiamin. Neuropathy is commonly found in persons with diabetes unrelated to thiamin deficiency (see Chapter 8).

The requirement for thiamin is small but important and is based on the caloric requirements. Thiamin is needed in increased amounts during pregnancy and breastfeeding, but these levels are easy to achieve through an increased food intake.

Deficiency of this vitamin can occur when unenriched processed white flour, white rice, or sugar are consumed as a main staple of the diet. Deficiency characteristics include beriberi (muscle wasting from nerve damage or edema), mental confusion, anorexia, and enlarged heart. Thiamin deficiency produces a variety of events, including mild impairment of oxidative metabolism (see Chapter 4), neuronal loss in select brain regions, and inflammation (Karuppagounder and colleagues, 2007). Thiamin-dependent enzymes are diminished in several neurodegenerative diseases (Shi and colleagues, 2007). Alcoholics also can develop **Wernicke-Korsakoff syndrome** related to deficiency of thiamin (see Chapter 4).

Although Wernicke's encephalopathy is most commonly associated with alcoholism, other causes have also been implicated such as excessive vomiting, as found with hyperemesis gravidarum during pregnancy (see Chapter 11), drastic–weight-loss diets, and bariatric surgery to induce weight loss. Wernicke's encephalopathy can also be found with hyperthyroidism (Bonucchi and colleagues, 2008).

Wernicke's encephalopathy, with thiamin deficiency, may exhibit a distinctive acid-base pattern consisting of a primary **metabolic acidosis** (a condition related to the accumulation of acid or depletion of alkaline reserves that lowers the pH level of blood and body tissues) in conjunction with a primary respiratory alkalosis (Donnino and colleagues, 2007). Thiamin deficiency may be the cause of severe **lactic acidosis** (severe buildup of lactate, often related to diabetes and genetic deficiencies of enzymes). High-risk populations include those who are malnourished or are alcoholics. Acute heart failure, neurologic deficits, weakness, and lower limb edema are found with severe thiamin deficiency. In one case study of beriberi the initial symptoms included stiffness of the legs and **nystagmus** (rapid, involuntary movement of the eyeball) with reduced visual acuity limited to counting fingers. Treatment with thiamin allowed this individual to dramatically improve his voluntary eye movement (Lindholt, 2006). Another man with schizophrenia and malnutrition presented with delirium, paralysis of the eye muscles, and seizures. He responded rapidly to the intravenous administration of thiamin. Wernicke's encephalopathy should be

suspected for any person at risk for malnutrition or with **ophthalmoplegia** (paralysis of the eye muscles), regardless of alcohol history (Harrison, Vu, and Hunter, 2006). Pulmonary hypertension can be caused by thiamin deficiency and is treatable. Persons with this condition at high risk of nutritional deficiency should be screened for thiamin deficiency (Park and colleagues, 2007).

A case of beriberi was induced from surgical removal of the upper portion of the intestinal tract (also found with a form of bariatric surgery—see Chapter 6) combined with diuretic use. The man had pretibial pitting edema, foot numbness, and gait disturbance. With inititiation of thiamin supplementation the edema disappeared within days, and signs of polyneuropathy gradually subsided. Caution should be used in persons with upper gastrointestinal surgery and use of diuretics (Tsujino and colleagues, 2007). One form of megaloblastic **anemia** is characterized by diabetes mellitus (see Chapter 8) and progressive deafness and responds with supplemental thiamin (Lagarde and colleagues, 2004). Whenever thiamin deficiency is suspected, treatment with thiamin should be initiated immediately.

The only known toxicity is from intravenously administered thiamin. However, the potential for toxicity exists in extremely large doses readily available in supplement form, especially with long-term, chronic use of very high amounts.

Riboflavin (Vitamin B_2)

The requirement for riboflavin is also related to caloric requirements. Riboflavin is involved in many enzyme reactions that allow for energy use at the cellular level. It is important for healthy skin, lips, tongue, and eye surface. Results from one study suggests that moderate consumption of riboflavin may be protective against postpartum depression (Miyake and colleagues, 2006).

Biochemical signs of depletion arise within only a few days of dietary deprivation. Riboflavin deficiency contributes to anemia, especially with low iron intake. Riboflavin appears to play a role in levels of homocysteine, a risk factor for cardiovascular disease. Deficiency symptoms are associated with skin changes such as cheilosis (see Figure 3-4), vulval and scrotal skin changes, and general dermatitis.

Without an adequate consumption of milk and milk products, riboflavin intake is likely to be impaired. Other food sources such as enriched white-flour products do contribute to riboflavin status, along with nuts, legumes, fish, organ meats, avocadoes, mushrooms, and green, leafy vegetables. There are no known toxic levels of this vitamin; however, excess intake can inhibit zinc utilization.

Niacin (Nicotinic Acid or Vitamin B_3)

Niacin requirements, along with thiamin and riboflavin, are related to caloric intake and are essential for energy metabolism at the cellular level. Niacin needs are met in part by the conversion of the essential amino acid tryptophan, found in milk, eggs, and turkey. Vegan diets therefore need to ensure adequate intake of niacin.

Pellagra is the main niacin deficiency syndrome due to inadequate dietary nicotinic acid and/or tryptophan, conditions of malabsorption, and certain medications such as antituberculosis medications and the sedative/anticonvulsant medication phenobarbital. It is characterized by three *D*s: diarrhea, dermatitis, dementia; these may also be referred to as the four *D*s with the final stage of death. The dermatitis

begins as redness of the skin and resembles sunburn in its first stages. The dermatitis worsens after reexposure to sunlight.

One young adult rapidly developed cataracts as a consequence of pellagra in combination with iron overload causing depletion of an important antioxidant; the cataracts were attributed to oxidative damage (Athanasiadis and colleagues, 2007). Niacin and vitamin E deficiency in patients with alcohol-associated pellagra may lead to increased intestinal permeability (Varella Morandi Junqueira-Franco and colleagues, 2006). Niacin should be started for the treatment of chronic alcoholic patients showing **myoclonus** (shocklike muscle contractions, usually related to a convulsive disorder such as epilepsy) and **ataxia** (lack of muscular coordination) even without the classical triads of diarrhea, dermatitis, and dementia (Sakai, Nakajima, and Fukuhara 2006). Treatment should also include other B vitamins, zinc, and magnesium as well as a diet rich in calories (Pitche, 2005).

There appears to be a protective role for niacin related to a coenzyme that may help to prevent neurodegenerative conditions and to fight a form of *Candida* infection. Adverse outcomes can occur with excessive intake such as with high-dose nicotinic acid used in the management of elevated triglyceride levels (see Chapter 7) with skin flushing and occasionally more serious side effects (Belenky, Bogan, and Brenner, 2007). Extended-release niacin therapy has been shown to help reverse the thickening of the lining of the carotid artery, increase high-density lipoprotein (HDL) cholesterol, reduce triglyceride levels, improve **endothelial** (the cells that make up the lining of blood vessels) function, and decrease vascular inflammation (Thoenes and colleagues, 2007). In a study of rats with arthritis, nicotinic acid contributed to reduced symptoms of inflammation of joint tissue (Mitrofanov and colleagues, 2005).

Nicotinamide (a form of niacin) and an enzyme it promotes help with cellular survival and life span. As such nicotinamide appears beneficial to the aging process, Alzheimer's disease, diabetes, cerebral ischemia, Parkinson's disease, and cancer (Li, Chong, and Maiese, 2006).

Pantothenic Acid (Vitamin B_5)

Pantothenic acid is an essential constituent of complex enzymes involved in fatty acid metabolism and synthesis of certain body constituents. Lack of pantothenic acid leads to a deficiency of an enzyme related to an inherited form of a neurologic disorder. A study of mice deprived of pantothenic acid similarly developed a movement disorder, weight loss, and loss of sperm in the semen. Reintroduction of this vitamin allowed reversal of these conditions (Kuo, Hayflick, and Gitschier, 2007). There is also evidence that pantothenic acid helps prevent cancer development (Schittl and Getoff, 2007). It is widely distributed in food and occurs abundantly in animal sources, whole-grain cereals, and legumes. The DRI reference may be found at the back of the book. Dietary deficiencies are unlikely, but marginal ones may exist in generally malnourished individuals, as well as in conjunction with deficiency of other B-complex vitamins. The usual dietary intake is between 5 and 20 mg daily.

Pyridoxine, Pyridoxal, and Pyridoxamine and Related Substances (Vitamin B_6)

Three interrelated substances—pyridoxine (from plants), pyridoxal, and pyridoxamine (from animal products)—are collectively known as vitamin B_6. Vitamin B_6 is involved in over 100 enzyme-catalyzed reactions, including many involved in the

synthesis or catabolism of neurotransmitters, and is a potent antioxidant. The need for vitamin B_6 increases with high-protein diets, pregnancy, the tuberculosis medication isoniazid (because of interference with the synthesis of pyridoxine, a supplement of vitamin B_6 is necessary), and some contraceptives.

Vitamin B_6 is necessary for normal cell membrane function and stability. Vitamin B_6 functions primarily in the cellular metabolism of protein and amino acids . It is also important in energy metabolism. Vitamin B_6 may be of importance in regeneration of red blood cells and the normal functioning of the nervous system. In addition, vitamin B_6 helps to convert tryptophan to niacin.

Another vitamin B_6-dependent sulfur-based enzyme is needed to synthesize cysteine from methionine. Vitamin B_6 also lowers levels of homocysteine, a risk factor for cardiovascular disease (see Chapter 7). Low vitamin B_6 is a risk factor for a recurrent form of venous thromboembolism or clots (Hron and colleagues, 2007).

There are at least four inborn errors of metabolism related to vitamin B_6 and present with early-onset epilepsy that is resistant to conventional medications. One form only responds to the active form of pyridoxine (Wang and Kuo, 2007).

Tardive dyskinesia is a condition related to long-term use of antipsychotic medication. It causes impairment in voluntary movement and resembles continual chewing motions with darting movements of the tongue, and may also be found with abnormal movements of the extremities. Tardive dyskinesia has shown improvement with vitamin B_6 (Lerner and colleagues, 2007).

Excess ingestion of pyridoxine causes a severe sensory neuropathy in humans. Previous attempts at controlling premenstrual syndrome (PMS) (see Chapter 13) with 500 to 5000 mg of vitamin B_6 daily resulted in peripheral neuropathy within a few years. The use of vitamin B_6 at doses less than 100 mg/day appears safe for adults.

Biotin (Vitamin B_8)

Biotin is a sulfur-containing vitamin that is essential for the activity of many enzyme systems (see Chapter 4). It is widely distributed in nature and is bound to protein in foods and tissues. It plays a central role in synthesis of fatty acids and participates in several metabolic reactions at the cellular level. Biotin is an essential micronutrient for growth and development and is needed for healthy skin. The process of **gluconeogenesis** (formation of glucose from protein breakdown) is dependent on biotin. Insufficient biotin intake results in signs and symptoms such as loss of appetite, nausea and vomiting, hair loss, dermatitis, and an increase in cholesterol levels. Inflammatory diseases have been linked with poor biotin status (Kuroishi and colleagues, 2008).

Biotin deficiency from diet generally occurs from excess intake of raw egg white or by long-term parenteral nutrition (see Chapter 15). An incident of acute onset quadriplegia occurred in a 10-year-old boy due to chronic intake of raw eggs; treatment with biotin allowed recovery (Adhisivam, Mahto, and Mahadevan, 2007).

Genetic causes of deficiency can occur. Lack of a biotin-dependent enzyme caused a 3-year-old boy to develop a variety of symptoms, including rash, projectile vomiting, progressive loss of consciousness, and hypotension (low blood pressure). These symptoms were found in conjunction with metabolic acidosis and hyperammonemia. This condition was ultimately related to a genetic disorder but responded to biotin, and the child experienced normal growth and development (Chou and

colleagues, 2006). Deficiency of a biotin-based enzyme should be considered in the diagnosis of unexplained spinal cord demyelination because treatment with biotin may enable a recovery if diagnosed early (Y Yang and colleagues, 2007b).

Biotin deficiency has further been associated with hyperglycemia and insulin resistance, and good intake appears to have a positive impact on lowering hypertension and stroke (Watanabe-Kamiyama and colleagues, 2008). The DRI reference may be found at the back of the book. There is no known toxicity.

Folate (Vitamin B_9)

The active form of folate is folic acid, which is formed from folate by vitamin C. Many forms of this water-soluble vitamin exist. Folate got its name from the word *foliage*, because all dark green, leafy vegetables are high in folate. Ideally, raw, fresh, dark green, leafy vegetables such as spinach or broccoli should be consumed, because folate may be lost in cooking. Legumes, wheat germ, and oranges are also high sources of folate.

Folate aids in the metabolism of protein and DNA, the basic structure of genes found in all cells. Folate helps prevent **spina bifida** (a neural tube defect that starts during the first month of pregnancy when the spinal cord is not fully enclosed). It is recommended that all women of childbearing age consume 0.4 mg of folic acid daily. Grain products that are enriched with B vitamins now must also be fortified with folic acid as a means to reduce the incidence of spina bifida.

One child with megaloblastic anemia improved with a supplement of folic acid and pyridoxine. Folate deficiency is a well-known cause of **megaloblastic anemia** (form of anemia characterized by enlarged red blood cells). However, less well known is that homocystinuria, as found with this particular child, due to inadequate intake of vitamin B_6 also contributes to megaloblastic anemia (Gomber and colleagues, 2004). Another positive role for folic acid supplementation appears for persons affected by chronic inflammatory skin diseases, including psoriasis (Gisondi and colleagues, 2007).

There are other conditions related to impaired folate metabolism or deficiency. Impaired folate metabolism may be a contributing factor related to the development of allergy tendency (Husemoen and colleagues, 2006). Clinical depression may be partially induced with folate deficiency. A study is currently under way to verify use of folate to help with clinical depression. Low folate levels appear to inhibit antidepressant response, and this B vitamin is required for the synthesis of neurotransmitters implicated in the development and treatment of depression (Roberts and colleagues, 2007). Further, folate deficiency appears to promote arsenic-induced skin cancer (Nelson and colleagues, 2007).

In normal, healthy adults, supplemental folate can be considered nontoxic. Those taking antiepileptic medications should consult their physicians. Other concerns related to supplemental folate include potential problems identifying a B_{12} deficiency resulting in neurologic damage, reduced zinc absorption, and interactions with drugs designed to inhibit folate metabolism.

Cobalamin (Vitamin B_{12})

Cobalt, a mineral, is an essential part of vitamin B_{12}. Vitamin B_{12} is important to DNA synthesis and may affect bone formation. The Framingham Offspring Osteoporosis

Study (1996 to 2001) concluded that vitamin B_{12} deficiency may be an important risk factor for osteoporosis (Tucker and colleagues, 2005). Common symptoms of vitamin B_{12} deficiency in infants include conditions related to poor neuromuscular development, including feeding difficulties, developmental delay, small head, failure to thrive, hypotonia, lethargy, irritability, involuntary movements, seizures, and cerebral atrophy.

Vitamin B_{12} is found bound to protein in foods of animal origin. There is relatively little in vegetables, which is why vegans (see Chapter 1) require a vitamin B_{12} supplement or vitamin B_{12}–fortified foods. Vitamin B_{12} status should be monitored in vegetarians to help prevent irreversible nerve damage in particular. Another group at risk of vitamin B_{12} deficiency, as well as vitamin B_6, is persons with phenylketonuria (PKU) (see Chapter 2) as a result of following a low-protein diet. A group of adults with PKU was found to be at increased risk of developing vitamin B_{12} deficiency, and their intake of vitamin B_6 was below the DRI. Daily vitamin supplementation is advised (Hvas, Nexo, and Nielsen, 2006).

Deficiency of vitamin B_{12}, like folate deficiency, is a well-known cause of megaloblastic anemia. **Pancytopenia** (low levels of all blood constituents) is also found with vitamin B_{12} deficiency. All forms of vitamin B_{12} deficiency are commonly referred to as **pernicious anemia** (the primary form of vitamin B_{12}-related anemia) but more correctly are known as megaloblastic anemia. Pernicious anemia is caused by autoimmune destruction related to the ability to produce **intrinsic factor** (a glycoprotein secreted in the stomach that attaches to vitamin B_{12} to aid its absorption).

Decreased amounts of intrinsic factor are common among the elder population (see Chapter 13). Ability to absorb vitamin B_{12} decreases with age, and injections are often necessary for older adults to prevent or control pernicious anemia. Use of antacids and proton-pump inhibitors in treatment of gastroesophageal reflux disease (see Chapter 4) is also common in older adults, and treatment may be related to vitamin B_{12} deficiency. Vitamin B_{12} status was found to decline during prolonged use of proton-pump inhibitors, such as with the medications Nexium, Prevacid, Prilosec, and Protonix use, but not with prolonged histamine$_2$ receptor antagonists. There appears to be an increased need for B_{12} beyond the RDA with these treatments (Dharmarajan and colleagues, 2008).

Intestinal malabsorption can also cause a deficiency. The lower portion of the small intestine, the ileum, is the main site of vitamin B_{12} absorption, although the duodenum also is important for absorption (see Chapter 4). Persons with gastric bypass surgery that reduces the length of the duodenum may require B_{12} injections and should be screened for megaloblastic anemia.

Mental or psychologic changes related to B_{12} deficiency may precede signs of megaloblastic anemia by months or years. The most common psychiatric symptoms are depression, mania, psychotic symptoms, cognitive impairment, and obsessive-compulsive disorder. It is recommended that serum B_{12} determinations be undertaken in all patients with organic mental disorders, atypical psychiatric symptoms, treatment-resistant depressive disorders, dementia, psychosis, or risk factors for malnutrition such as found with alcoholism. Vitamin B_{12} deficiency is often found with psychiatric illness, and recovery may occur with a combination of vitamin B_{12} and psychiatric medication (Bhat and colleagues, 2007).

Vitamin B_{12} deficiency should be suspected when altered cognition and/or neurologic manifestations follow the use of nitrous oxide with surgery (El Otmani and colleagues, 2007). This can also be caused by nitrous oxide "whippit" associated with psychiatric manifestations (Sethi and colleagues, 2006).

Other issues of vitamin B_{12} deficiency include an unusual manifestation of enlarged spleen along with pancytopenia and severe megaloblastic anemia (Halfdanarson and colleagues, 2008b). Demyelination of the spinal cord is another neurologic complication due to vitamin B_{12} deficiency. In one case a young woman without anemia but with a 10-month history of paresthesia was found to have vitamin B_{12} deficiency. Treatment with vitamin B_{12} supplements showed gradual improvement in her clinical symptoms (Maamar and colleagues, 2008). Children with bladder augmentation surgery involving the ileum are at high risk of vitamin B_{12} deficiency beginning at 7 years postoperatively, and the risk increases with time. An annual screen for serum B_{12} value in these children beginning at 5 years following bladder augmentation is advised (Rosenbaum and colleagues, 2008).

A low vitamin B_{12} status with elevated levels of serum folate has been associated with increased risk of cognitive impairment. Evidence suggests a worsening of enzymatic functions with vitamin B_{12} deficiency as folate status increases (Selhub, Morris, and Jacques, 2007).

There is no known toxicity related to excess intake or serum levels of vitamin B_{12}.

Choline

Choline is a constituent of several compounds that are necessary for certain aspects of nerve function and lipid metabolism. In a mice study, fatty liver and liver failure developed with a choline-deficient diet (Li and Vance, 2008). Choline is important for normal membrane function and the production of **acetylcholine** (an important neurotransmitter). A choline-deficient diet has been implicated in a form of mitochondrial dysfunction that may be at the root of nonalcoholic fatty liver disease (Petrosillo and colleagues, 2007). The DRI may be found at the back of the book.

Foods with the highest choline content are, in order, beef liver, chicken liver, eggs, wheat germ, dried soybeans, and pork. Peanuts and peanut butter are other good sources of choline. The body can synthesize choline from methionine as found in animal protein, thus the inclusion of soy products, whole grains, and peanuts are of particular importance for persons following vegan diets. Including choline-rich foods, especially during pregnancy, is advised.

Vitamin C (Ascorbic Acid)

Vitamin C, also called ascorbic acid, is a water-soluble derivative of glucose and performs a variety of functions. It is required for synthesis of collagen fibers through metabolism of the amino acids proline and lysine. Vitamin C is therefore important for tooth dentin, bones, cartilage, connective tissue, and blood vessels. Through its role of promoting skin integrity, it is thought to help protect the body against infections. Vitamin C helps heal wounds, which is critical for a person recovering from a surgical operation and for healing skin breakdown (see Chapter 15). Vitamin C is well known as an antioxidant responsible for the elimination of **free radicals** (reac-

tive oxygen species responsible for damaging cells and linked with various diseases). Vitamin C is an essential cofactor for a range of enzymes involved in diverse metabolic pathways. Consumption of foods rich in vitamin C (fruits and vegetables) is associated with decreased risk of cardiovascular disease, many types of cancer, and possibly neurodegenerative disease. This may be a result of its role as an antioxidant. Vitamin C further appears to help in the removal of neurotoxic lead (Tariq, 2007).

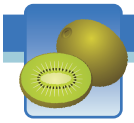
Higher levels of intake may be necessary during conditions of stress, with certain medications, or in persons who smoke. However, these increased needs can easily be met with an extra serving of a food high in vitamin C. Citrus fruits; melons; dark green, leafy vegetables; potatoes; and green pepper are all high in vitamin C. Although citrus fruit is a well-known source of vitamin C, other foods may be included around the world such as guava, papaya, and bitter gourd. It has been found that vitamin C content of regional varieties of foods can vary widely based on country of origin. Bananas, for example, were found to be high in vitamin C in Pakistan but are considered poor sources of vitamin C in the United States, the same applying to cauliflower (Iqbal, Kazim, and Mehboobali, 2006). Fresh fruits have been shown to have three to four times more antioxidants than dry fruits (Tarwadi and Agte, 2007). Vitamin C content of foods is required on food labels, being considered a marker nutrient for other necessary nutrients in the diet. Thus foods high in vitamin C provide additional vitamins and minerals needed for health.

Inadequate vitamin C intake may eventually lead to swollen and bleeding gums, loose teeth, and ruptures of small blood vessels (Figure 3-6), which are early forerunners of scurvy. In a study in the United States, scurvy was found to occur with the most common signs and symptoms being pedal edema, mucosal changes, bruising, **arthralgias**, and joint swelling. A diet history and measurement of serum ascorbic acid levels may be warranted for persons with nonspecific musculoskeletal complaints (Olmedo and colleagues, 2006). There is evidence of oxidative damage of DNA with inadequate levels of vitamin C (Krajcovicova-Kudlackova and colleagues, 2007).

FIGURE 3-6 Scorbutic gingivitis. (From Neville BW, Damm DD, Allen CM, Bouquot JE: *Oral and maxillofacial pathology*, ed 2, Philadelphia, 2002, Saunders.)

Tadeus Reichstein (1897-1996), who in 1950 was the first scientist born in Poland to receive the Nobel Prize in medicine or physiology, was the first to develop a strategy for the mass production of vitamin C. This process led to drastically reduced cost and has allowed widespread use of supplemental vitamin C. Vitamin C is generally not toxic. However, some individuals are at risk for toxicity. About one eighth of men with African, Asian, Sephardic Jewish, or Mediterranean heritage are born with glucose-6-phosphate dehydrogenase deficiency. In these individuals, megadoses of vitamin C will instantly affect red blood cells and can lead to death within hours. In addition, megadoses of vitamin C can precipitate an acute sickle cell crisis in those with **sickle cell disease** (a disease in which red blood cells take on a sickle shape). Also, because megadoses of vitamin C cause **hyperosmotic diarrhea** (in which excess substances attract water in the intestinal tract through the process of osmosis, resulting in watery stools), persons with preexisting diarrhea—such as those with acquired immunodeficiency syndrome (AIDS)—can go into hypovolemic shock. A safe dose of vitamin C is less than 1000 mg daily, 500 mg being already nearly 10 times the recommended daily amount. Very high amounts of vitamin C increase oxalate and urate excretion, which can promote the development of renal stones (see Chapter 9).

Rebound scurvy may occur if the body has become accustomed to high doses of vitamin C and the dose is then suddenly discontinued. Instead, health professionals should recommend that people in this category gradually decrease from high doses. Much more research is needed on the safety of high doses of vitamin C and other vitamins. A more prudent approach at the present time is to obtain vitamin C, as well as other vitamins and minerals, from food sources to help avoid toxicity problems.



Cultural Considerations

Tropical fruits from south Florida include red guava, white guava, carambola, red pitaya (red dragon), white pitaya (white dragon), mamey sapote, sapodilla, lychee, longan, green mango, ripe mango, green papaya, and ripe papaya. The greatest antioxidant activity was found in red guava and carambola; the lowest found in sapodilla and green papaya. Guava and mamey sapote exhibited the highest total dietary fiber and pectin levels (Mahattanatawee and colleagues, 2006). ■

Fact & Fallacy

FALLACY People who have colds should take megadoses of vitamin C (greater than 1 g/day).

FACT Cold symptoms may lessen because of the antihistamine effect of large doses of ascorbic acid. The risks of large doses of vitamin C can outweigh any possible benefits. A 1-g dose is more than 10 times the RDA for vitamin C, which is less than 100 mg/day. This quantity can result in rebound scurvy when the dosage is stopped. Also, a vitamin C supplement that is in chewable pill form promotes dental decay because the acidity of vitamin C is very destructive to dental enamel. ■

WHAT IS THE ROLE OF MINERALS IN NUTRTITION?

Minerals function as building materials in the following:

Bony tissue: Calcium, magnesium, and phosphorus in bones and teeth; fluoride in teeth

Soft body tissue (muscles, nerves, and glands): All salts, especially phosphorus, potassium, sulfur, and chloride

Hair, nails, and skin: Sulfur

Blood: All salts, as well as iron for **hemoglobin** and copper for red blood cells

Glandular secretions: Chloride in gastric juice, sodium in intestinal juice, iodine in thyroxine, manganese in endocrine secretions, and zinc and magnesium in enzymes

Minerals also function as regulators of the following:

Fluid pressure: All salts, especially sodium and potassium

Muscle contraction and relaxation: Calcium, magnesium, potassium, sodium, phosphorus, and chloride

Nerve responses: All salts, with a balance among calcium, magnesium, and sodium

Blood clotting: Calcium

Oxidation in tissues and blood: Iron and iodine

*The **acid-base balance**:* A balance between acidic compounds—chloride, sulfur, and phosphorus—and basic compounds—calcium, sodium, potassium, and magnesium

Coenzymes: Zinc, magnesium, potassium, calcium, and chloride

HOW ARE MINERALS CLASSIFIED?

Minerals are usually classified into two groups: major minerals and trace minerals. The major minerals are those present in the human body in amounts greater than 5 g. The trace minerals are found in the human body in amounts less than 5 g. Tables 3-3 and 3-4 list the major and trace minerals, their functions and sources, and signs and symptoms of deficiency and toxicity. The known DRIs for minerals can be found at the back of the book.

Other trace minerals are now thought to be essential, but no DRI has been set for amounts needed for health. These minerals include aluminum, arsenic, bromine, cadmium, germanium (used in semiconductors, which muscle and nerve cells essentially are), lead, lithium, rubidium, silicon, and tin.

Because minerals are meant to be found in the body only in small amounts, chronic excess ingestion has potential for toxicity. An adequate diet allows for a safe intake of these trace minerals, especially if whole grains; legumes; nuts; dark green, leafy vegetables; and dairy products are consumed regularly.

MAJOR MINERALS

Calcium (Ca^{2+})

Stored in the form of calcium phosphate, calcium is the major mineral constituent of the body; 99% of it is found in bones and teeth (giving rigidity), with the remainder found in the blood, other body fluids, and soft tissues. A test used currently to measure bone density is the **dual-energy x-ray absorptiometry (DXA or DEXA) scan**.

In conjunction with the other minerals, calcium facilitates passage of materials into and out of cells. Vitamin D is required for proper absorption and use of dietary calcium. Calcium absorption is enhanced by stomach acid released in digestion (see Figure 4-5). Inadequate calcium levels lead to poor bone growth and tooth development, stunted body growth, rickets in children (see Figure 3-5), thin and fragile bones, and poor blood clotting.

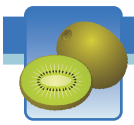
Calcium is effective in reducing blood pressure in various types of hypertension, including that induced by pregnancy. Low levels of calcium in the blood can lead to **tetany**, a condition of muscle twitches, cramps, and convulsions. The condition is not likely caused by inadequate calcium intake but rather by **hypoparathyroidism** (reduced function of the parathyroid gland), some bone diseases, certain kidney diseases, or low serum protein. High levels of calcium can be caused by hyperparathyroidism and excess vitamin A. Hyperparathyroidism-induced hypercalcemia may be masked by severe vitamin D deficiency (Pitukcheewanont, Numbenjapon, and Costin, 2008).

Malabsorption can lead to low calcium levels. With celiac disease (see Chapter 4), intestinal malabsorption of calcium without a vitamin D deficiency is possible because of the involvement of the upper part of the small intestine early in the disease process. The use of a gluten-free diet with celiac disease can correct calcium status, with an increase in bone mineral density.

Milk, one of the best sources of calcium, is also a major contributor of protein, vitamin D, riboflavin, potassium, and magnesium. Milk intake is a major contributor to health. Calcium supplements cannot replace the nutritive value of milk. Pooled results from randomized controlled trials show no reduction in hip fracture risk with calcium supplementation for either gender, and an increased risk of fracture is possible. For any nonvertebral fractures, there was a neutral effect in the randomized trials (Bischoff-Ferrari and colleagues, 2007). This is likely due to bone health requiring more than just calcium and vitamin D; milk provides many other nutrients. Another concern with reliance on calcium supplements versus milk is the purity of the supplement. Calcium supplements made of bone have the highest lead content. Measures to prevent potential lead toxicity from excess intake of some calcium supplements should be considered.

Individuals who cannot tolerate milk can use calcium alternatives such as low-lactose milk and fortified soy milk. For those trying to control their fat intake, low-fat or skim milk can be used. Figure 3-3 shows where calcium foods are found in the MyPyramid Food Guidance System. Although dark green, leafy vegetables are high in calcium, the calcium in Swiss chard, beet greens, spinach, and rhubarb generally is not available to the body because an insoluble salt forms with the oxalic acid found in these foods. Collard greens are a good source of available calcium similar to the content of milk as based on volume.

The UL is 2500 mg calcium; other DRIs can be found at the back of the book.



Cultural Considerations

The incidence of rickets is high in the Middle East and was found to be more severe in Egypt than in Turkey. Europe-dwelling children of Middle Eastern origin also have increased risk of rickets. In Egypt the cause was found to be mainly inadequate intake of calcium along with vitamin D deficiency. Vitamin D deficiency appears to be the primary cause of rickets in Turkey.

There is evidence this has a genetic basis and the RDI may not address these unique needs for calcium and vitamin D (Baroncelli and colleagues, 2008). A genetic basis for vitamin D–deficiency rickets was also found among children of Chinese heritage (Wu and colleagues, 2006). ■

Teaching Pearl

An interesting experiment (and a useful teaching technique) is to soak a chicken bone in vinegar, which leaches the calcium from the bone. This activity clearly demonstrates how calcium lends rigidity to the bone, because without it the bone becomes extremely soft and pliable. ■

Fact & Fallacy

FALLACY Butter and eggs are high in calcium because they are dairy products.

FACT Butter comes from milk fat and does not contain a significant amount of calcium. Eggs do not have any significant amount of calcium. ■

Magnesium (Mg^{2+})

Magnesium ions are essential to all living cells. As the second most abundant intracellular cation (positively charged ion), magnesium has a crucial role in fundamental metabolic processes such as DNA and protein synthesis, neuromuscular excitability, and muscular contraction and relaxation and is also essential for bone stability. Magnesium plays a role in more than 300 enzymatic reactions and is critically involved in energy metabolism (adenosine triphosphate [ATP]), the production of fatty acids, and virtually all hormonal reactions. Magnesium acts as a natural **calcium channel blocker** (a form of medication used to control blood pressure) and promotes a healthy cardiovascular system (Myoishi and Kitakaze, 2005). Magnesium helps with the transport of potassium and calcium ions in and out of body cells and is involved with cell proliferation.

Increasing consumption of magnesium appears to decrease the risk of symptomatic gallstones in men (Ko, 2008). Evidence suggests that magnesium intake may lower risk of hypertension and type 2 diabetes mellitus and improve **dyslipidemia** (a condition of elevated blood triglyceride and low HDL cholesterol; see Chapter 7) (He and colleagues, 2006). This may be due to its role in reducing inflammation as commonly found with the metabolic syndrome (see Chapter 5). Magnesium salts, the prevalent minerals in the Dead Sea, are known to exhibit favorable effects in inflammatory diseases and are beneficial to the skin. Asthma, an inflammatory condition, can effectively be treated with intravenous delivery of magnesium sulphate during acute episodes. This has been shown to have a significant effect upon respiratory function among children, but with adults only a minor effect was found (Mohammed and Goodacre, 2007).

The major food sources of magnesium are those containing chlorophyll, such as the dark green, leafy vegetables (magnesium is involved in the green color of the chlorophyll molecule). Legumes, fish, and whole grains (the germ portion) are also significant sources of magnesium (Table 3-3).

Magnesium deficiency has been believed to be rare because blood levels usually are normal. However, with the development of new technologies to measure the

Table 3-3 Major Minerals (Macronutrients)*

FUNCTIONS	SOURCES	SYMPTOMS OF DEFICIENCY	SYMPTOMS OF TOXICITY
Calcium (Ca^{2+})			
Helps muscles to contract and relax, thereby helping to regulate heartbeat Plays a role in the normal functioning of the nervous system Aids in blood coagulation and the functioning of some enzymes Helps build strong bones and teeth May help prevent hypertension	**25% DRI:** 1½ oz cheese 3 oz sardines ¾ c cooked rhubarb 6 oz yogurt 1 c collard greens 1 c soybeans 1 c milk 1½ c turnip greens 1½ c white beans 6 slices whole-grain bread	Poor bone growth and tooth development, leading to stunted growth and increased risk of dental caries, rickets in children, osteomalacia and osteoporosis in adults, poor blood clotting, and possible hypertension	Kidney stones in predisposed individuals
Chloride (Cl^-)			
Involved in the maintenance of fluid and acid-base balance Provides an acid medium in the form of hydrochloric acid for activation of gastric enzymes	Major source is table salt (sodium chloride); also found in fish and vegetables	Disturbances in acid-base balance, with possible growth retardation, psychomotor defects, and memory loss	No toxicity known
Magnesium (Mg^{2+})			
Helps build strong bones and teeth Participates in protein synthesis and lipid metabolism Helps regulate heartbeat Involved in 300 enzymatic reactions and energy metabolism (ATP) Involved with most hormonal reactions Acts as a natural calcium channel blocker (related to blood pressure control)	**25% DRI:** 5 tbsp wheat germ 1 oz hazelnuts/filberts 1¼ oz almonds 3 oz fish ¾ c spinach ¾ c soybeans, white beans, and black beans 1 c lima beans 1 c beet greens and okra 10 oz milk	New evidence indicates deficiency states more common than previously thought, and related to: • Hypertension • Ischemic heart disease • Arrhythmia • Preeclampsia • Asthma	Increased calcium excretion
Phosphorus (P)			
Helps build strong bones and teeth Present in the nuclei of all cells Helps in the oxidation of fats and carbohydrates (energy metabolism) Aids in maintaining the body's acid-base balance	**25% DRI:** 2 oz fish 3 oz turkey ½ c soybeans & lentils ¾ c baked beans ¾ c sunflower seeds ¾ c cottage cheese 6 oz milk	Rare, but with malabsorption can cause anorexia, weakness, stiff joints, and fragile bones	Hypocalcemic tetany (muscle spasms)

Table 3-3 Major Minerals (Macronutrients)*—cont'd

FUNCTIONS	SOURCES	SYMPTOMS OF DEFICIENCY	SYMPTOMS OF TOXICITY
Potassium (K^+)			
Plays a key role in fluid and acid-base balance Transmits nerve impulses, helps control muscle contractions, and promotes regular heartbeat Needed for enzyme reactions	**25% DRI:** 2 tbsp blackstrap molasses 1 c potato (white or sweet), beet greens, legumes, winter squash, and dates 1½ plantain, papaya, mango **>500 mg:** 7 apricots (14 dried halves) 1 banana 1 c tomato and orange juice 1 c beet 12 oz milk 1½ c leafy greens, melon	May cause impaired growth, hypertension, bone fragility, central nervous system changes, renal hypertrophy, diminished heart rate, and death	Hyperkalemia (excess potassium in the blood) with cardiac function disturbances
Sodium (Na^+)			
Plays a key role in the maintenance of acid-base balance Transmits nerve impulses and helps control muscle contractions	Salt (sodium chloride) is the major dietary source via table salt and processed foods; minor sources occur naturally in meat, milk and milk products, and several vegetables	**Hyponatremia** (low blood sodium)	May cause hypertension, which can lead to cardiovascular diseases and renal (kidney) disease In the form of salt tablets, can cause gastric irritation
Sulfur (S)			
Part of three amino acids and the B vitamins thiamin and biotin Plays a role in oxidation-reduction reactions Regulates cell membrane permeability	Protein-rich foods (meat, eggs, milk)	None documented in humans	Unlikely to cause significant symptoms

Data from U.S. Department of Agriculture, Agricultural Research Service: USDA National Nutrient Database for Standard Reference, release 17; Davis J, Sherer K: *Applied nutrition and diet therapy for nurses,* ed 2, Philadelphia, 1994, Saunders; and Mahan KL, Escott-Stump S: *Krause's food, nutrition, and diet therapy,* ed 12, Philadelphia, 2008, Saunders.

DRI, Dietary Reference Intake.

*Amounts of foods listed meet the Dietary Reference Intake for adults ages 31 to 50 (largest amount used as reference) as rounded off to the nearest portion size to meet the DRI.

intracellular concentration of magnesium, deficiency states are being recognized. Conditions in which magnesium deficiency has been implicated include hypertension, ischemic heart disease, arrhythmias, preeclampsia (see Chapter 11), and asthma. Magnesium is now considered the therapeutic agent of choice for preeclampsia (see Chapter 11). In a rat study, magnesium deficiency was found to cause a low-level inflammation in the small intestine. Magnesium deficiency further led to a variety of functional changes and increased sensitivity to oxidative stress. Correction with magnesium reduced the inflammation (Scanlan and colleagues, 2007). Lead neurotoxicity increases with decreased levels of magnesium and thiamin (Anetor and colleagues, 2007).

Causes of magnesium deficiency include decreased absorption, increased urination, and poor dietary intake. Chronic diarrhea, hypokalemia (low serum potassium), and **hypocalcemia** contribute to poor absorption. **Diuretics** (medications that cause fluid loss), uncontrolled diabetes, excess intake of liquids, and alcohol abuse contribute to increased urination. Magnesium deficiency occurs more frequently than generally assumed in the past (Mouw and Latessa, 2005). There may also be a genetic basis to some situations of hypomagnesemia—low levels of magnesium in the blood (Naderi and Reilly, 2008).

Magnesium deficiency is common among alcoholics. Magnesium treatment may speed up the normalization of an elevated liver enzyme and decrease the risk of death from alcoholic liver disease (Poikolainen and Alho, 2008).

High levels of magnesium can be caused by renal failure, heavy use of laxatives and antacids containing magnesium, dialysis, total parenteral nutrition (TPN) (see Chapter 15), and inadequate amounts of the hormone aldosterone. Reduced renal function in general among the elderly population increases the risk for toxicity symptoms as a result of excessive retention of magnesium. Antacids, laxatives, or other drugs containing magnesium should be used cautiously in such individuals. Among a group of elder individuals with congestive heart failure (also referred to as heart failure; see Chapter 7) it was found that about one in four had hypermagnesemia (excess magnesium in the blood). This appeared to be due to laxative/antacid use and was related to shorter life spans (Corbi and colleagues, 2008).

Hypermagnesaemia may lead to reduced activity and psychomotor function, which is observed in clinically depressed persons. This appears to be due to a relationship between **catecholamines** (hormones such as dopamine and adrenaline) and magnesium metabolism (Barra and colleagues, 2007). Because red blood cells contain high amounts of magnesium, elevated serum levels of magnesium may be reflective of breakdown of red blood cells. This is found in malaria, and one study noted a threefold increase in serum magnesium above normal levels (Garba and Ubom, 2006).

Phosphorus (P)

Phosphorus helps enzymes act in energy metabolism. Among minerals, the total amount of phosphorus in the body is second only to the amount of calcium. The largest amount of phosphorus is found with calcium in the bones; the remainder is in soft tissues and fluids. A wide variation in the ratio of calcium to phosphorus is tolerated in the adult diet that includes adequate vitamin D. A ratio of 1.5:1 is recommended in early infancy to prevent tetany caused by hypocalcemia (low blood levels of calcium). A study involving the United States, the United Kingdom, China,

and Japan found that increased phosphorus intake was related to reduced incidence of high blood pressure, although this was in conjunction with calcium and magnesium intake (Elliott and colleagues, 2008).

Phosphorus is widely available in most foods. Therefore deficiency is not a problem in the United States.

Potassium (K^+)

Potassium is an **electrolyte** (a substance that conducts electric flow through the body; see Chapter 4). Potassium is necessary for intracellular enzyme reactions and the synthesis of proteins.

Serum potassium fluctuations can be fatal because potassium affects the rate of the heartbeat. This is one reason that taking potassium supplements, such as those found in salt substitutes (e.g., potassium chloride), should be based on a physician's recommendation. It is imperative that individuals who are taking potassium-depleting diuretics receive additional potassium, preferably through food and again on the advice of a physician. Persons taking hypertensive medications called angiotensin-converting enzyme (ACE) inhibitors retain potassium and therefore need to avoid use of salt substitutes containing it. These ACE inhibitors often end in the suffix -il, such as with enalapril and captopril.

The DRI for potassium has been set at 4700 mg for adults (see DRI at the back of the book) and is easily met in a variety of food sources. Appendixes 6 and 7 on the Evolve website provide potassium content of foods. Based on kcalorie and carbohydrate content, dark, leafy green vegetables contain far more potassium than the usually recommended bananas and orange juice for a person taking a potassium-depleting diuretic. One average banana contains 120 kcal and 30 g of carbohydrate. For the same amount of potassium, ½ cup of spinach or broccoli provides only 25 kcal and 5 g of carbohydrate.

Sodium (Na^+)

Sodium is an electrolyte and as such is vital to health. It is naturally found in low levels in food, although rather significant levels are found in some foods such as milk and certain vegetables. The major dietary sources are table salt (sodium chloride) and foods with added salt, such as processed meats, convenience foods, and canned vegetables and soups (canned fruit is low in sodium). One teaspoon of salt contains about 2400 mg of sodium. Increased sodium intake can increase loss of calcium into the urine. See Chapter 7 for a more detailed discussion of sodium as it relates to heart disease.

The recommended daily value for sodium, as found on the original food label design is 2400 mg (see Figure 1-4). An intake up to 4000 mg is generally safe for healthy adults, although the UL more recently has been set at 2300 mg (see the back of this book).

TRACE MINERALS

Chloride (Cl^-)

Chloride is found in extracellular fluids. It is an electrolyte and is found in gastric juice as hydrochloric acid. Deficiency is generally found only in association with sodium depletion occurring with excessive fluid loss such as in diarrhea, vomiting,

or excessive sweating. The only excess known to occur results from water-deficiency dehydration. The DRI for chloride is 2300 mg/day for younger adults.

Chromium (Cr^{3+})

Chromium exists in different forms: chromium 3+, which is nontoxic, and chromium 6+, which is toxic. Chromium activates several enzymes, has an antioxidant role, and appears to be required for proper carbohydrate and lipid metabolism in mammals.

Chromium plays an important role in insulin receptors. Antidiabetic effects of chromium have been described. In rats consuming a high-fat diet, the addition of chromium picolinate was found to dramatically lower blood glucose level, to significantly lower triglycerides and creatinine level, and to show improved renal function (see Chapter 9) and reduced microvascular complications (Sahin and colleagues, 2007), although this finding did not bear out in a study of young overweight women (Diaz and colleagues, 2008). Another review of the impact on chromium indicated potential benefit only with blood glucose among persons with diabetes (Balk and colleagues, 2007).

The research is not strong enough to promote supplementation. This is particularly true in light of the potential for adverse effects with excess chromium intake; in addition, supplements containing chromium may not specify whether it is in the 3+ or the 6+ form.

Good sources of chromium include whole grains, legumes, meat, cheese, and brewer's yeast. Most of the chromium is removed from grains during the processing of white-flour products and is not returned during the **enrichment** process.

Copper (Cu^{2+})

Copper aids in the absorption of iron from the intestinal tract and in the production and survival of red blood cells and is also an essential part of many enzymes. It is an essential trace element in the maintenance of the cardiovascular system. Copper is used in a multitude of cellular activities, including respiration, immune responses, and embryo development. Copper deficiency has been related to birth defects, including major heart, brain, and vascular anomalies. There is evidence that copper deficiency causes altered nitric oxide function leading to abnormal embryo development (SJ Yang and colleagues, 2007). Menkes disease is a fatal neurodegenerative disorder of infancy caused by mutation in a copper-transport gene. Early treatment with copper has been found to extend life expectancy, but rarely halts the course of the disease (Kaler and colleagues, 2008).

Copper deficiency is related to a form of anemia and **neutropenia** (a condition of low levels of neutrophils, a component of the blood) and neurologic abnormalities that resemble vitamin B_{12} deficiency. Copper absorption in humans is expected to occur in the duodenum as with other minerals. Copper deficiency may be a delayed complication of bariatric surgery. In a study of 40 individuals with **hypocupremia** (copper deficiency) over half had previous gastrointestinal tract surgery either for weight reduction or other reasons. No cause could be found for the others in the study. Signs and symptoms included anemia and neutropenia, and the majority also had neurologic findings, most commonly due to nerve damage involving the spinal column (Halfdanarson and colleagues, 2008a).

Because excess zinc interferes with copper absorption, zinc supplements can lead to symptomatic copper deficiency. Excess blood levels of zinc may be present even

in the absence of oral zinc ingestion and lead to copper deficiency. There are similar signs of degeneration with copper deficiency as seen with vitamin B_{12} deficiency, and copper and vitamin B_{12} deficiency may coexist. The neurologic syndrome may be present without the hematologic evidence (Kumar, 2006).

One case study was of a 30-year-old woman with copper deficiency who presented with progressive gait disorder and sensory disturbances in her feet. Neurologic examination showed muscle weakness of her extremities with spastic ataxia. The cause was attributed to malabsorption, and after copper supplementation the progression of her neurologic symptoms was stopped (Jung and Marziniak, 2008). Copper status should be evaluated when there is noninflammatory nerve damage of the spinal cord of unknown etiology and corrected with copper treatment as needed. Small-bowel bacterial overgrowth syndrome should further be investigated as a possible contributing factor to copper deficiency after gastric surgery; antibiotic treatment has been found to prevent further nerve damage (Spinazzi and colleagues, 2007).

Toxicity is generally rare. **Wilson's disease** is a genetically inherited form of copper toxicity. Wilson's disease should be considered in case of any liver disease of unknown origin or neuropsychiatric symptoms. Copper is a common fungicide used in grape vineyards. The soil content of copper can accumulate excessively. A study in Australia found the vast majority of soil samples taken from vineyards had higher levels than normal and were in concentrations known to cause adverse effects, including growth inhibition, impact on reproduction, and social avoidance behavior (Wightwick and colleagues, 2008).

Fluorine (Fl^-)

Fluorine is generally referred to as fluoride and helps in the formation of solid bones and teeth. It also helps reduce the incidence of dental caries (see Chapter 12). There is some evidence that it aids calcium in bone formation. The Food and Nutrition Board recommends fluoridation of public water supplies if natural fluoride levels are low. The American Dental Association recommends fluoride supplements until about age 13 or until the adult teeth are fully formed. Like other trace minerals, fluoride is toxic when consumed in excessive amounts. The DRIs have now been established, as listed in the DRI table at the back of the book.

Iodine (I^-)

Iodine is found in thyroid hormones involved in general metabolism, and inadequate intake induces hypothyroidism. Conversely, excessive intake of the nutrient leads to a form of hyperthyroidism. Excessive intake of iodine was noted among children in Port Sudan. This was due to excessive and unregulated local fortification of salt and lack of monitoring of imported and donated salt. All the salt samples collected from the schools in this study had more than 150 mg potassium iodate per kilogram of salt, or almost 2½ times the DRI (Izzeldin, Crawford, and Jooste, 2007). Iodized salt and saltwater fish are the most common sources of iodine. Other issues related to inadequate iodine intake include **goiter**, a disease of the thyroid gland (Figure 3-7). A Russian study of children with goiter who lived in an area with a natural iodine supply found excess silicon and deficiency of cobalt, magnesium, and selenium along with low body content of iodine was related to goiter development (Gorbachev, Skalny, and Koubassov, 2007). Other nutrients further adversely affect-

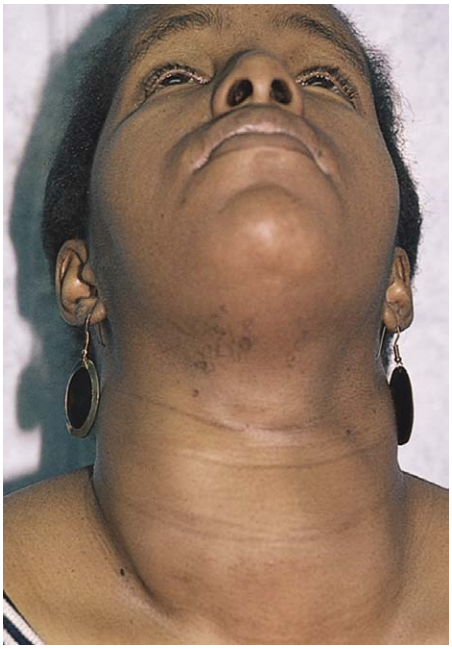


FIGURE 3-7 Goiter. (From Swartz MH: *Textbook of physical diagnosis: history and examination*, ed 6, Philadelphia, 2010, Saunders.).

ing iodine status include deficiency of vitamin A, and, by affecting vitamin A metabolism, zinc deficiency adversely affects thyroid function (Tsikunib and Kondratova, 2007).

A form of mental retardation, **cretinism**, was once a relatively common phenomenon in infants born to mothers who had iodine deficiency during pregnancy. This condition impairs brain development of the growing fetus and young child. With the advent of fortification, iodine began to be added to salt in the 1930s, and goiter and cretinism have virtually disappeared in the United States. With the avoidance of salt for health reasons and the gourmet trend toward increased use of noniodized sea salt, iodine deficiency may redevelop.

Severe iodine deficiency still occurs in third-world countries and leads to stunted growth and mental retardation in utero. In a study of elementary school children in Mexico, the overall rate of goiter was found to be over 20%, and moderate iodine deficiency was related to a quadrupled risk of low IQ scores (Pineda-Lucatero and colleagues, 2008). Adoption of fortified salt appeared to contribute to partial recovery of intelligence and psychomotor development among iodine-deficient children in China (Tang and colleagues, 2007).

Iron (Fe^{3+})

More than one half of the 4 to 5 g of iron in the body is in hemoglobin found in the bloodstream. Iron is a key element of several enzymes. Some water-soluble vitamins play a role in the metabolism of iron. Hemoglobin promotes tissue respiration by carrying oxygen from the lungs to the tissue cells and by carrying the carbon dioxide

formed in oxidation away from cells. Iron and protein are necessary for hemoglobin synthesis. Tests for levels of hemoglobin indicate whether iron deficiency anemia (a condition of lack of iron needed to carry oxygen throughout the body) is present. Confirmation of iron deficiency anemia should be undertaken if there is a low level of hemoglobin. These tests include total iron content, percent iron saturation, total iron-binding capacity, and levels of **transferrin** (a protein that binds and transports iron) and **ferritin** (the storage form of iron).

Iron comes in two forms: **heme iron** and nonheme iron. Heme iron, found in high quantities in red meat and organ meats such as liver, kidney, and heart, is absorbed extremely well by the body. In contrast, nonheme iron—found in plant foods such as blackstrap molasses, whole grains, iron-fortified cereals, and legumes—is poorly absorbed unless vitamin C foods or meat are consumed at the same meal. For example, an orange or coleslaw, each with a high vitamin C content, would enhance the iron absorption from a peanut butter sandwich or other nonheme iron source. The use of iron cooking pans is also known to increase the iron content of food greatly; the amount of that increase is related to the length of cooking time and acidity of the food.

It is well known that iron deficiency anemia needs to be corrected, at any age. For children, it is vitally important to ensure full growth potential (see Chapter 12) along with optimal brain and neurologic development. The prevention of iron deficiency appears to be even more beneficial to infants and young children while their brain and neurologic system is still developing than correcting anemia once it has developed (Lozoff, 2007). However, iron supplementation should not exceed need, with evidence of adverse outcomes of supplementation among nondeficient infants. This is likely due to an immature ability to regulate iron use in infancy (Lönnerdal and Kelleher, 2007). Iron deficiency anemia can be related to other health problems such as was found with an episode of childhood stroke (see Chapter 7). This was attributed to elevated blood platelets caused by iron deficiency anemia (Basak and colleagues, 2008).

During periods of rapid growth, such as during pregnancy, and growth spurts occurring with infants older than 6 months of age, children through the preschool years, and adolescence, the need for iron increases. Loss of blood (e.g., in menstruating women or GI blood loss) also increases the need for iron. Malabsorption can also contribute to iron deficiency anemia as with celiac disease or bariatric surgery for weight loss (see Chapter 6). Celiac disease should be ruled out with unexplained situations of iron deficiency anemia. Excess zinc inhibits absorption of iron and vice versa (Table 3-4).

True iron toxicity from food sources has been documented only from long-term ingestion of home-brewed alcohol made in iron stills. However, toxic overdoses from iron supplements do occur in the United States, especially among young children who accidentally ingest large quantities of adult iron preparations. Genetically some persons are at risk for **iron overload** (idiopathic **hemochromatosis**), which has recently been recognized as a common disorder. Iron overload is highly prevalent among males of northern European descent but has also been found among Hispanics and African Americans. The liver is a principal target for iron toxicity because it is chiefly responsible for taking up and storing excess amounts of iron. Problems related to hemochromatosis can be averted by early detection if those affected avoid

Table 3-4 Some Nutrient Interactions With Vitamins and Minerals

NUTRIENT	INHIBITING NUTRIENT	ENHANCING NUTRIENT
Vitamins		
Vitamin A (carotene)	Excess vitamin E; deficiency of protein, iron, and zinc	Dietary fat
Vitamin D		Dietary fat
Vitamin E		Dietary fat
Vitamin K	Excess vitamin E	Dietary fat
Vitamin B_1	Tannins (as found in coffee)	
Vitamin B_2	Excess vitamin B_1	
Vitamin B_3	Deficiency of vitamin B_6	
Vitamin B_6	Excess choline and leucine	Deficiency of vitamin C
Vitamin B_{12}	Excess vitamin C; deficiency of vitamin B_6	
Folacin	Thiamin hastens decomposition in supplements	
Biotin	Pantothenic deficiency	
Choline	Excess inositol	
Vitamin C	Deficiency of vitamin B_6	
Minerals		
Calcium	Excess sodium, protein, phosphorus, oxalates	Vitamin D, lactose, and certain amino acids
Phosphorus	Excess iron	
Magnesium	Excess sodium, calcium, vitamin D, phosphate, protein, and alcohol; low serum potassium	
Iron	Excess manganese, zinc	Vitamin C, copper, cobalt
Zinc	Excess iron, copper, tin, folic acid, ascorbic acid, riboflavin, tannins, and possibly calcium	Thiamin, vitamin C, possible fluoride role
Copper	Excess zinc, molybdenum, and vitamin C	Possible fluoride role; estrogen increases copper serum levels
Molybdenum	Excess sulfur	

excess iron intake and regularly donate blood. To assess if a person has iron overload, health professionals are recommended to measure the transferrin index, which is the serum iron level divided by measured transferrin. Values greater than 1.0 are associated with this disorder. Lowering intake of iron can result in decreased need for phlebotomy (bloodletting).

Manganese (Mn^{2+})

Manganese is essential for normal bone structure, reproduction, and functioning of the central nervous system. It is a component of some enzymes. In general there is low risk of toxicity, but workers exposed to manganese dust or fumes have been known to develop central nervous system problems. Good food sources include whole grains, legumes, and nuts.

Manganese neurotoxicity in adults can result in conditions of psychologic, behavioral, and neurologic disturbances similar to Parkinson's disease and other conditions involving involuntary, abnormal movements. As found in a rat study, iron

deficiency can enhance brain manganese accumulation even in the absence of excess intake from the environment or diet. Accumulation of manganese further appears to increase brain content of other trace minerals, including copper, chromium, zinc, cobalt, aluminum, molybdenum, and vanadium (Garcia and colleagues, 2007). Toxicity is most often associated with inhalation exposures in occupational settings. This is not the only cause, with one case study noting a family with elevated plasma levels of manganese attributed to their summer cottage. Their well water used for drinking and cooking exceeded recommended guidelines, and their diet was high in manganese. However, only one child of the family developed neurotoxicity, and this may have been due to pica (ingestion of nonfood material, such as dirt) (Sahni and colleagues, 2007).

Molybdenum (Mo)

The role of this essential mineral in humans is not well understood, but molybdenum deficiency may be implicated in certain neurologic dysfunctions by its essential presence in at least three enzymes. There is insufficient knowledge about the demands for molybdenum in infancy. The foods known to be high in this mineral include legumes, milk, and whole grains. The molybdenum content of vegetation is determined by the amount of this element in the soil and its pH value. The danger of molybdenum toxicity in plants is small (Anke and Seifert, 2007).

Selenium (Se)

There is a wealth of research on the role of selenium. It is found in at least 25 proteins, named selenoproteins, in the form of the amino acid selenocysteine. The positive role of selenium has been noted with a variety of conditions, including bone health, cancer, inflammatory diseases, thyroid function, cardiovascular disease, neurologic diseases, aging, infertility, and immunity.

Selenium has been shown to reduce inflammation in a number of conditions. Data from one study suggest that selenium intake and allergic airway inflammation, as with asthma, are not related in a simple dose-response manner. With low or high levels of selenium intake there was a limited response, but the medium dose was effective at reducing evidence of inflammation. Although this was a study involving mice, the study may explain the inconsistent results obtained from studies involving humans (Hoffmann and colleagues, 2007). Selenium was shown to prevent inflammatory and necrotic changes after induction of colitis in a rat study. Selenium in a high dose is therefore a potential therapeutic agent in inflammatory bowel disease (Tirosh, Levy, and Reifen, 2007).

Selenium is a potent antioxidant and has a close metabolic relationship with the antioxidant vitamin E. A selenium-dependent enzyme is recognized for its antioxidant and antiinflammatory activity. Selenium is essential for protection from oxidative damage induced by sun exposure.

Incidents related to coronary heart disease may benefit from short-term selenium supplementation. This is believed to be due to increased production of antioxidant enzymes that are dependent on selenium for their function. When blood flow is rapidly restored during a heart attack, the sequence of ischemia followed by reperfusion is often followed by complications. There is evidence implicating **reactive oxygen species (ROS)** as an initial cause of the injury and potentially damaging to normal cellular function. This occurrence can follow routine clinical procedures such

as coronary bypass surgery. Targeting the generation of ROS with various antioxidants, including selenium, has been shown to reduce injury following oxidative stress and improve recovery from ischemia-reperfusion injury (Venardos and colleagues, 2007).

Selenium appears to reduce the adverse effects of aging. Deficiency, with reduced associated enzymes, appears to contribute to age-related loss of muscle strength and the development of frailty and disability due to oxidative damage. Serum selenium level was found to be related to grip strength in older women (Beck and colleagues, 2007). Low serum selenium also appears to be one cause of anemia among older adults (Semba and colleagues, 2009).

The brain contains high amounts of selenium, even with conditions of selenium deficiency. Reduced brain selenium content, from an impairment in the ability of a transport protein to function, can cause reduction in selenium-based enzymes and may be involved in the development of neurodegenerative disease (Scharpf and colleagues, 2007).

Inadequate or excess intake is related to thyroid problems. Selenium supplementation does not seem to prevent type 2 diabetes, and it may increase risk for the disease (Stranges and colleagues, 2007). This is related to high serum selenium levels increasing the prevalence of diabetes. Thus among persons with low risk of selenium deficiency, increased intake, including supplementation, should not be recommended (Bleys, Navas-Acien, and Guallar, 2007). Large quantities of selenium of 300 mcg or more may also affect other hormones adversely. Symptoms of toxic levels of selenium include anorexia, diarrhea, dermatitis, depression, hemorrhage, liver and kidney damage, blindness, and central nervous system problems, including ataxia and respiratory disturbances (Kaprara and Krassas, 2006).

Selenium toxicity and deficiency have been noted mainly as a result of soil selenium content. Selenium deficiency was first noted in China, where it was associated with **cardiomyopathy** (a form of heart disease). Excess selenium intake resulting from soil content has been noted to cause hair loss and toxic defects in fingernails and toenails.

Malabsorption states, as with celiac disease, can affect selenium status. Low plasma selenium levels are especially marked at the early stage of celiac disease and in persons not adequately avoiding gluten in the diet. Because persons with uncontrolled celiac disease are at increased risk for cancer development, selenium deficiency may play a role. Persons with celiac disease may need supplementation of their diet with selenium along with other micronutrients.

The selenium requirement for adults appears to be related to body weight. The RDA for selenium was first set in 1989, and DRI values may be found in the table at the back of the book. Consumption of two Brazil nuts daily is effective for increasing selenium status (Thomson and colleagues, 2008).

Zinc (Zn^{2+})

Zinc has an antioxidant role and is one of the essential trace elements. Zinc is a component of more than 50 enzymes and helps to activate up to 300. Growth is inhibited with low zinc intake, and there is a high need for zinc during periods of rapid growth. It promotes cell division and differentiation, mainly because of its role in protein synthesis. Zinc is a key constituent of over 300 mammalian proteins.

Dietary deficiencies in zinc can contribute to single- and double-strand DNA breaks and modifications to DNA that increase risk for cancer. Zinc is involved in DNA repair. Although zinc is stored primarily in bone, it is poorly mobilized, and therefore regular dietary intake is crucial. Zinc is found in high amounts in the germ portion of grains and in nuts, animal protein foods, and especially oysters and crabmeat (Table 3-5).

Low birth weight has long been associated with increased frequency of chronic disease in adulthood, such as cardiovascular disease and type 2 diabetes. Evidence suggests this is due to zinc deficiency in utero. In animal studies impaired neuropsychologic function and impaired immunity develop as a result of zinc deficiency in utero that continued despite later correction of the deficiency, and some evidence the adverse outcomes persist into the next generation of progeny (Maret and Sandstead, 2008). Maternal zinc deficiency also is associated with an increased risk for fetal heart malformations (Lopez and colleagues, 2008).

Skin disorders are related to zinc deficiency. Among preterm infants zinc deficiency may develop despite normal zinc quantities in breast milk. Symptoms that have been noted, and corrected with zinc supplementation, include dermatitis with red, raised patches and overlying crusts around the mouth, anal canal, head, and extremities (Kiechl-Kohlendorfer, Fink, and Steichen-Gersdorf, 2007). Another skin disorder related to zinc deficiency is **acrodermatitis enteropathica**, which is either due to a rare genetic disorder or due to impaired absorption or inadequate intake of zinc. One case study of zinc deficiency occurred in a woman with **psoriasis** (often an inherited, noninfectious, skin disease caused by cellular proliferation that appears as reddened patches generally near the trunk of the body) who developed skin lesions near her mouth and anal canal, **alopecia** (severe hair loss), diarrhea, and increased frequency of infections (Sanchez, Barham, and Sangueza, 2007).

Research with zinc status shows diverse functions and impacts. Zinc is required for normal taste perception through smell acuity. It is related to sexual development and is at the root of the belief that oysters are an aphrodisiac. Zinc therapy has been shown to improve sperm motility (Omu and colleagues, 2008). The retina contains particularly high amounts of zinc, suggesting a pivotal role in this tissue. There is also suggestive evidence that zinc deficiency in humans may result in abnormal dark adaptation and age-related **macular degeneration**. Zinc appears to promote normal vitamin A levels through use of retinol supplementation in persons with cystic fibrosis (Tinley and colleagues, 2008).

Zinc is known to be essential for the immune system. Impaired immune functions caused by zinc deficiency normalize with adequate zinc supplementation. Aging is associated with low-grade inflammation and mild zinc deficiency contributing to suppressed immunity with resultant increased risk of infections and autoimmune diseases. Unlike antiinflammatory drugs, zinc does not suppress but improves immune reaction with infection. It is thus suggested that mildly zinc-deficient, healthy elderly persons might benefit from moderate zinc supplementation (Kahmann and colleagues, 2008). Under conditions of oxidative stress, the uptake of zinc appears inhibited, especially by folic acid. Vitamin C promotes zinc uptake with these conditions (Tupe, Chiplonkar, and Agte, 2007).

Individuals with malabsorption, as with chronic diarrhea, alcohol abuse, pancreatitis, celiac disease, Crohn's disease (see Chapter 4), and short bowel syndrome, are

Table 3-5 Trace Minerals (Micronutrients)*

FUNCTIONS	SOURCES	SYMPTOMS OF DEFICIENCY	SYMPTOMS OF TOXICITY
Chromium (Cr^{3+})			
Activates several enzymes Enhances the removal of glucose from the blood	Liver and other meats, whole grains, cheese, legumes, and brewer's yeast	Weight loss, abnormalities of the central nervous system, and possible aggravation of diabetes mellitus	Liver damage and lung cancer caused by industrial exposure
Cobalt (Co^{2+})			
An essential component of vitamin B_{12} Activates enzymes	Figs, cabbage, beet greens, spinach, lettuce, watercress	Pernicious anemia	Polycythemia (excess number of red corpuscles in blood) Hyperplasia of bone marrow Increased blood volume
Copper (Cu^{2+})			
Aids in the production and survival of red blood cells Part of many enzymes involved in respiration Plays a role in normal lipid metabolism	**100% DRI:** 3 tbsp blackstrap molasses ¼ oz beef liver 1 oyster 1½ oz cashews 1½ c white beans **25% DRI:** 2 tbsp sunflower seeds ¾ c kidney beans ¾ c pears 6 oz soy milk	Anemia, neurologic problems, abnormal electrocardiograms, bone fragility, impaired immune response; may be a factor in failure to thrive in premature infants	In Wilson's disease, copper accumulation causes neuron and liver cell damage
Fluorine (F^-)			
Helps the formation of solid bones and teeth, thereby reducing incidence of dental caries (see Chapter 13) and may help prevent osteoporosis	Fluoridated water (and foods cooked in fluoridated water), fish, tea, gelatin	Increased susceptibility to dental caries	Fluorosis and mottling of teeth
Iodine (I^-)			
Helps regulate energy metabolism as a part of thyroid hormones Essential for normal cell functioning, helping to keep skin, hair, and nails healthy	Primarily from iodized salt Also found in saltwater fish, seaweed products, and vegetables grown in iodine-rich soils	Goiter, cretinism in infants born to iodine-deficient mothers, with accompanying mental retardation and diffuse central nervous system abnormalities	Little toxic effect in individuals with normal thyroid gland functioning Goiter may also occur in toxic states

Table 3-5 Trace Minerals (Micronutrients)*—cont'd

FUNCTIONS	SOURCES	SYMPTOMS OF DEFICIENCY	SYMPTOMS OF TOXICITY
Iron (Fe^{3+})			
Essential to the formation of hemoglobin, which is important for tissue respiration and ultimately growth and development, and proteins in the body Part of several enzymes	Heme sources: meats Nonheme sources: nonmeat sources, iron-fortified cereals, foods cooked in iron pans **100% DRI:** 5 oz clams **25% DRI:** 2 chicken livers ¾ c soybeans, baked beans, and lentils ¾ c enriched rice 6 oz beef 10 oz chicken **10% DRI:** 1 oz almonds 2½ eggs	Iron deficiency anemia and possible alterations that impair behavior	Idiopathic hemochromatosis, which can lead to cirrhosis, diabetes mellitus, and cardiomyopathy
Manganese (Mn^{2+})			
Needed for normal bone structure, reproduction, normal functioning of cells and the central nervous system A component of some enzymes	**100% DRI:** ¾ oz macadamia nuts 1 oz pine nuts 2 oz hazelnuts/filberts and pecans ½ c whole-wheat flour 1 c pineapple 1¼ c whole-wheat pasta **25% DRI:** ½ c chickpeas (garbanzo beans) ½ c spinach ¾ c fresh blackberries	None observed in humans	Parkinson's-like symptoms have been noted in miners and with long-term TPN (see Chapter 15)
Molybdenum (Mo)			
A component of three enzymes Important for normal cell functioning	Organ meats, milk, legumes, whole grains, dark green vegetables	Vomiting, tachypnea (fast breathing), tachycardia, possible neurologic dysfunction, coma, hypermethioninemia in premature infants (methionine is an amino acid)	No toxicity known

Continued

Table 3-5 Trace Minerals (Micronutrients)*—cont'd

FUNCTIONS	SOURCES	SYMPTOMS OF DEFICIENCY	SYMPTOMS OF TOXICITY
Selenium (Se)			
Part of an enzyme system Acts as an antioxidant with vitamin E to protect the cells from oxygen Helps prevent inflammatory, cardiovascular, and neurologic diseases Helps fertility Promotes immunity and thyroid function Appears to play a role in glucose metabolism	**100% DRI:** ¾ oz Brazil nuts **25% DRI:** 1 oz mixed nuts 6 oz turkey and herring 12 oysters 7 oz sardines 9 oz beef	Keshan disease (a human cardiomyopathy) and Kashin-Beck disease (an endemic human osteoarthropathy) Reduced production of sperm with flagellar defects	Physical defects of the fingernails and toenails Hair loss Nausea Abdominal pain Diarrhea Peripheral neuropathy Fatigue Irritability
Zinc (Zn^{2+})			
Component of 50 enzymes Plays a role in protein synthesis and DNA repair Essential for normal growth and sexual development, wound healing, immune function, cell division and differentiation, and smell acuity	**100% DRI:** 1 oyster 6 oz beef (on average) 1 c baked beans **25% DRI:** 5 tbsp wheat germ 3 oz pork 1¼ c chickpeas 12 oz yogurt 2 c milk	Depressed immune function, poor growth, dwarfism, impaired skeletal growth and delayed sexual maturation, acrodermatitis Decreased myelinated nerve fibers Low level of alkaline phosphatase enzyme	Severe anemia Nausea Vomiting Abdominal cramps Diarrhea Fever Hypocupremia (low blood serum copper) Malaise Fatigue Renal damage Impaired immunity also found

Data from U.S. Department of Agriculture, Agricultural Research Service: USDA National Nutrient Database for Standard Reference, release 17; Davis J, Sherer K: *Applied nutrition and diet therapy for nurses,* ed 2, Philadelphia, 1994, Saunders; and Mahan KL, Escott-Stump S: *Krause's food, nutrition, and diet therapy,* ed 12, Philadelphia, 2008, Saunders.
DRI, Dietary Reference Intake; *TPN,* total parenteral nutrition.
*Amounts of foods listed meet the Dietary Reference Intake for adults ages 31 to 50 (largest amount used as reference) as rounded off to the nearest portion size to meet the DRI.

at particular risk for zinc deficiency. Zinc absorption is reduced in the elder population, and deficiency is relatively common. Typical symptoms include dermatitis as described above, impaired immunity, disturbed wound healing, and diarrhea (Miyata, 2007). Zinc supplementation has been implicated in the reduced duration and severity of diarrhea whether acute or chronic (Lukacik, Thomas, and Aranda, 2008). Zinc absorption is also impaired by excessive intake of folic acid, iron, copper, tin, and possibly calcium. Persons who have excess urination from uncontrolled diabetes (see Chapter 8) or who take diuretics may be predisposed to loss of zinc in the urine.

Excess of zinc can cause a severe form of anemia related to its inhibiting the use of copper. It is for this reason that zinc supplementation needs to be used cautiously,

and if high doses are used such as with wound healing, it needs to be done only for a limited duration.

OTHER TRACE MINERALS

The following minerals do not have established DRIs at present, but all are believed to be essential. Including a variety of low-processed foods will likely meet health needs for these trace minerals.

Cobalt (Co^{2+})

Cobalt is an essential component of vitamin B_{12} that is found in animal protein foods such as meat, fish, eggs, and milk. Inadequate intake of cobalt may result in pernicious anemia with a vitamin B_{12} deficiency. No other deficiency symptoms or toxicities are known.

Sulfur (S)

Sulfur is a component of skin, hair, nails, cartilage, and some organ tissue. It is a component of all body proteins. Protein-rich foods are the primary source of sulfur. Little is known about the effect on human health of a deficiency or toxicity. Sulfur is the sixth most abundant mineral in breast milk and the third most abundant mineral based on percentage of total body weight. Dietary analysis of sulfur-based amino acids (see Chapter 2) and protein supplementation may be indicated for vegan athletes, children, or patients with human immunodeficiency virus (HIV) infection, because of an increased risk for deficiency of these amino acids in these people (Parcell, 2002).

Cadmium (Cd^{2+}), Nickel (Ni^{2+}), Tin (Sn^{4+}), Vanadium (V^{5+}), and Silicon (Si^{4+})

Findings produced in experimental animal feeding suggest that these elements are essential, but the implications for human nutrition are not well known. Cadmium appears to help with RNA function, in conditions of zinc deficiency, at low concentrations, but is inhibitory at high concentrations (Lee and colleagues, 2006). At high levels, cadmium is a toxic agent. Nickel is more well known as being toxic from environmental pollution and being involved in allergic skin reactions; however, in trace amounts it is felt to have a role in human health. Vanadium may affect the activity of various intracellular enzyme systems and alter their physiologic functions. There have been accounts of vanadium, in the form of vanadyl sulfate, having insulin-like properties or promoting insulin signaling in cells and therefore helping in blood glucose management (see Chapter 8). The potential for vanadium toxicity precludes recommendations for high doses of this supplement for diabetes management in humans.

ARE THERE ANY HARMFUL MINERALS?

All minerals are harmful in excess. Arsenic is probably the best known of the harmful minerals; it is, however, probably important for health in very trace amounts. Arsenic is receiving a great deal of attention because of worldwide problems with excess levels in drinking water (see Chapter 14). Arsenic inactivates up to 200 enzymes, is associated with gastroenteritis, nerve damage, reduced brain function, vascular changes, diabetes, and cancers (bladder, lung, liver, kidney, testicular, and prostate).

Acute arsenic poisoning causes nausea, vomiting, abdominal pain, diarrhea, and peripheral neuropathy. See Chapter 14 for more information on public health measures regarding mineral toxicity.

WHAT ARE PHYTOCHEMICALS AND WHAT IS THEIR ROLE IN NUTRITION?

Phytochemicals, or phytonutrients, are substances in food that are generally not considered vitamins or minerals. Phytochemicals were discovered in the latter part of the twentieth century. It is anticipated that there are at least 100 phytochemicals yet to be discovered in foods. This is one reason that reliance on a multivitamin and mineral supplement cannot fully meet nutritional needs.

Lutein and lycopene are actually types of carotenoids but are thought of as phytochemicals. The Observed Safe Level (OSL) indicates that the evidence of safety is up to 20 mg/day for lutein and 75 mg/day for lycopene via supplementation. Intakes above these levels have not been shown to be safe for long-term use (Shao and Hathcock, 2006).

Tomato products, including ketchup, contain lycopene and have been shown to lower indicators of oxidative stress related to lower risk of heart disease and to help prevent cancer in general. Dietary fats enhance this process and should be consumed together with food sources. Lycopene has the potential to decrease prostate tumor aggressiveness. This benefit is likely due to a combination of naturally occurring nutrients in tomatoes (Basu and Imrhan, 2007; Ivanov and colleagues, 2007).

Lutein and zeaxanthin may be protective in eye disease because they absorb damaging blue light that enters the eye (Krinsky and Johnson, 2005). Average intakes of lutein in the United States are below levels associated with eye disease prevention. Therefore increased intakes of food sources rich in lutein may be warranted (Renzi and Johnson, 2007). The Food and Drug Administration (FDA) has concluded that no credible evidence exists for a health claim about the intake of lutein and/or zeaxanthin in supplement form and the risk of age-related macular degeneration or cataracts.

HOW CAN VITAMINS AND MINERALS BE PRESERVED IN FOOD PREPARATION?

In general, it has been found that fruits and vegetables visually spoil before any significant antioxidant capacity loss occurs except in bananas and broccoli. The same applies to vitamin C foods (Kevers and colleagues, 2007).

The following food-handling practices will enhance vitamin and mineral retention:

1. Store vegetables properly to avoid wilting and drying out, which cause loss of vitamins A and C.
2. Cook vegetables whole as often as possible. Cutting and peeling release oxidative enzymes and increase surfaces from which water-soluble vitamins and minerals leach out.
3. Use cooking water and canned food juices to conserve soluble nutrients, or, preferably, steam fresh or frozen vegetables to lessen the leaching of water-soluble vitamins and minerals.
4. Avoid use of baking soda in cooking vegetables because it is destructive to thiamin and ascorbic acid. Avoid long cooking for the same reason. Cooling meat

drippings before use allows one to easily remove solidified fats without sacrificing thiamin and niacin.
5. Store fats covered—and preferably refrigerated—to prevent them from becoming rancid, which destroys vitamin A.
6. Keep milk in glass containers away from light, which is destructive to riboflavin, or put in opaque containers. Waxed cardboard containers for milk prevent destruction of riboflavin by light.
7. Keep fruit juices covered and cold to prevent oxygen from destroying vitamin C.
8. While cooking foods containing vitamin C, avoid stirring because oxygen destroys it.
9. Cook vegetables quickly in a covered container just until fork tender. Store leftovers covered.
10. Cook vegetables in the microwave or in a steamer.

WHAT IS FOOD FORTIFICATION?

The question sometimes posed in the war among cereal brands—"How many bowls of your cereal does it take to equal one of ours?"—illustrates food fortification. This differs from enrichment, a method to replace known nutrients lost in processing such as B vitamins and iron in white-flour products. White breads are enriched with vitamins B_1, B_2, and B_3 to replace what was removed from the whole grain during processing. The more recent fortification of white bread products with folic acid is an example of fortification, or adding more of a nutrient than would normally be found in a food. Fortification means "to make stronger, to fortify" and involves either adding nutrients in higher amounts than naturally occur or adding nutrients that are generally not present, such as adding calcium to orange juice. Food fortification does play an important role in the promotion of the health of our society. With the advent of fortification, many deficiency diseases such as goiter have been overcome in the United States (although goiter is still found in some other areas of the world). Iron-fortified cereal and infant formula help prevent iron deficiency anemia.

The food industry generally has a profit motive rather than society's health as its basis for food fortification. Advertisements that promote fortified food as the best alternative can mislead the public. To use the preceding example, calcium-fortified orange juice is not a replacement for milk because milk offers many other nutrients. Also, because we know that overconsumption of vitamins and minerals can be harmful, if not toxic, indiscriminate use of and reliance on fortified foods is not a healthful practice, particularly if those foods are used as a replacement for a balanced, varied diet.

HOW ARE VITAMINS AND OTHER DIETARY SUPPLEMENTS REGULATED AND USED?

Under the Nutrition and Labeling Education Act (NLEA), dietary supplements are not eligible for health claims authorized by the FDA. Supplement manufacturers do not need FDA approval to market their products. The FDA must prove that a supplement is not safe after it is on the market before the FDA can intervene and restrict sales.

In 1995, when DSHEA (refer back to the chapter introduction) was passed, it expanded and clarified the definition of dietary supplements. However, because of DSHEA, there are only voluntary regulations on labeling requirements—what is listed in the ingredients does not legally have to be found inside the container. It is advised that supplements used should state on the label one of the following: "USP" or "United States Pharmacopeia" (an independent group that analyzes the contents of supplements for use in labeling of the product); or the supplement label should state that the supplement has been chemically analyzed or assayed. If the supplement does not state "USP," "National Science Foundation (NSF)," "chemically assayed," or "potency guaranteed," it is recommended that a telephone call to the 800 number listed on the bottle be undertaken to ask if a chemical assay was performed. If the company states no analysis was done, the product should not be taken, because no one knows what is in the supplement. Quality control of supplements needs to be ensured to avoid excess, potentially toxic, amounts of vitamins and minerals or insignificant amounts such that health benefits are not achieved.

Since DSHEA there has been an explosion of supplements on the market. This is reflected in the overall increased use of nutrient and botanic dietary supplements. Common, legitimate uses for supplements include high levels of homocysteine (B vitamins), treatment of different forms of anemia (iron, B_{12}, folic acid), cancer prevention (selenium), and prevention of spina bifida (folic acid), or multivitamin and mineral supplements for persons known to be malnourished or at high risk, such as those with malabsorption.

A review of long-term users of supplements manufactured by Shaklee Corporation along with data from the NHANES 2001-2002 and NHANES III 1988-1994 found that the dietary supplements consumed daily by the majority in the study included a multivitamin/mineral supplement, B complex, vitamin C, carotenoids, vitamin E, calcium with vitamin D, omega-3 fatty acids, flavonoids, lecithin, alfalfa, coenzyme Q_{10} with resveratrol, glucosamine, and an herbal immune supplement. The majority of women also consumed gamma linolenic acid (GLA) and a probiotic supplement, whereas men also consumed zinc, garlic, saw palmetto, and a soy protein supplement. With the supplement users there were generally more favorable concentrations of serum homocysteine, and less inflammation and other conditions found with the metabolic syndrome (Block and colleagues, 2007).

Supplements may have no effect. One study of antioxidant supplementation with beta-carotene, vitamins C and E, and the minerals zinc and selenium found that supplementation resulted in significant increases in serum levels of most of these micronutrients but was not associated with improved health outcomes of the intended goal of improved allergen immune responses (Dunstan and colleagues, 2007). A review of 68 randomized trials involving adults indicated treatment with beta-carotene, vitamin A, and vitamin E may increase mortality (Bjelakovic and colleagues, 2007).

A study looking at healthy infants and toddlers found most can achieve recommended levels of intake from food alone. When warranted, it is advised that supplements not lead to excessive intake, especially those widely used in food fortification, including vitamin A, zinc, and folate (Briefel and colleagues, 2006).

The medical and health community should still advocate food sources because of the complementary nutrients found in food and should advise caution with supplements with regard to accuracy of the supplement labels, purity, and avoidance

of potential toxins such as lead with calcium supplements. The overall quality and quantity of the literature on the safety of multivitamin/mineral supplements is limited. Some supplements can be potentially harmful, such as with beta-carotene supplementation increasing lung cancer risk in smokers or the risk of mad cow disease with creatine supplements. Financial concerns and inadequate knowledge of nutrition can lead a person to buy supplements rather than foods. Nutrient-drug interactions, such as that of excess calcium with some antibiotics, can also be a problem.

HOW CAN HERBAL PRODUCTS BE USED IN ACHIEVING HEALTH?

Herbal therapies have been used in many regions around the world for centuries. In the Western world medicinal herbs are becoming increasingly popular and are often used with complementary and alternative medicine (CAM). Their role in the achievement and maintenance of health is still controversial. There is little scientific research outlining the specific active compounds found in herbs as they relate to health, and thus the ability to analyze the active components and their effect on health and disease cannot be readily determined. Most herbal therapies have been based on anecdotal evidence from their centuries of use. However, because individual metabolism varies, the ability to appropriately advise their use for a specific person and condition is limited. The National Center for Complementary and Alternative Medicine (NCCAM) is one group seeking to validate safety and efficacy of herbs.

A great deal of variation in known compounds found in herbs occurs because of different growing conditions such as amount of sun, level of soil acidity, and amount of rain. Thus an herb originally grown in China can have different actions if grown in another part of the world. Another factor to consider before recommending specific herbs is there are many different varieties. For example, ephedra, also known as ma huang, is a perennial, evergreen shrub represented by 42 species around the world. It may be for this reason, with the great variety of species, that ephedra has shown positive outcomes but also enough adverse outcomes that the FDA banned this substance in 2004. In particular, products containing ephedra and caffeine showed toxic effects on heart function.

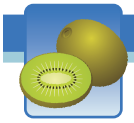
Furthermore, as a result of DSHEA, herbs are regarded in this country as dietary supplements, which means that consumers can purchase any and as much as they want. One scientist, working on developing consistency in labeling to ensure that what is listed on the label actually reflects the contents of the container, called the degree of accuracy between label statements and actual content a "crapshoot." As noted previously, it is advisable for consumers who choose to take herbs to ensure quality and purity with the USP guidelines or to verify that the product has been chemically assayed by calling the herbal company or looking for this statement on the label.

Many pharmaceutical medications are actually based on substances in nature such as willow bark that had been used for centuries. This led to the discovery in 1899 of the compound acetylsalicylic acid, which was registered and introduced commercially as aspirin by the Bayer Company of Germany. The cardiac medication digitalis comes from foxglove. Medications continue to be developed that are based on natural substances but that undergo research to verify benefits and adverse outcomes with standardized quantities of active ingredients.

Most persons are unaware of the potential toxicity of herbs. For example, black cohosh may be used for hot flashes during menopause. Another name for black cohosh is snakeroot. There are different varieties of snakeroot, one of which is believed to have killed President Lincoln's mother after she drank milk from a cow that had eaten wild snakeroot and developed a condition referred to by the early pioneers as "milk sickness." Acute hepatitis was noted in one woman who complained of fatigue and upper right abdominal pain beginning 2 weeks after using black cohosh. Her health returned to normal after discontinuing the herb (Nisbet and O'Connor, 2007). Individuals should alert their health care providers of supplements and herbal products taken because of the possible adverse interactions with prescribed medications and to rule out their being a cause of various health problems (Table 3-6).

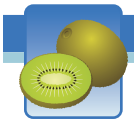
Traditional Chinese medicine includes several *Aristolochia* species. Commercial herbal preparations containing forms of this herb were found to cause kidney damage and cancer, and ultimately herbs containing this product were banned worldwide. Recently, the cause of kidney damage in individuals living in areas of the Balkans is being attributed to consumption of bread made with flour contaminated with seeds of *Aristolochia clematitis* (Arlt and colleagues, 2007; see Table 3-6).

Native Caribbean plants have been less studied than herbs from other parts of the world. However, *Chamaesyce hirta* has scientific support as a diuretic. Other plants with good evidence for reproductive issues are *Achyranthes indica, Coleus aromaticus, Hibiscus rosa-sinensis, Parthenium hysterophorus,* and *Ruta graveolens* (Lans, 2007). Some herbal products demonstrate both positive and negative effects (see Table 3-6).



Cultural Considerations

Common herbs used in Mexico include nopal (*Opuntia ficus*), peppermint (*Mentha piperita*), chaparral (*Larrea divaricata*), dandelion (*Taraxacum officinale*), mullein (*Verbascum densiflorum*), chamomile (*Matricaria recutita*), nettle or stinging nettle (*Urtica dioica*), passionflower (*Passiflora incarnata*), linden flower (*Tilia europea*), and aloe (*Aloe vera*). However, the therapeutic benefits and risks of some herbal medicines used in Mexico are still limited and are mainly advised from local anecdotal stories. For a number of reasons some are implicated with morbidity and mortality (Rodriguez-Fragoso and colleagues, 2008). ■



Cultural Considerations

Japanese traditional medicine with herbal therapy is called kampo. One study found the herbs goshuyuto for prevention of migraine and senkyuchachosan as a painkiller were effective and patients were satisfied with their effects as compared to traditional medications such as triptans (Ishida and Sato, 2006). ■

WHAT IS THE ROLE OF THE NURSE OR OTHER HEALTH CARE PROFESSIONAL IN EDUCATING THE PUBLIC ABOUT VITAMINS AND MINERALS?

The nurse or other health care professional needs to be aware of how positive nutritional messages about food can be conveyed in informal settings, such as while a person in the hospital is eating a meal. Emphasis should be on positive mes-

Table 3-6 Selected Herbal Therapies: Benefits and Toxicities

SELECTED HERBS	POTENTIAL BENEFIT	POTENTIAL TOXICITY/INTERACTIONS
Aristolochia (now banned)		Kidney damage; cancer—still found as contaminant in the herb Mu Tong (Martena and colleagues, 2007); in flours contaminated with seeds (Arlt and colleagues, 2007); weight control supplements (Cheung and colleagues, 2006)
Stephania	Fever, malaria (Chea and colleagues, 2007)	
Milk thistle *(Silybum marianum)*	Reported decreased symptoms of hepatitis C (Seeff and colleagues, 2008)	
Comfrey	In topical cream: antiinflammatory action and analgesic effects (Grube and colleagues, 2007; Kucera and colleagues, 2005)	Noted to be a carcinogen in rats due to toxic alkaloid (Mei and colleagues, 2005)
Teucrium polium	Blood glucose– and lipid-lowering effects	Hepatitis, elevated liver enzymes, jaundice (Savvidou and colleagues, 2007)
Chan Su		False reading of digoxin levels (Hu and colleagues, 2005)
Dan Shen/danshen		Increased effect of warfarin with increased bleeding risk (Hu and colleagues, 2005)
Germander (*Teucrium* family)	Liver disease	Acute liver failure (Chitturi and Farrell, 2008)
Kava *(Piper methysticum)*	Liver disease; anxiety/depression (Sarris, 2007); reduced symptoms of Parkinson's with levodopa (Hu and colleagues, 2005)	Induced semicomatose state with alprazolam
Chaparral	Used for liver disease	Liver toxicity (Kauma and colleagues, 2004; Stickel and Schuppan, 2007)
St. John's wort *(Hypericum)*	Anxiety/depression	Increases clearance resulting in low concentrations of the following: • Cyclosporine with potential organ transplant rejection • Digoxin • Theophylline • Protease inhibitors (Dasgupta and Bernard, 2006) • Midazolam • Tacrolimus • Amitriptyline • Warfarin • Phenprocoumon • Oral contraceptives with breakthrough bleeding and pregnancy • Serotonin syndrome with sertraline and paroxetine (Hu and colleagues, 2005)
Garlic *(Allium sativum)*		Increased action of warfarin Increased action of chlorpropamide (an older oral hypoglycemic agent)

Continued

Table 3-6 Selected Herbal Therapies: Benefits and Toxicities—cont'd

SELECTED HERBS	POTENTIAL BENEFIT	POTENTIAL TOXICITY/INTERACTIONS
Ginkgo biloba		Increased action of warfarin (Bebbington and colleagues, 2005) Increased blood pressure with thiazide diuretics Coma with trazodone use
Ginseng	Increased effectiveness of flu vaccine	Decreased warfarin use Mania with phenelzine Increased concentration of digoxin
Piperine (from black and long pepper)		Increased concentration of the following: • Phenytoin • Propranolol • Theophylline
Black cohosh *(Cimicifuga racemosa)*	Primarily advised for menopausal symptoms; does not appear to have phytoestrogenic activity and may be an inhibitor of cancer tumor growth (Walji and colleagues, 2007)	Regulatory agencies in Australia, Canada, and the European Union have released statements regarding potential liver damage; cautionary statement now advised on supplement label by U.S. Dietary Supplement Information Expert Committee
Bitter melon/gourd *(Momordica charantia)*	Active compounds helped diabetes, dyslipidemia, and obesity in studies of mice (Nerurkar and colleagues, 2008; Tan and colleagues, 2008); this is also true in human studies (Krawinkel and Keding, 2006)	Adverse effects can occur from supplements and cannot be advised until further research is undertaken; melon juice (from unripened fruit: *Momordica charantia*) may be appropriate
Echinacea; purple coneflower	Was the preferred treatment for infections before antibiotics; may have antiviral and antiinflammatory actions; effects vary based on different species of *Echinacea* (Birt and colleagues, 2008); may activate cannabinoid receptors (Gertsch, 2008)	
Cinnamon	Only one controlled trial found lowered fasting plasma glucose in type 2 diabetes; no studies show effects with type 1 (Kleefstra and colleagues, 2007); may reduce advanced glycation end products (see Chapter 8) (Peng and colleagues, 2008); dose needed +/– 1 tsp daily.	No adverse effects known from actual cinnamon intake
Ginger	At 1 g/day helps decrease nausea and vomiting in pregnancy (Ensiyeh and Sakineh, 2008)	
Gymnema sylvestre (Asclepiadaceae)	Used for diabetes, in tea form used for obesity	

Table 3-6 Selected Herbal Therapies: Benefits and Toxicities—cont'd

SELECTED HERBS	POTENTIAL BENEFIT	POTENTIAL TOXICITY/INTERACTIONS
Feverfew	Traditional folk remedy for various conditions, including inflammation, fever, psoriasis, rheumatism, asthma, and migraine; active compounds generally unknown and actions vary based on extraction method	
Saw palmetto *(Serenoa repens)*	Used for benign prostatic enlargement; may have benefit in the treatment of prostate cancer (Y Yang and colleagues, 2007a)	May cause hepatitis and pancreatitis (Jibrin and colleagues, 2006)
Valerian	Used to help treat insomnia	
Goldenseal *(Hydrastis canadensis)*		Adverse interactions may result from simultaneous use with drugs that are CYP2D6 enzyme substrates (Gurley and colleagues, 2008)

Data from Hu Z, Yang X, Ho PC, Chan SY, Heng PW, Chan E, Duan W, Koh HL, Zhou S: Herb-drug interactions: a literature review, *Drugs* 65(9):1239-1282, 2005.

sages, for example, "That cantaloupe looks really good. Did you know that half a cantaloupe has all the vitamin A and vitamin C that you need for the day?" or "No milk? Can I get you something else in the dairy group—pudding, yogurt, cheese?" These types of messages reinforce good nutritional practices.

It is a disservice to consumers to speak of minerals as if they alone can cure some of humanity's ills. Claims such as "Calcium prevents osteoporosis," "Selenium prevents cancer," or "Zinc promotes sexual performance" have an element of truth but are simplistic messages at best. A better approach would be to take facts, put them in their proper perspective, and apply them to the relevant food sources. For example, a nurse might say, "Milk and milk products help prevent osteoporosis," "Fruits and vegetables are known to reduce cancer risk," or "Wheat germ and legumes help promote sexual maturation." This approach promotes good nutrition without placing undue emphasis on one mineral over another. This is particularly important with potential excess mineral intake leading to toxicity or imbalances.

The health care professional also should assess inadequate or excess nutrient intake. For example, are excessive amounts of supplements being taken, particularly of the fat-soluble vitamins or trace minerals? Supplement quality (USP or other claim of potency on the label) can be determined, and amount of nutrient intake in supplements can be assessed by comparison with the RDAs. For persons concerned with their vitamin needs, a quick comparison of their diet to the foods in the MyPyramid Food Guidance System can decrease fears of vitamin deficiency. It may be helpful to point out that an excess of one vitamin or mineral (in supplement form) can have a negative effect on the body's use of other vitamins or minerals (such as excess vitamin C inhibiting the absorption of zinc). Also, it cannot be stressed enough that if a person chooses to take a supplement, it should not exceed 100% to 200% of the DRI unless the person has been so advised by a physician or other health care provider (see Chapter 1). Referral to a health care provider or a registered dietitian is

appropriate for high-risk individuals (those with an impaired ability to excrete excess vitamins and minerals, such as persons with renal disease or those with multiple food restrictions for health or cultural reasons).

Chapter Challenge Questions & Classroom Activities

1. Bring vitamin bottles to class to quantify the daily value percentage of various vitamins and minerals. Do amounts vary from one brand to another? Why might this be? Do any labels indicate quantities greater than the UL? Identify vitamins and minerals described in this chapter that are found in low amounts or not at all on the supplement labels.
2. Why do minerals not break down when cooked, as some vitamins do?
3. Why must some foods containing vitamins be eaten daily? Which vitamins can be stored by the body? Which ones cannot be stored?
4. What is meant by the vitamin B complex? What foods need to be included in the diet to ensure an adequate amount of the B-complex vitamins?
5. List the foods in the MyPyramid that will help meet vitamin and mineral requirements, as well as the correct numbers of servings.
6. Calculate the calcium content of your diet. How could you meet the DRI for calcium without relying on supplements?
7. Name several procedures in food care, preparation, and cooking that will help retain water-soluble vitamins and minerals.
8. Role-play in class, portraying each of three characteristics detrimental to nutrition (lack of knowledge, food dislikes, and inadequate food habits or knowledge of food preparation), singly or in combination, to practice strategies to encourage an AI of foods high in vitamin A.
9. On the table of DRIs at the back of the book, underline in red pencil the figures that indicate the requirements for calories and each of the nutrients for a person of your age. You will be referring to these figures throughout the course.
10. *Class activity.* Have students form a circle, and practice stating functions and food sources of the various vitamins and minerals by tossing a stuffed vegetable toy, or other object, to one another. The student who tosses the object states a vitamin or mineral, and the one who catches the object has to state a fact about this nutrient.
11. Have students list at least five foods and realistic quantities that meet the DRI for vitamin C and vitamin A needs by referring to the DRI table and using Appendix 6 on the Evolve website on nutritive values of various foods. Ask the students if they recall the other name for vitamin C.

Case Study

Joey walked out of the doctor's office feeling stunned. He was just told he had signs of osteoporosis. He thought to himself, "I thought only old women got this disease." The doctor had been surprised as well, but after the series of bone fractures he had ordered a DXA scan for Joey's bones, which confirmed the diagnosis. His doctor didn't know that Joey had been a wrestler and had restricted his diet throughout his teenage years trying to "make weight."

Critical Thinking Applications

1. How might a restrictive diet during his teens have promoted osteoporosis?
2. What is important for Joey to do with his diet to prevent further bone damage?
3. How could osteoporosis have been prevented during his teenage years?

How Have Your Food Habits and Nutritional Attitudes Changed as You Have Studied About Nutrients and Foods Necessary for Good Nutrition?

Now is a good time for you to check your food habits.

Keep a record of your food intake (at meals and between meals) for 1 week.

Score your diet for each day, using the accompanying Food Selection Scorecard, and determine your average score for the week. Repeat this activity later in the semester, and compare the scores to see if you have improved your eating habits.

Analyze and comment on your last food selection score in the space provided.

FOOD GROUPS	PERFECT SCORE	MY SCORE	COMMENTS
Milk group			
Meat group			
Vegetable group			
Fruit group			
Bread and cereal group			
Water			

____ • What thought did you give to the principles of meal planning as you selected the necessary foods for your various meals?

____ • What improvements have you made in your food selection habits thus far?

____ • What further improvements would you like to make?

Note to Instructor: Each student should keep and score a week's food intake at least once more (preferably twice more) before the end of the course.

____ **1.** Why are good food habits important? How are they formed? How can they be improved?

____ **2.** What are five good food habits for you to acquire and follow daily?

FOOD SELECTION SCORECARD

Score your diet for each day, and determine your average score for the week. If your final score is between 85 and 100, your food selection standard has been good. A score of 75 to 85 indicates a fair standard. A score lower than 75 indicates a low standard.

MAXIMUM SCORE FOR EACH FOOD GROUP	CREDITS	COLUMNS FOR DAILY CHECK
20	**Milk Group:** Milk (including foods prepared with low-fat milk, part-skim cheese, and yogurt) Adults: 1 glass, 10; 2 glasses, 15; 3 glasses, 20*	
25	**Meat Group:** Eggs, meat, cheese, fish, poultry, dry peas, dry beans, and nuts 1 serving of any one of above, 10 1 serving of any two of above, 20 Extra credit for lean meats, 5	
35	**Vegetable and Fruit Group:** Vegetables: 1 c, 5; 2 c, 10; 2½ c, 15 Potatoes may be included as one of the preceding servings	

How Have Your Food Habits and Nutritional Attitudes Changed as You Have Studied About Nutrients and Foods Necessary for Good Nutrition?—cont'd

MAXIMUM SCORE FOR EACH FOOD GROUP	CREDITS	COLUMNS FOR DAILY CHECK
	If dark green or orange vegetable is included, extra credit, 5	
	Fruits: 1 c, 5; 2 c, 10	
	If citrus fruit, raw vegetable, or canned tomatoes are included, extra credit, 5†	
15	**Bread and Cereal Group:**	
	Bread—dark whole grain, enriched or restored	
	Cereals—dark whole grain	
	1 serving, 5; 2 servings, 10; 3 servings, 15	
5	**Water:**	
	(total liquid, including milk, coffee and tea, or other beverage):	
	Adults: 6 glasses, 2½; 8 glasses, 5	
100	**Final Score:**	

*Count ½ c milk in creamy soups, puddings, cream pies.
†Count ½ serving vegetables in soups or fruit in salad. Deductions from final score: each meal omitted, 10; excessive consumption of soft drinks, 10.

REFERENCES

Adhisivam B, Mahto D, Mahadevan S: Biotin responsive limb weakness, *Indian Pediatr* 44(3):228-230, 2007.

Anetor JI, Ajose OA, Adebiyi JA, Akingbola TS, Iyanda AA, Ebesunu MO, Babalola OO, Aadeniyi FA: Decreased thiamine and magnesium levels in the potentiation of the neurotoxicity of lead in occupational lead exposure, *Biol Trace Elem Res* 116(1):43-51, 2007.

Anke M, Seifert M: The biological and toxicological importance of molybdenum in the environment and in the nutrition of plants, animals and man. Part 1: Molybdenum in plants, *Acta Biol Hung* 58(3):311-324, 2007.

Arlt VM, Stiborová M, vom Brocke J, Simões ML, Lord GM, Nortier JL, Hollstein M, Phillips DH, Schmeiser HH: Aristolochic acid mutagenesis: molecular clues to the aetiology of Balkan endemic nephropathy-associated urothelial cancer, *Carcinogenesis* 28(11):2253-2261, 2007.

Athanasiadis I, Konstantinidis A, Kyprianou I, Robinson R, Moschou V, Kouzi-Koliakos K: Rapidly progressing bilateral cataracts in a patient with beta thalassemia and pellagra, *J Cataract Refract Surg* 33(9):1659-1661, 2007.

Balk EM, Tatsioni A, Lichtenstein AH, Lau J, Pittas AG: Effect of chromium supplementation on glucose metabolism and lipids: a systematic review of randomized controlled trials, *Diabetes Care* 30(8):2154-2163, 2007.

Baroncelli GI, Bereket A, El Kholy M, Audì L, Cesur Y, Ozkan B, Rashad M, Fernández-Cancio M, Weisman Y, Saggese G, Hochberg Z: Rickets in the Middle East: role of environment and genetic predisposition, *J Clin Endocrinol Metab* 93(5):1743-1750, 2008.

Barra A, Camardese G, Tonioni F, Sgambato A, Picello A, Autullo G, Silvia D, Bria P, Cittadini A: Plasma magnesium level and psychomotor retardation in major depressed patients, *Magnes Res* 20(4):245-249, 2007.

Basak R, Chowdhury AM, Fatmi LE, Saha NC, Mollah AH, Yasmin S: Stroke in the young: relationship with iron deficiency anemia and thrombocytosis, *Mymensingh Med J* 17(1):74-77, 2008.

Basu A, Imrhan V: Tomatoes versus lycopene in oxidative stress and carcinogenesis: conclusions from clinical trials, *Eur J Clin Nutr* 61(3):295-303, 2007.

Bebbington A, Kulkarni R, Roberts P: Ginkgo biloba: persistent bleeding after total hip arthroplasty caused by herbal self-medication, *J Arthroplasty* 20(1):125-126, 2005.

Beck J, Ferrucci L, Sun K, Walston J, Fried LP, Varadhan R, Guralnik JM, Semba RD: Low serum selenium concentrations are associated with poor grip strength among older women living in the community, *Biofactors* 29(1):37-44, 2007.

Belenky P, Bogan KL, Brenner C: NAD+ metabolism in health and disease, *Trends Biochem Sci* 32(1):12-19, 2007.

Bhat AS, Srinivasan K, Kurpad SS, Galgali RB: Psychiatric presentations of vitamin B_{12} deficiency, *J Indian Med Assoc* 105(7):395-396, 2007.

Birt DF, Widrlechner MP, Lalone CA, Wu L, Bae J, Solco AK, Kraus GA, Murphy PA, Wurtele ES, Leng Q, Hebert SC, Maury WJ, Price JP: Echinacea in infection, *Am J Clin Nutr* 87(2):488S-492S, 2008.

Bischoff-Ferrari HA, Dawson-Hughes B, Baron JA, Burckhardt P, Li R, Spiegelman D, Specker B, Orav JE, Wong JB, Staehelin HB, O'Reilly E, Kiel DP, Willett WC: Calcium intake and hip fracture risk in men and women: a meta-analysis of prospective cohort studies and randomized controlled trials, *Am J Clin Nutr* 86(6):1780-1790, 2007.

Bjelakovic G, Nikolova D, Gluud LL, Simonetti RG, Gluud C: Mortality in randomized trials of antioxidant supplements for primary and secondary prevention: systematic review and meta-analysis, *JAMA* 297(8):842-857, 2007.

Bleys J, Navas-Acien A, Guallar E: Serum selenium and diabetes in U.S. adults, *Diabetes Care* 30(4):829-834, 2007.

Block G, Jensen CD, Norkus EP, Dalvi TB, Wong LG, McManus JF, Hudes ML: Usage patterns, health, and nutritional status of long-term multiple dietary supplement users: a cross-sectional study, *Nutr J* 6(1):30, 2007.

Bonucchi J, Hassan I, Policeni B, Kaboli P: Thyrotoxicosis associated Wernicke's encephalopathy, *J Gen Intern Med* 23(1):106-109, 2008.

Borel P, Drai J, Faure H, Fayol V, Galabert C, Laromiguière M, Le Moël G: Recent knowledge about intestinal absorption and cleavage of carotenoids, *Ann Biol Clin* 63(2):165-177, 2005.

Briefel R, Hanson C, Fox MK, Novak T, Ziegler P: Feeding Infants and Toddlers Study: do vitamin and mineral supplements contribute to nutrient adequacy or excess among US infants and toddlers? *J Am Diet Assoc* 106(1 Suppl 1): S52-S65, 2006.

Castaño G, Etchart C, Sookoian S: Vitamin A toxicity in a physical culturist patient: a case report and review of the literature, *Ann Hepatol* 5(4):293-395, 2006.

Chambellan-Tison C, Horen B, Plat-Wilson G, Moulin P, Claudet I: Severe hypercalcemia due to vitamin D intoxication, *Arch Pediatr* 14(11):1328-1332, 2007.

Chea A, Hout S, Bun SS, Tabatadze N, Gasquet M, Azas N, Elias R, Balansard G: Antimalarial activity of alkaloids isolated from *Stephania rotunda*, *J Ethnopharmacol* 112(1): 132-137, 2007.

Cheruvattath R, Orrego M, Gautam M, Byrne T, Alam S, Voltchenok M, Edwin M, Wilkens J, Williams JW, Vargas HE: Vitamin A toxicity: when one a day doesn't keep the doctor away, *Liver Transpl* 12(12):1888-1891, 2006.

Cheung TP, Xue C, Leung K, Chan K, Li CG: Aristolochic acids detected in some raw Chinese medicinal herbs and manufactured herbal products—a consequence of inappropriate nomenclature and imprecise labelling? *Clin Toxicol* 44(4):371-378, 2006.

Chitturi S, Farrell GC: Hepatotoxic slimming aids and other herbal hepatotoxins, *J Gastroenterol Hepatol* 23(3):366-373, 2008.

Chou IC, Wang CS, Lin WD, Lin HC, Tsai CH, Wang TR, Tsai FJ: Holocarboxylase synthetase deficiency: report of one case, *Acta Paediatr Taiwan* 47(6):309-311, 2006.

Corbi G, Acanfora D, Iannuzzi GL, Longobardi G, Cacciatore F, Furgi G, Filippelli A, Rengo G, Leosco D, Ferrara N: Hypermagnesemia predicts mortality in elderly with congestive heart disease: relationship with laxative and antacid use, *Rejuvenation Res* 11(1):129-138, 2008.

Cranney A, Horsley T, O'Donnell S, Weiler H, Puil L, Ooi D, Atkinson S, Ward L, Moher D, Hanley D, Fang M, Yazdi F, Garritty C, Sampson M, Barrowman N, Tsertsvadze A, Mamaladze V: Effectiveness and safety of vitamin D in relation to bone health, *Evid Rep Technol Assess* (158):1-235, 2007.

Dasgupta A, Bernard DW: Herbal remedies: effects on clinical laboratory tests. *Arch Pathol Lab Med* 130(4):521-528, 2006.

Depeint F, Bruce WR, Shangari N, Mehta R, O'Brien PJ: Mitochondrial function and toxicity: role of the B vitamin family on mitochondrial energy metabolism. *Chem Biol Interact* 163(1-2):94-112, 2006.

Dharmarajan TS, Kanagala MR, Murakonda P, Lebelt AS, Norkus EP: Do acid-lowering agents affect vitamin B_{12} status in older adults? *J Am Med Dir Assoc* 9(3):162-167, 2008.

Diaz ML, Watkins BA, Li Y, Anderson RA, Campbell WW: Chromium picolinate and conjugated linoleic acid do not synergistically influence diet- and exercise-induced changes in body composition and health indexes in overweight women, *J Nutr Biochem* 19(1):61-68, 2008.

Donnino MW, Miller J, Garcia AJ, McKee E, Walsh M: Distinctive acid-base pattern in Wernicke's encephalopathy, *Ann Emerg Med* 50(6):722-725, 2007.

Dunstan JA, Breckler L, Hale J, Lehmann H, Franklin P, Lyons G, Ching SY, Mori TA, Barden A, Prescott SL: Supplementation with vitamins C, E, beta-carotene and selenium has no effect on anti-oxidant status and immune responses in allergic adults: a randomized controlled trial, *Clin Exp Allergy* 37(2):180-187, 2007.

Elliott P, Kesteloot H, Appel LJ, Dyer AR, Ueshima H, Chan Q, Brown IJ, Zhao L, Stamler J; INTERMAP Cooperative Research Group: Dietary phosphorus and blood pressure: international study of macro- and micro-nutrients and blood pressure, *Hypertension* 51(3):669-675, 2008.

El Otmani H, El Moutawakil B, Moutaouakil F, Gam I, Rafai MA, Slassi I: Postoperative dementia: toxicity of nitrous oxide, *Encephale* 33(1):95-97, 2007.

Ensiyeh J, Sakineh MA: Comparing ginger and vitamin B_6 for the treatment of nausea and vomiting in pregnancy: a randomised controlled trial, *Midwifery* 2008 Feb 11 (Epub ahead of print).

Filippatos TD, Derdemezis CS, Gazi IF, Nakou ES, Mikhailidis DP, Elisaf MS: Orlistat-associated adverse effects and drug interactions: a critical review, *Drug Saf* 31(1):53-65, 2008.

Garba IH, Ubom GA: Potential role of serum magnesium measurement as a biomarker of acute falciparum malaria

infection in adult patients, *Biol Trace Elem Res* 114(1-3): 115-120, 2006.
Garcia SJ, Gellein K, Syversen T, Aschner M: Iron deficient and manganese supplemented diets alter metals and transporters in the developing rat brain, *Toxicol Sci* 95(1):205-214, 2007.
Gertsch J: Immunomodulatory lipids in plants: plant fatty acid amides and the human endocannabinoid system, *Planta Med* 74(6):638-650, 2008.
Gianello R, Hall WC, Kennepohl E, Libinaki R, Ogru E: Subchronic oral toxicity study of mixed tocopheryl phosphates in rats, *Int J Toxicol* 26(5):475-490, 2007.
Girona J, Guardiola M, Cabré A, Manzanares JM, Heras M, Ribalta J, Masana L: The apolipoprotein A5 gene-1131T→C polymorphism affects vitamin E plasma concentrations in type 2 diabetic patients, *Clin Chem Lab Med* 46(4):453-457, 2008.
Gisondi P, Fantuzzi F, Malerba M, Girolomoni G: Folic acid in general medicine and dermatology, *J Dermatolog Treat* 18(3):138-146, 2007.
Gomber S, Dewan P, Dua T: Homocystinuria: a rare cause of megaloblastic anemia, *Indian Pediatr* 41(9):941-943, 2004.
Gorbachev AL, Skalny AV, Koubassov RV: Bioelement effects on thyroid gland in children living in iodine-adequate territory, *J Trace Elem Med Biol* 21(Suppl 1):56-58, 2007.
Graham-Maar RC, Schall JI, Stettler N, Zemel BS, Stallings VA: Elevated vitamin A intake and serum retinol in preadolescent children with cystic fibrosis, *Am J Clin Nutr* 84(1):174-182, 2006.
Grant WB: Epidemiology of disease risks in relation to vitamin D insufficiency, *Prog Biophys Mol Biol* 92(1):65-79, 2006.
Grube B, Grünwald J, Krug L, Staiger C: Efficacy of a comfrey root (Symphyti offic. radix) extract ointment in the treatment of patients with painful osteoarthritis of the knee: results of a double-blind, randomised, bicenter, placebo-controlled trial, *Phytomedicine* 14(1):2-10, 2007.
Gurley BJ, Swain A, Hubbard MA, Williams DK, Barone G, Hartsfield F, Tong Y, Carrier DJ, Cheboyina S, Battu SK: Clinical assessment of CYP2D6-mediated herb-drug interactions in humans: effects of milk thistle, black cohosh, goldenseal, kava kava, St. John's wort, and Echinacea, *Mol Nutr Food Res* 52(7):755-763, 2008.
Halfdanarson TR, Kumar N, Li CY, Phyliky RL, Hogan WJ: Hematological manifestations of copper deficiency: a retrospective review, *Eur J Haematol* 80(6):523-531, 2008a.
Halfdanarson TR, Walker JA, Litzow MR, Hanson CA: Severe vitamin B_{12} deficiency resulting in pancytopenia, splenomegaly and leukoerythroblastosis, *Eur J Haematol* 80(5):448-451, 2008b.
Harrison RA, Vu T, Hunter AJ: Wernicke's encephalopathy in a patient with schizophrenia, *J Gen Intern Med* 21(12): C8-C11, 2006.
He K, Song Y, Belin RJ, Chen Y: Magnesium intake and the metabolic syndrome: epidemiologic evidence to date, *J Cardiometab Syndr* 1(5):351-355, 2006.
Herrmann W, Lorenzl S, Obeid R: Review of the role of hyperhomocysteinemia and B-vitamin deficiency in neurological and psychiatric disorders—current evidence and preliminary recommendations, *Fortschr Neurol Psychiatr* 75(9):515-527, 2007.
Hoffmann PR, Jourdan-Le Saux C, Hoffmann FW, Chang PS, Bollt O, He Q, Tam EK, Berry MJ: A role for dietary selenium and selenoproteins in allergic airway inflammation, *J Immunol* 179(5):3258-3267, 2007.
Hron G, Lombardi R, Eichinger S, Lecchi A, Kyrle PA, Cattaneo M: Low vitamin B_6 levels and the risk of recurrent venous thromboembolism, *Haematologica* 92(9):1250-1253, 2007.
Hu Z, Yang X, Ho PC, Chan SY, Heng PW, Chan E, Duan W, Koh HL, Zhou S: Herb-drug interactions: a literature review, *Drugs* 65(9):1239-1282, 2005.
Husemoen LL, Toft U, Fenger M, Jørgensen T, Johansen N, Linneberg A: The association between atopy and factors influencing folate metabolism: is low folate status causally related to the development of atopy? *Int J Epidemiol* 35(4):954-961, 2006.
Hvas AM, Nexo E, Nielsen JB: Vitamin B_{12} and vitamin B_6 supplementation is needed among adults with phenylketonuria (PKU), *J Inherit Metab Dis* 29(1):47-53, 2006.
Iqbal MP, Kazim SF, Mehboobali N: Ascorbic acid contents of Pakistani fruits and vegetables, *Pak J Pharm Sci* 19(4):282-285, 2006.
Ishida K, Sato H: Kampo medicines as alternatives for treatment of migraine: six case studies, *Complement Ther Clin Pract* 12(4):276-280, 2006.
Ivanov NI, Cowell SP, Brown P, Rennie PS, Guns ES, Cox ME: Lycopene differentially induces quiescence and apoptosis in androgen-responsive and -independent prostate cancer cell lines, *Clin Nutr* 26(2):252-263, 2007.
Izzeldin HS, Crawford MA, Jooste PL: Population living in the Red Sea State of Sudan may need urgent intervention to correct the excess dietary iodine intake, *Nutr Health* 18(4):333-341, 2007.
Jibrin I, Erinle A, Saidi A, Aliyu ZY: Saw palmetto–induced pancreatitis, *South Med J* 99(6):611-612, 2006.
Jung A, Marziniak M: Copper deficiency as a treatable cause of myelopathy, *Nervenarzt* 79(4):421-425, 2008.
Kahmann L, Uciechowski P, Warmuth S, Plümäkers B, Gressner AM, Malavolta M, Mocchegiani E, Rink L: Zinc supplementation in the elderly reduces spontaneous inflammatory cytokine release and restores T cell functions, *Rejuvenation Res* 11(1):227-237, 2008.
Kaler SG, Holmes CS, Goldstein DS, Tang J, Godwin SC, Donsante A, Liew CJ, Sato S, Patronas N: Neonatal diagnosis and treatment of Menkes disease, *N Engl J Med* 358(6):605-614, 2008.
Kaprara A, Krassas GE: Selenium and thyroidal function: the role of immunoassays, *Hell J Nucl Med* 9(3):195-203, 2006.
Karuppagounder SS, Shi Q, Xu H, Gibson GE: Changes in inflammatory processes associated with selective vulner-

ability following mild impairment of oxidative metabolism, *Neurobiol Dis* 26(2):353-362, 2007.

Kauma H, Koskela R, Mäkisalo H, Autio-Harmainen H, Lehtola J, Höckerstedt K: Toxic acute hepatitis and hepatic fibrosis after consumption of chaparral tablets, *Scand J Gastroenterol* 39(11):1168-1171, 2004.

Kelleher SL, Lonnerdal B: Low vitamin A intake affects milk iron level and iron transporters in rat mammary gland and liver, *J Nutr* 135(1):27-32, 2005.

Kevers C, Falkowski M, Tabart J, Defraigne JO, Dommes J, Pincemail J: Evolution of antioxidant capacity during storage of selected fruits and vegetables, *J Agric Food Chem* 55(21):8596-8603, 2007.

Kiechl-Kohlendorfer U, Fink FM, Steichen-Gersdorf E: Transient symptomatic zinc deficiency in a breast-fed preterm infant. *Pediatr Dermatol* 24(5):536-540, 2007.

Kim YN, Lora KR, Giraud DW, Driskell JA: Nonsupplemented children of Latino immigrants have low vitamin E intakes and plasma concentrations and normal vitamin C, selenium, and carotenoid intakes and plasma concentrations, *J Am Diet Assoc* 106(3):385-391, 2006.

Kimmoun A, Leheup B, Feillet F, Dubois F, Morali A: Hypercalcemia revealing iatrogenic hypervitaminosis A in a child with autistic troubles, *Arch Pediatr* 15(1):29-32, 2008.

Kleefstra N, Logtenberg SJ, Houweling ST, Verhoeven S, Bilo HJ: Cinnamon: not suitable for the treatment of diabetes mellitus, *Ned Tijdschr Geneeskd* 151(51):2833-2837, 2007.

Ko CW: Magnesium: does a mineral prevent gallstones? *Am J Gastroenterol*, 103(2):383-385, 2008.

Krajcovicova-Kudlackova M, Babinska K, Valachovicova M, Paukova V, Dusinska M, Blazicek P: Vitamin C protective plasma value, *Bratisl Lek Listy* 108(6):265-268, 2007.

Krawinkel MB, Keding GB: Bitter gourd (*Momordica charantia*): a dietary approach to hyperglycemia, *Nutr Rev* 64(7 Pt 1):331-337, 2006.

Krinsky NI, Johnson EJ: Carotenoid actions and their relation to health and disease, *Mol Aspects Med* 26(6):459-516, 2005.

Kucera M, Barna M, Horàcek O, Kàlal J, Kucera A, Hladìkova M: Topical symphytum herb concentrate cream against myalgia: a randomized controlled double-blind clinical study, *Adv Ther* 22(6):681-692, 2005.

Kumar N: Copper deficiency myelopathy (human swayback), *Mayo Clin Proc* 81(10):1371-1384, 2006.

Kuo YM, Hayflick SJ, Gitschier J: Deprivation of pantothenic acid elicits a movement disorder and azoospermia in a mouse model of pantothenate kinase–associated neurodegeneration, *J Inherit Metab Dis* 30(3):310-317, 2007.

Kuroishi T, Endo Y, Muramoto K, Sugarawa S: Biotin deficiency up-regulates TNF-alpha production in murine macrophages, *J Leukoc Biol* 83(4):912-920, 2008.

Lagarde WH, Underwood LE, Moats-Staats BM, Calikoglu AS: Novel mutation in the SLC19A2 gene in an African-American female with thiamine-responsive megaloblastic anemia syndrome, *Am J Med Genet A* 15;125A(3):299-305, 2004.

Lam HS, Chow CM, Poon WT, Lai CK, Chan KC, Yeung WL, Hui J, Chan AY, Ng PC: Risk of vitamin A toxicity from candy-like chewable vitamin supplements for children, *Pediatrics* 118(2):820-824, 2006.

Lans C: Ethnomedicines used in Trinidad and Tobago for reproductive problems. *J Ethnobiol Ethnomed* 3:13, 2007.

Lappe JM, Davies KM, Travers-Gustafson D, Heaney RP: Vitamin D status in a rural postmenopausal female population. *J Am Coll Nutr* 25(5):395-402, 2006.

Lee MJ, Ayaki H, Goji J, Kitamura K, Nishio H: Cadmium restores in vitro splicing activity inhibited by zinc-depletion, *Arch Toxicol* 80(10):638-643, 2006.

Lerner V, Miodownik C, Kaptsan A, Bersudsky Y, Libov I, Sela BA, Witztum E: Vitamin B_6 treatment for tardive dyskinesia: a randomized, double-blind, placebo-controlled, crossover study, *J Clin Psychiatry* 68(11):1648-1654, 2007.

Levis S, Gomez A, Jimenez C, Veras L, Ma F, Lai S, Hollis B, Roos BA: Vitamin D deficiency and seasonal variation in an adult South Florida population, *J Clin Endocrinol Metab* 90(3):1557-1562, 2005.

Li F, Chong ZZ, Maiese K: Cell life versus cell longevity: the mysteries surrounding the NAD+ precursor nicotinamide, *Curr Med Chem* 13(8):883-895, 2006.

Li Z, Vance DE: Phosphatidylcholine and choline homeostasis, *J Lipid Res* 49(6):1187-1194, 2008.

Lindholt ME: Reduced vision in Wernicke's syndrome with symptoms of nystagmus, *Ugeskr Laeger* 168(14):1451-1452, 2006.

Lönnerdal B, Kelleher SL: Iron metabolism in infants and children, *Food Nutr Bull* 28(4 Suppl):S491-S499, 2007.

Lopez V, Keen CL, Lanoue L: Prenatal zinc deficiency: influence on heart morphology and distribution of key heart proteins in a rat model, *Biol Trace Elem Res* 122(3):238-255, 2008.

Lozoff B: Iron deficiency and child development, *Food Nutr Bull* 28(4 Suppl):S560-S571, 2007.

Lukacik M, Thomas RL, Aranda JV: A meta-analysis of the effects of oral zinc in the treatment of acute and persistent diarrhea, *Pediatrics* 121(2):326-336, 2008.

Maamar M, Mezalek ZT, Harmouche H, Adnaoui M, Aouni M, Maaouni A: Contribution of spinal MRI for unsuspected cobalamin deficiency in isolated sub-acute combined degeneration, *Eur J Intern Med* 19(2):143-145, 2008.

Mahattanatawee K, Manthey JA, Luzio G, Talcott ST, Goodner K, Baldwin EA: Total antioxidant activity and fiber content of select Florida-grown tropical fruits, *J Agric Food Chem* 54(19):7355-7363, 2006.

Maret W, Sandstead HH: Possible roles of zinc nutriture in the fetal origins of disease, *Exp Gerontol* 43(5):378-381, 2008.

Martena MJ, van der Wielen JC, van de Laak LF, Konings EJ, de Groot HN, Rietjens IM: Enforcement of the ban on aristolochic acids in Chinese traditional herbal preparations on the Dutch market, *Anal Bioanal Chem* 389(1): 263-275, 2007.

Martins D, Wolf M, Pan D, Zadshir A, Tareen N, Thadhani R, Felsenfeld A, Levine B, Mehrotra R, Norris K: Prevalence of cardiovascular risk factors and the serum levels of 25-hydroxyvitamin D in the United States: data from the Third National Health and Nutrition Examination Survey, *Arch Intern Med* 167(11):1159-1165, 2007.

Masters ET, Jedrychowski W, Schleicher RL, Tsai WY, Tu YH, Camann D, Tang D, Perera FP: Relation between prenatal lipid-soluble micronutrient status, environmental pollutant exposure, and birth outcomes, *Am J Clin Nutr* 86(4):1139-1145, 2007.

Mei N, Guo L, Fu PP, Heflich RH, Chen T: Mutagenicity of comfrey (*Symphytum officinale*) in rat liver, *Br J Cancer* 92(5):873-875, 2005.

Milman U, Blum S, Shapira C, Aronson D, Miller-Lotan R, Anbinder Y, Alshiek J, Bennett L, Kostenko M, Landau M, Keidar S, Levy Y, Khemlin A, Radan A, Levy AP: Vitamin E supplementation reduces cardiovascular events in a subgroup of middle-aged individuals with both type 2 diabetes mellitus and the haptoglobin 2-2 genotype: a prospective double-blinded clinical trial, *Arterioscler Thromb Vasc Biol* 28(2):341-347, 2008.

Mitrofanov VA, Ovchinnikova NM, Belova SV, Fedotova MV, Gladkova EV: Inflammatory degeneration of joint tissue in adjuvant arthritis after intraarticular treatment with the mixture of silver drug and nicotinic acid, *Bull Exp Biol Med* 140(6):702-704, 2005.

Miyake Y, Sasaki S, Tanaka K, Yokoyama T, Ohya Y, Fukushima W, Saito K, Ohfuji S, Kiyohara C, Hirota Y; Osaka Maternal and Child Health Study Group: Dietary folate and vitamins B_{12}, B_6, and B_2 intake and the risk of postpartum depression in Japan: the Osaka Maternal and Child Health Study, *J Affect Disord* 96(1-2):133-138, 2006.

Miyata S: Zinc deficiency in the elderly, *Nippon Ronen Igakkai Zasshi* 44(6):677-689, 2007.

Mohammed S, Goodacre S: Intravenous and nebulised magnesium sulphate for acute asthma: systematic review and meta-analysis, *Emerg Med J* 24(12):823-830, 2007.

Mouw DR, Latessa RA: What are the causes of hypomagnesemia? *J Fam Pract* 54(2):174-176, 2005.

Myhre AM, Carlsen MH, Bøhn SK, Wold HL, Laake P, Blomhoff R: Water-miscible, emulsified, and solid forms of retinol supplements are more toxic than oil-based preparations, *Am J Clin Nutr* 78(6):1152-1159, 2003.

Myoishi M, Kitakaze M: A role of magnesium in the therapy for cardiovascular diseases, *Clin Calcium* 15(2):265-270, 2005.

Naderi AS, Reilly RF Jr: Hereditary etiologies of hypomagnesemia, *Nat Clin Pract Nephrol* 4(2):80-89, 2008.

Nelson GM, Ahlborn GJ, Delker DA, Kitchin KT, O'Brien TG, Chen Y, Kohan MJ, Roop BC, Ward WO, Allen JW: Folate deficiency enhances arsenic effects on expression of genes involved in epidermal differentiation in transgenic K6/ODC mouse skin, *Toxicology* 241(3):134-145, 2007.

Nerurkar PV, Lee YK, Motosue M, Adeli K, Nerurkar VR: *Momordica charantia* (bitter melon) reduces plasma apolipoprotein B-100 and increases hepatic insulin receptor substrate and phosphoinositide-3 kinase interactions, *Br J Nutr* 5:1-9, 2008.

Nettekoven S, Ströhle A, Trunz B, Wolters M, Hoffmann S, Horn R, Steinert M, Brabant G, Lichtinghagen R, Welkoborsky HJ, Tuxhorn I, Hahn A: Effects of antiepileptic drug therapy on vitamin D status and biochemical markers of bone turnover in children with epilepsy, *Eur J Pediatr* 167(12):1369-1377, 2008.

Nisbet BC, O'Connor RE: Black cohosh-induced hepatitis, *Del Med J* 79(11):441-444, 2007.

Olmedo JM, Yiannias JA, Windgassen EB, Gornet MK: Scurvy: a disease almost forgotten, *Int J Dermatol* 45(8):909-913, 2006.

Omu AE, Al-Azemi MK, Kehinde EO, Anim JT, Oriowo MA, Mathew TC: Indications of the mechanisms involved in improved sperm parameters by zinc therapy, *Med Princ Pract* 17(2):108-116, 2008.

Parcell S: Sulfur in human nutrition and applications in medicine, *Altern Med Rev* 7(1):22-44, 2002.

Park JH, Lee JH, Jeong JO, Seong IW, Choi SW: Thiamine deficiency as a rare cause of reversible severe pulmonary hypertension, *Int J Cardiol* 121(1):e1-e3, 2007.

Peng X, Cheng KW, Ma J, Chen B, Ho CT, Lo C, Chen F, Wang M: Cinnamon bark proanthocyanidins as reactive carbonyl scavengers to prevent the formation of advanced glycation endproducts, *J Agric Food Chem* 56(6):1907-1911, 2008.

Petrosillo G, Portincasa P, Grattagliano I, Casanova G, Matera M, Ruggiero FM, Ferri D, Paradies G: Mitochondrial dysfunction in rat with nonalcoholic fatty liver involvement of complex I reactive oxygen species and cardiolipin, *Biochim Biophys Acta* 1767(10):1260-1267, 2007.

Pineda-Lucatero A, Avila-Jiménez L, Ramos-Hernández RI, Magos C, Martínez H: Iodine deficiency and its association with intelligence quotient in schoolchildren from Colima, Mexico, *Public Health Nutr* 11(7):690-698, 2008.

Pitche PT: Pellagra, *Sante* 15(3):205-208, 2005.

Pitukcheewanont P, Numbenjapon N, Costin G: Ectopic thymic parathyroid adenoma and vitamin D deficiency rickets: a 5-year-follow-up case report and review of literature, *Bone* 42(4):819-824, 2008.

Poikolainen K, Alho H: Magnesium treatment in alcoholics: a randomized clinical trial, *Subst Abuse Treat Prev Policy* 3(1):1, 2008.

Renzi LM, Johnson EJ: Lutein and age-related ocular disorders in the older adult: a review, *J Nutr Elder* 26(3-4): 139-157, 2007.

Ribaya-Mercado JD, Maramag CC, Tengco LW, Dolnikowski GG, Blumberg JB, Solon FS: Carotene-rich plant foods ingested with minimal dietary fat enhance the total-body vitamin A pool size in Filipino schoolchildren as assessed by stable-isotope-dilution methodology, *Am J Clin Nutr* 85(4):1041-1049, 2007.

Roberts SH, Bedson E, Hughes D, Lloyd K, Moat S, Pirmohamed M, Slegg G, Tranter R, Whitaker R, Wilkinson C, Russell I: Folate augmentation of treatment—evaluation for depression (FolATED): protocol of a randomised controlled trial, *BMC Psychiatry* 7:65, 2007.

Rodriguez-Fragoso L, Reyes-Esparza J, Burchiel SW, Herrera-Ruiz D, Torres E: Risks and benefits of commonly used herbal medicines in Mexico, *Toxicol Appl Pharmacol* 227(1):125-135, 2008.

Rosenbaum DH, Cain MP, Kaefer M, Meldrum KK, King SJ, Misseri R, Rink RC: Ileal enterocystoplasty and B_{12} deficiency in pediatric patients, *J Urol* 179(4):1544-1547, 2008.

Rovner AJ, Stallings VA, Schall JI, Leonard MB, Zemel BS: Vitamin D insufficiency in children, adolescents, and young adults with cystic fibrosis despite routine oral supplementation, *Am J Clin Nutr* 86(6):1694-1699, 2007.

Sahin K, Onderci M, Tuzcu M, Ustundag B, Cikim G, Ozercan IH, Sriramoju V, Juturu V, Komorowski JR: Effect of chromium on carbohydrate and lipid metabolism in a rat model of type 2 diabetes mellitus: the fat-fed, streptozotocin-treated rat, *Metabolism* 56(9):1233-1240, 2007.

Sahni V, Léger Y, Panaro L, Allen M, Giffin S, Fury D, Hamm N: Case report: a metabolic disorder presenting as pediatric manganism, *Environ Health Perspect* 115(12):1776-1779, 2007.

Sakai K, Nakajima T, Fukuhara N: A suspected case of alcoholic pellagra encephalopathy with marked response to niacin showing myoclonus and ataxia as chief complaints, *No To Shinkei* 58(2):141-144, 2006.

Sanchez JE, Barham KL, Sangueza OP: Acquired *acrodermatitis enteropathica:* case report of an atypical presentation, *J Cutan Pathol* 34(6):490-493, 2007.

Sarris J: Herbal medicines in the treatment of psychiatric disorders: a systematic review, *Phytother Res* 21(8):703-716, 2007.

Savvidou S, Goulis J, Giavazis I, Patsiaoura K, Hytiroglou P, Arvanitakis C: Herb-induced hepatitis by *Teucrium polium* L.: report of two cases and review of the literature, *Eur J Gastroenterol Hepatol* 19(6):507-511, 2007.

Scanlan BJ, Tuft B, Elfrey JE, Smith A, Zhao A, Morimoto M, Chmielinska JJ, Tejero-Taldo MI, Mak IuT, Weglicki WB, Shea-Donohue T: Intestinal inflammation caused by magnesium deficiency alters basal and oxidative stress-induced intestinal function, *Mol Cell Biochem* 306(1-2): 59-69, 2007.

Scharpf M, Schweizer U, Arzberger T, Roggendorf W, Schomburg L, Köhrle J: Neuronal and ependymal expression of selenoprotein P in the human brain, *J Neural Transm* 114(7):877-884, 2007.

Schittl H, Getoff N: Radiation-induced antitumor properties of vitamin B_5 (pantothenic acid) and its effect on mitomycin C activity: experiments in vitro. *Oncol Res* 16(8):389-394, 2007.

Seaton A: From nurture to nature—the story of the Aberdeen asthma dietary hypothesis, *QJM* 101(3):237-239, 2008.

Seeff LB, Curto TM, Szabo G, Everson GT, Bonkovsky HL, Dienstag JL, Shiffman ML, Lindsay KL, Lok AS, Di Bisceglie AM, Lee WM, Ghany MG; HALT-C Trial Group: Herbal product use by persons enrolled in the Hepatitis C Antiviral Long-Term Treatment Against Cirrhosis (HALT-C) Trial, *Hepatology* 47(2):605-612, 2008.

Selhub J, Morris MS, Jacques PF: In vitamin B_{12} deficiency, higher serum folate is associated with increased total homocysteine and methylmalonic acid concentrations, *Proc Natl Acad Sci USA* 104(50):19995-20000, 2007.

Semba RD, Ricks MO, Ferrucci L, Xue QL, Guralnik JM, Fried LP: Low serum selenium is associated with anemia among older adults in the United States, *Eur J Clin Nutr* 63(1):93-99 2009.

Sethi NK, Mullin P, Torgovnick J, Capasso G: Nitrous oxide "whippit" abuse presenting with cobalamin responsive psychosis, *J Med Toxicol* 2(2):71-74, 2006.

Shao A, Hathcock JN: Risk assessment for the carotenoids lutein and lycopene, *Regul Toxicol Pharmacol* 45(3):289-298, 2006.

Shi Q, Karuppagounder SS, Xu H, Pechman D, Chen H, Gibson GE: Responses of the mitochondrial alpha-ketoglutarate dehydrogenase complex to thiamine deficiency may contribute to regional selective vulnerability, *Neurochem Int* 50(7-8):921-931, 2007.

Spinazzi M, De Lazzari F, Tavolato B, Angelini C, Manara R, Armani M: Myelo-optico-neuropathy in copper deficiency occurring after partial gastrectomy. Do small bowel bacterial overgrowth syndrome and occult zinc ingestion tip the balance? *J Neurol* 254(8):1012-1017, 2007.

St Claire MB, Kennett MJ, Besch-Williford CL: Vitamin A toxicity and vitamin E deficiency in a rabbit colony, *Contemp Top Lab Anim Sci* 43(4):26-30, 2004.

Stickel F, Schuppan D: Herbal medicine in the treatment of liver diseases, *Dig Liver Dis* 39(4):293-304, 2007.

Stranges S, Marshall JR, Natarajan R, Donahue RP, Trevisan M, Combs GF, Cappuccio FP, Ceriello A, Reid ME: Effects of long-term selenium supplementation on the incidence of type 2 diabetes: a randomized trial, *Ann Intern Med* 147(4):217-223, 2007.

Su LJ, Arab L: Salad and raw vegetable consumption and nutritional status in the adult US population: results from the Third National Health and Nutrition Examination Survey, *J Am Diet Assoc* 106(9):1394-1404, 2006.

Tan MJ, Ye JM, Turner N, Hohnen-Behrens C, Ke CQ, Tang CP, Chen T, Weiss HC, Gesing ER, Rowland A, James DE, Ye Y: Antidiabetic activities of triterpenoids isolated from bitter melon associated with activation of the AMPK pathway, *Chem Biol* 15(3):263-273, 2008.

Tang Z, Liu W, Yin H, Wang P, Dong J, Wang Y, Chen J: Investigation of intelligence quotient and psychomotor development in schoolchildren in areas with different degrees of iodine deficiency, *Asia Pac J Clin Nutr* 16(4):731-737, 2007.

Tariq SA: Role of ascorbic acid in scavenging free radicals and lead toxicity from biosystems, *Mol Biotechnol* 37(1): 62-65, 2007.

Tarwadi K, Agte V: Antioxidant and micronutrient potential of common fruits available in the Indian subcontinent, *Int J Food Sci Nutr* 58(5):341-349, 2007.

Thoenes M, Oguchi A, Nagamia S, Vaccari CS, Hammoud R, Umpierrez GE, Khan BV: The effects of extended-release niacin on carotid intimal media thickness, endothelial function and inflammatory markers in patients with the metabolic syndrome, *Int J Clin Pract* 61(11):1942-1948, 2007.

Thomson CD, Chisholm A, McLachlan SK, Campbell JM: Brazil nuts: an effective way to improve selenium status, *Am J Clin Nutr* 87(2):379-384, 2008.

Tinley CG, Withers NJ, Sheldon CD, Quinn AG, Jackson AA: Zinc therapy for night blindness in cystic fibrosis, *J Cyst Fibros* 7(4):333-335, 2008.

Tirosh O, Levy E, Reifen R: High selenium diet protects against TNBS-induced acute inflammation, mitochondrial dysfunction, and secondary necrosis in rat colon, *Nutrition* 23(11-12):878-886, 2007.

Tsikunib AD, Kondratova ES: Assessment of the structure and quality of nutrition as a factor that influences thyroid functional activity, *Gig Sanit* (6):67-70, 2007.

Tsujino T, Nakao S, Wakabayashi K, Lee M, Kimura T, Yoshikawa H, Sakoda T, Ohyanagi M, Masuyama T: Loop diuretic precipitated beriberi in a patient after pancreaticoduodenectomy: a case report, *Am J Med Sci* 334(5):407-409, 2007.

Tucker KL, Hannan MT, Qiao N, Jacques PF, Selhub J, Cupples LA, Kiel DP: Low plasma vitamin B_{12} is associated with lower BMD: The Framingham Osteoporosis Study, *J Bone Miner Res* 20(1):152-158, 2005.

Tupe RS, Chiplonkar SA, Agte VV: Changes in zinc uptake in response to ascorbic acid and folic acid in rat liver slices under normal and oxidative stress conditions, *Biofactors* 30(1):27-34, 2007.

van Summeren MJ, van Coeverden SC, Schurgers LJ, Braam LA, Noirt F, Uiterwaal CS, Kuis W, Vermeer C: Vitamin K status is associated with childhood bone mineral content, *Br J Nutr* 1-7, 2008.

Varella Morandi Junqueira-Franco M, Ernesto Troncon L, Garcia Chiarello P, do Rosário Del Lama Unamuno M, Afonso Jordao A, Vannucchi H: Intestinal permeability and oxidative stress in patients with alcoholic pellagra, *Clin Nutr* 25(6):977-983, 2006.

Venardos KM, Perkins A, Headrick J, Kaye DM: Myocardial ischemia-reperfusion injury, antioxidant enzyme systems, and selenium: a review, *Curr Med Chem* 14(14):1539-1549, 2007.

Wagner JG, Jiang Q, Harkema JR, Ames BN, Illek B, Roubey RA, Peden DB: Gamma-tocopherol prevents airway eosinophilia and mucous cell hyperplasia in experimentally induced allergic rhinitis and asthma, *Clin Exp Allergy* 38(3):501-511, 2008.

Walji R, Boon H, Guns E, Oneschuk D, Younus J: Black cohosh (*Cimicifuga racemosa* [L.] Nutt.): safety and efficacy for cancer patients, *Support Care Cancer* 15(8):913-921, 2007.

Wang HS, Kuo MF: Vitamin B_6 related epilepsy during childhood, *Chang Gung Med J* 30(5):396-401, 2007.

Watanabe-Kamiyama M, Kamiyama S, Horiuchi K, Ohinata K, Shirakawa H, Furukawa Y, Komai M: Antihypertensive effect of biotin in stroke-prone spontaneously hypertensive rats, *Br J Nutr* 99(4):756-763, 2008.

Wightwick AM, Mollah MR, Partington DL, Allinson G: Copper fungicide residues in Australian vineyard soils, *J Agric Food Chem* 56(7):2457-2464, 2008.

Wu SH, Yu XD, Yan CH, Shen LX, Yu XG, Zhang YP, Zhang JS, Jin XM, Shen XM: Association between vitamin D receptor gene polymorphism and vitamin D deficiency rickets, *Zhongguo Dang Dai Er Ke Za Zhi* 8(2):121-124, 2006.

Yang SJ, Keen CL, Lanoue L, Rucker RB, Uriu-Adams JY: Low nitric oxide: a key factor underlying copper-deficiency teratogenicity, *Free Radic Biol Med* 43(12):1639-1648, 2007.

Yang Y, Ikezoe T, Zheng Z, Taguchi H, Koeffler HP, Zhu WG: Saw palmetto induces growth arrest and apoptosis of androgen-dependent prostate cancer LNCaP cells via inactivation of STAT 3 and androgen receptor signaling, *Int J Oncol* 31(3):593-600, 2007a.

Yang Y, Li C, Qi Z, Xiao J, Zhang Y, Yamaguchi S, Hasegawa Y, Tagami Y, Jiang Y, Xiong H, Zhang Y, Qin J, Wu XR: Spinal cord demyelination associated with biotinidase deficiency in 3 Chinese patients, *J Child Neurol* 22(2):156-160, 2007b.

chapter

4

Digestion, Absorption, and Metabolism in Health and Disease

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Chapter Topics

The Meaning of Digestion, Absorption, and Metabolism
Energy Macronutrients' Digestion and Absorption
The Role of the Digestive Tract and Common Conditions
The Role of Cellular Metabolism
The Role of Water and Electrolytes in Digestion and Metabolism
The Role of the Endocrine System in Metabolism
Food Intolerances Versus Allergies
Alcohol's Effect on Digestion, Absorption, and Metabolism
The Role of the Nurse or Other Health Care Professional in Aiding the Digestive Process

Objectives

After completing this chapter, you should be able to:

- Describe the mechanical and chemical processes of digestion, absorption, and metabolism of foods.
- Describe the digestion and metabolism of carbohydrates, proteins, and fats.
- Summarize the role of the mouth, stomach, and intestines in the digestive process in health and disease states.
- Describe the role of enzymes and the endocrine system in digestion, absorption, and cell metabolism.
- Discuss the difference between digestive intolerances and systemic inflammatory allergic reactions.
- Describe the metabolism and effect of alcohol on digestion, absorption, and metabolism of food nutrients.
- Describe the role of the nurse or other health care professional in aiding the digestive and metabolic processes.

Terms to Identify

Absorption
Achalasia
Addison's disease
Adenosine triphosphate (ATP)
Amylases
Anabolism
Anaphylactic shock
Ascites
Aspiration pneumonia
Atonic constipation
Autoimmune disorders
Basal metabolism
Bifidobacteria
Bile
Capillaries
Catabolism
Cecum
Celiac disease

Cholecystitis
Cholecystokinin
Cholelithiasis
Chyme
Cirrhosis
Cleft palate
Constipation
Counterregulatory hormones
Crohn's disease
Cystic fibrosis
Diabetes mellitus
Diarrhea
Digestion
Digestive enzymes
Diverticulitis
Diverticulosis
Dumping syndrome
Duodenum
Dyspepsia
Dysphagia
Elemental diet
Elimination diet
Encopresis
Endocrine system
Esophageal varices
Flatus
Food allergens
Food allergies
Food intolerances
Fructose intolerance
Gastrectomy
Gastritis
Gastroesophageal reflux disease (GERD)
Gliadin
Gluten
Glycogen
Hepatic coma
Hepatic encephalopathy
Hepatitis
Hiatal hernia
Homeostasis
Hormones
Hydrolysis
Hypothyroidism
Ileum
Immunoglobulin E (IgE) antibody
Inflammatory bowel disease (IBD)
Insulin
Intracellular
Irritable bowel syndrome (IBS)
Jaundice
Jejunum
Krebs cycle
Lactase
Lactobacilli
Lactose intolerance
Leptin
Masticated
Medium-chain triglycerides (MCTs)
Metabolic rate
Mitochondria
Nonalcoholic steatohepatitis (NASH)
Nontropical sprue
Obstipation
Osmotic effect
Oxidation
Pancreatitis
Pepsin
Peptic ulcer
Peristalsis
Phenylketonuria (PKU)
Polypeptides
Probiotics
Protease
Ptyalin
Radioallergosorbent test (RAST)
Short bowel syndrome (SBS)
Specific dynamic action
Steatorrhea
Thyroxine
Transaminases
Trypsin
Ulcerative colitis
Umami
Videofluoroscopy
Villi

INTRODUCTION

Good nutrition goes beyond obtaining and consuming appropriate amounts of macronutrients, micronutrients, and water. Without adequate digestion and absorption in the intestinal tract and metabolism at the cellular level, nutrients cannot be used for their intended biologic functions.

The gastrointestinal (GI) tract is much more than a long tube with a few attachments (the liver, the gallbladder, and the pancreas) that allows passage of food. It is a major endocrine gland, producing a wide variety of hormones and digestive enzymes that control how food is digested, absorbed, and metabolized. The process of digestion and cellular metabolism can affect nutritional status and health as much as food choices can. Health care professionals need to be aware of the effect of digestion and metabolism on the use of food nutrients.

WHAT IS MEANT BY THE DIGESTION, ABSORPTION, AND METABOLISM OF FOODS?

Digestion is the change of food from a complex to a simpler form and from an insoluble to a soluble state in the digestive tract. These changes facilitate absorption through the intestinal walls into circulation for eventual use by the body cells (Figure 4-1). The processes of digestion occur simultaneously:

1. *Physical (mechanical):* During the physical, or mechanical, process, food is broken into small particles in the mouth, then mixed with digestive juices by a churning action in the stomach, then propelled through the digestive tract in rhythmic movements known as **peristalsis.**
2. *Chemical:* During the chemical process, **digestive enzymes** change food nutrients into simple soluble forms that can be absorbed: carbohydrates to simple sugars, proteins to amino acids, and fats to fatty acids and glycerol. This chemical breakdown, called **hydrolysis,** involves adding water to molecules. Water, simple sugars, salts, vitamins, and minerals require no digestion.

   Enzymatic digestion of carbohydrates begins in the mouth, that of proteins in the stomach, and that of fats in the small intestines.
3. *Metabolic:* During the metabolic process, nutrients are used at the cellular level for basic life processes. The liver plays a key role in the metabolic process, with the reassembly of digested nutrients back into complex molecules and structures. Metabolic enzymes are necessary in this process. Vitamins and minerals are required for metabolic enzymes and hormones to function effectively at the cellular level.

There are a variety of digestive enzymes that have specific actions and optimal conditions under which they act. The name of each group of enzymes generally ends in *-ase:* salivary **amylases** act on starch, proteases act on protein, and lipases and pancreatic lipase act on fat. Other enzymes include **lactase** (to digest lactose) and sucrase (to digest sucrose). Not all digestive enzymes end in *-ase.* One example is **pepsin,** which digests protein into **polypeptides** (small chains of amino acids) before ultimately being broken down into single amino acids. If there is inadequate digestion of the macronutrients, absorption in the intestinal tract cannot take place. Abdominal cramping and diarrhea can result from inadequate digestion, especially with carbohydrates and fats.

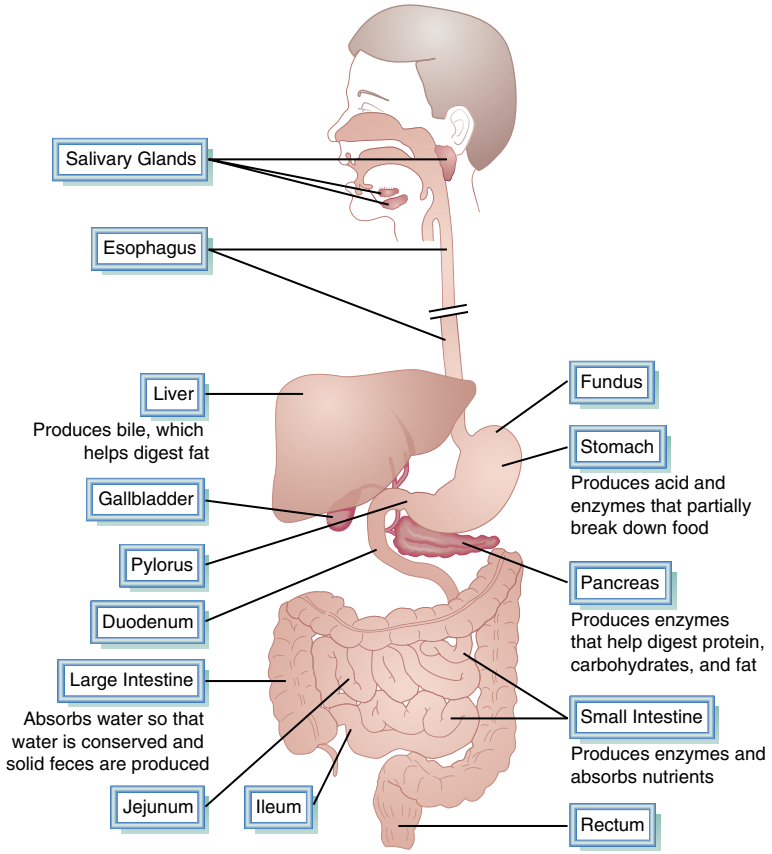


FIGURE 4-1 The digestive system.

Other chemical substances assist in the physical and chemical processes, such as hydrochloric acid and mucin in the gastric secretion. **Bile,** which promotes the digestion of fat, is excreted from the liver into the gallbladder, where it is stored then released into the small intestine after intake of a meal containing fat. The pancreas produces digestive enzymes that are secreted into the small intestine for metabolism of the macronutrients, bicarbonate ions to neutralize chyme, and hormones such as insulin.

Certain **hormones** (chemicals produced by the body) influence the body's metabolic use of nutrients found in food. For example, the hormone insulin is required for the cell's use of glucose as a fuel source. **Thyroxine** is a hormone produced by the thyroid gland that contains the mineral iodine and is derived from the amino acid tyrosine. This hormone influences the rate of metabolism of the macronutrients through the use of oxygen.

Digestion begins with ingestion. Ingestion of foods relates to food choices and options, as well as the ability to chew and swallow. A person with missing teeth or dental cavities with pain will choose foods that are easy to chew. This can result in reduced intake of fiber-based foods. Protein status may be affected if meat cannot be

chewed. The mechanism of swallowing is far more complex than is generally realized and is described later in the chapter.

Level of appetite and feelings of satiety (the feeling of satisfaction) affect the quantity of food ingested. To maintain appropriate intake of food, hormones help the body recognize hunger and satiety. **Insulin** induces hunger by lowering blood glucose levels. Two hormones that promote satiety include **cholecystokinin,** which is produced in response to dietary fat intake, and **leptin.** Hormonal signals can also affect the whole GI tract. It is estimated that at least 100 hormones are produced in the stomach alone, and knowledge about their various functions continues to develop.

Research is developing on flavors and taste sensation. Along with the standard four recognized tastes of salty, sweet, bitter, and sour is another referred to as **umami.** This is the rich flavor found with soy sauce.

Flavor is the primary basis by which young children determine food acceptance, and they have a heightened preference for sweet tastes and greater rejection of bitter-tasting foods. The sensory system matures with age and then declines. The taste for sweet typically remains and is the reason why many of the elder population like sweet foods.

A strong correlation between liking sweet foods and cravings for sweets has been linked to genetic factors (Keskitalo and colleagues, 2007). There are genetic differences with bitter taste perception. This difference has been known for decades, and an individual can be described as being a supertaster, taster, or nontaster (El-Sohemy and colleagues, 2007). A study at the Monell Chemical Senses Center in Philadelphia grouped children and their mothers based on their DNA, aimed at studying the effects of a newly discovered taste gene. As a group, it was found the African American children preferred higher-sugar cereals and were more likely to add sugar to their cereals than white children. However, the genetic differences did not bear out with adults, suggesting an environmental override of the need for sweet cereal (Mennella, Pepino, and Reed, 2005).

Smell is critical to recognizing the flavors in foods, well known by anyone who has had a head cold and could not breathe through his or her nose. There is also evidence that perception of flavor, based on word descriptors, can influence flavor ratings and appears to correlate with specific regions in the brain (Grabenhorst, Rolls, and Bilderbeck, 2008). Different neurons and regions of the brain respond to different sensory properties of food, including flavor, temperature, and mouth feel (Rolls, 2006).

There can also be a physiologic basis for taste preference. Rats, for example, have been found to increase their intake of potassium-based fluids when they are deficient in this mineral (Guenthner and colleagues, 2008). In a study of lambs, their intake of phosphorus-containing foods and water increased or decreased based on their body needs (Villalba and colleagues, 2006). This was later further demonstrated with lambs who were able to discriminate among different-flavored feeds, displaying preferences for calcium and phosphorus ones based on their specific needs (Villalba, Provena, and Hall, 2008).

Digestibility of food refers to the rapidity and ease of digestion and to its completeness. Liquid foods and thoroughly **masticated** (chewed) solid foods are more rapidly digested than are foods left in large pieces. Well-masticated food begins to

leave the stomach 15 to 30 minutes after ingestion. Forms of liquid sugar such as fruit juice leave an empty stomach almost immediately.

Foods that stay in the stomach longer have a higher satiety value. Small meals move out of the stomach faster than do larger ones. Solid foods stay in the stomach longer than liquids. The amount and type of food eaten at one time affects the rapidity of digestion.

Of the three macronutrients, carbohydrates are digested and leave the stomach most rapidly (about 1 hour), proteins are digested and leave less rapidly (about 2 hours), and fats require the longest time for digestion (about 4 hours). Therefore a balanced meal stays in the stomach longer than a meal of only carbohydrate foods. Foods containing a large amount of fiber are digested more slowly than are low-fiber foods. A meal high in both fat and fiber takes the longest to digest and leave the stomach.

Absorption is the passage of soluble digested food materials through the intestinal walls into the blood, either directly or through osmosis by way of the lymphatic system. The primary site of absorption is in the small intestine. Tiny fingerlike projections called **villi,** which contain small **capillaries** (tiny blood vessels), line the intestinal wall. The villi are in constant motion and trap the tiny nutrients, which are then taken in by the adjacent cells and transported through the circulatory and lymphatic system to every body cell. Microvilli are even smaller projections on the surface of the villi (Figure 4-2).

Simple sugars, amino acids, a few fatty acids, minerals, and water-soluble vitamins reach the general circulation through the capillaries. Undigested carbohydrates that reach the large bowel are fermented to short-chain fatty acids contributing some caloric value. The exact amounts and types of carbohydrate that reach the **cecum** (upper portion of the large intestine) are unknown but are expected to be higher with ingestion of high-fiber foods. Fiber (nonstarch polysaccharides) clearly affects bowel habits. Water is absorbed from the large intestine. Absorbed materials are carried by the blood to the liver and from there to various organs and tissues to be used as needed. The body is able to digest and absorb about 90% to 98% of an average mixed diet.

Metabolism can be of a constructive nature, resulting in the building up of new substances. This is called **anabolism.** If metabolism is of a destructive or oxidative nature, resulting in the release of energy, it is called **catabolism.** Energy metabolism refers to the oxidation of the macronutrients (carbohydrate, protein, and fat) within the body, resulting in the release of heat and energy. **Metabolic rate** refers to the rate at which food energy is burned, with a high metabolic rate requiring a high amount of calories and a low metabolic rate requiring few calories to sustain life.

All metabolism happens at the cellular level, with the **mitochondria** acting like small furnaces to burn food energy (catabolism) and allow for anabolism. Food nutrients must enter the body cells in order for the body to metabolize or use these nutrients. It is at the **intracellular** (inside the cell) level that extremely complex biochemical reactions take place. In fact, through the science of molecular biology it is now recognized that the biochemical processes at the cellular level are so complex, because of multiple pathways of metabolism, that it is highly unlikely they will be totally understood in our lifetime. Good digestion and absorption of food nutrients

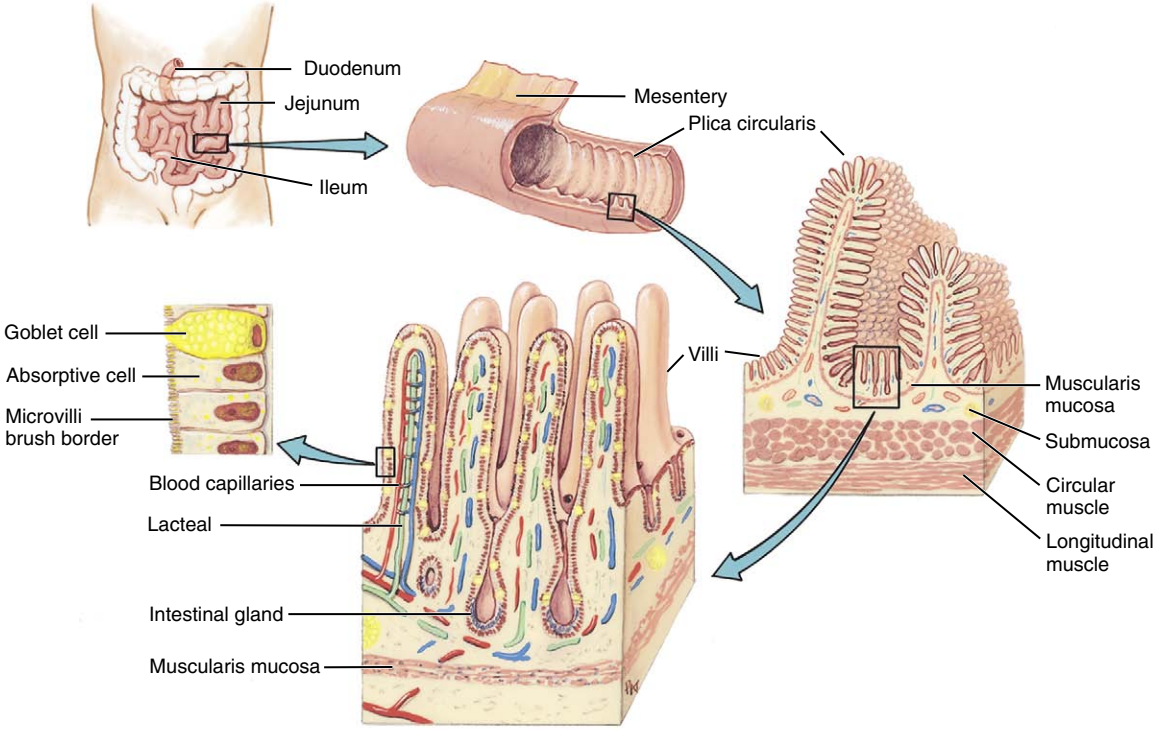


FIGURE 4-2 Wall of the small intestine. (From Applegate EJ: *The anatomy and physiology learning system*, ed 3, Philadelphia, 2006, Saunders.)

is, however, essential for proper metabolism at the cellular level. Further, diet quality has an impact. Cellular metabolism is altered in response to the main types of fat: polyunsaturated, saturated, and monounsaturated fatty acids (Khodadadi, Griffen, and Thumser, 2008). A diet high in the fat palmitic acid has been found to lower energy expenditure and fat oxidation compared with a diet high in oleic acid (Børsheim, Kien, and Pearl, 2006). Thus the type of fat may have an effect on weight management (see Chapter 6). Genetic differences also affect the process of metabolism.

Teaching Pearl

If you "fan a fire," it will burn better. This is somewhat like our own increased intake of air or oxygen from aerobic exercise—our metabolic rate increases because we are "fanning the fire" in the body cells. Exercise also promotes increased muscle mass, allowing for an increased number of mitochondria, or "furnaces" in which to burn kilocalories (kcalories or kcal) more efficiently. ■

WHAT IS BASAL METABOLISM?

The body needs energy for the internal, involuntary activities of organs and tissues and oxidation within the tissues. Energy is also needed for circulation, respiration, digestion, elimination, and maintenance of muscle tone, heartbeat, and so on. All internal activities continue 24 hours per day, while a person is asleep and awake. The amount of energy required to sustain these processes alone is known as **basal metabolism.**

The basal metabolic rate is influenced by body composition, body size, and age. The more muscle tissue a person has, the more calories are needed. The basal metabolic rate varies from person to person, but on the average it amounts to approximately 1200 to 1400 kcal daily for women and 1600 to 1800 kcal daily for men. Total energy requirements and weight management are discussed in Chapter 6.

A simple and relatively accurate method of estimating daily basal metabolism is to multiply weight in kilograms by 0.9 for women and 1.0 for men, then by 24 (the number of hours in a day). This estimate is generally accurate enough, except during times of physiologic stress (see Chapter 15). In large institutions, metabolic carts are used to measure a person's oxygen intake and carbon dioxide output. This technique can precisely measure the basal metabolic kcalorie needs. Various measurements of oxygen intake and carbon dioxide output have been used over the years to determine basal metabolic rate (Figure 4-3).

The process of digestion and absorption requires energy. Total food intake alters metabolism. Increased eating raises metabolism and vice versa. This is referred to as the **specific dynamic action.** This action raises the total energy needs about 10% for a person who eats a mixed diet. It is because of the specific dynamic action that some vegetables may be referred to as having "negative kcalories." This is because the amount of energy to digest the vegetables is greater than the actual kcalorie content of the vegetables.

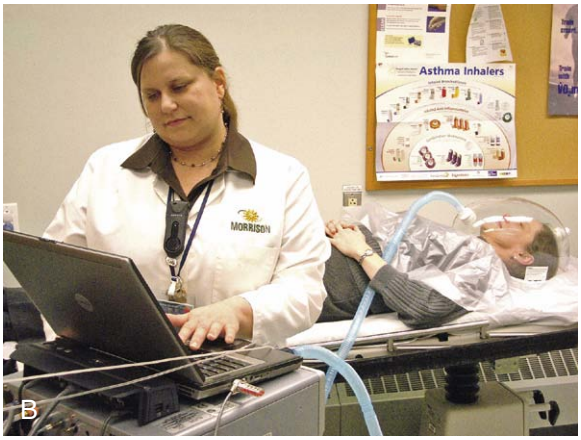
HOW ARE THE MACRONUTRIENTS DIGESTED AND ABSORBED?

CARBOHYDRATES

Carbohydrates (except for fiber) are easily digested, and the degree of absorption is high. Digestion of starch starts in the mouth with the enzyme amylase, also called **ptyalin,** and is completed in the small intestine. Glucose, which is normally formed from carbohydrates eaten in food, is absorbed into the bloodstream through the walls of the small intestine and is metabolized as shown in Figure 4-4.

The monosaccharides glucose and fructose are ready for absorption in the digestive tract because they are single sugar molecules. Double sugars, such as sucrose and lactose, must be changed to simple sugars for absorption, which is a quick process when there is adequate digestive enzyme production. Absorption occurs in the small intestine (Figure 4-5).

Starch now is known to be digested as quickly as sugars. It was once believed that the glucose links on either end of the polysaccharide chain were disconnected one at a time. It is now recognized that all chemical bonds connecting the chain of glucose molecules break apart simultaneously. It is for this reason that the American Diabetes Association now states that sugar can be included in a diabetes meal plan



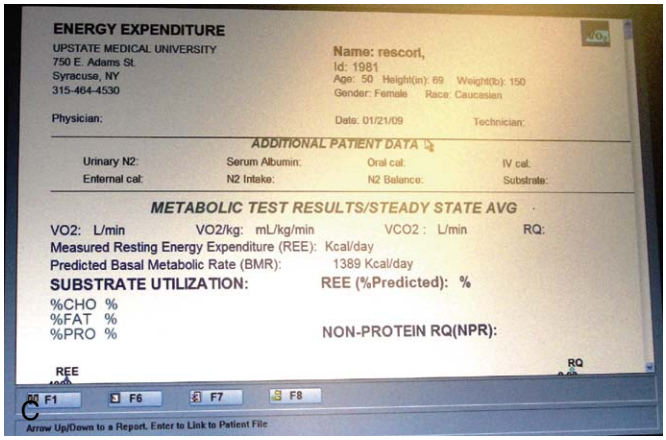


FIGURE 4-3 **A,** Metabolic cart with a computer interface. **B,** A person undergoes procedure using the metabolic cart. **C,** A sample report with estimated kcalorie needs.

because the digestion time is no faster than that of starch. Cooking starch does facilitate digestion because it breaks down the cell walls, which makes the action of the digestive enzymes easier.

Dietary fiber is essentially indigestible and passes through the intestinal tract virtually unchanged. Bacteria naturally found in the GI tract do allow for minimal digestion of fiber, which promotes the production of the gases hydrogen and methane, medically referred to as **flatus.** Reduction in flatus can be achieved by thorough chewing and a slow increase in the regular intake of fiber foods.

There is debate on how to precisely define and therefore quantify carbohydrate content on food labels. Around the world there are three different food energy systems used in food tables and on food labels. One suggested descriptive approach suggests noting the difference between metabolizable energy (ME) and net metabolizable energy (NME). This would take into account the amount of carbohydrate able

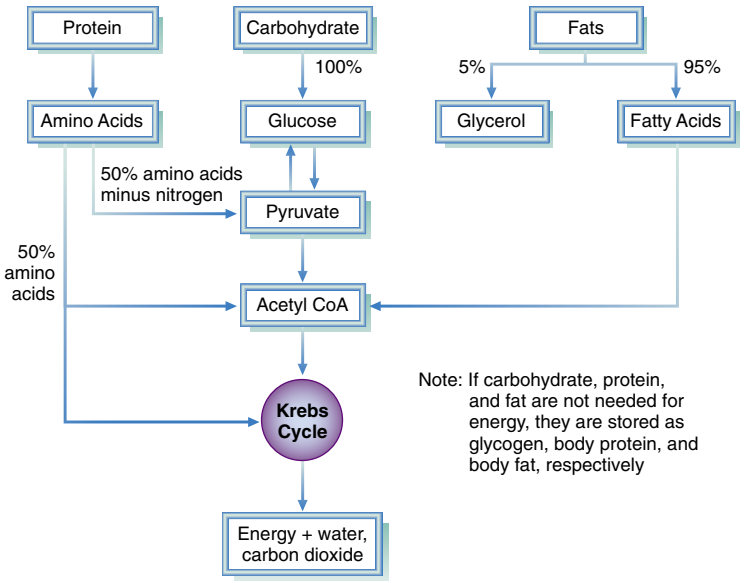


FIGURE 4-4 Metabolic pathways.

to be digested and absorbed, versus nondigested but fermentable (Elia and Cummings, 2007). The American Diabetes Association advocates subtracting fiber from the total carbohydrate listed on food labels if it is more than 5 g. This is due to an individual basing insulin injections on carbohydrate consumed to avoid developing hypoglycemia (see Chapter 8). The American Dietetic Association promotes subtracting half of the fiber from the total carbohydrates if it is over 5 g, which is more related to kcalorie utilization and not blood glucose outcomes per se.

Probiotics are now being promoted to help with digestion. These are live microbes found in food supplements aimed at the growth of the beneficial bacteria such as **bifidobacteria** and **lactobacilli** within the intestinal tract. Probiotics are naturally found in yogurt and buttermilk. Current studies are focused on their potential to improve immunity and promote health and well-being in a variety of conditions.

Teaching Pearl

The carbon part of carbohydrate is used as energy in animal and human cells, similar to the burning of carbon in coal and wood in actual furnaces. The black substance formed in burnt toast is carbon. ■

PROTEIN

The proteins in the daily diet must be broken down by digestion into the component parts: peptides and amino acids. The mechanical digestive process begins in the mouth through mastication. The chemical digestive process of proteins begins in the stomach and is completed in the small intestines (see Figure 4-5). Hydrochloric acid prepares protein for enzymatic breakdown. The mechanical and chemical processes

Site	Carbohydrate	Protein	Fat
Mouth	starch → maltose (by salivary amylase)	No action	No action
Stomach	No action	proteins→ proteoses → peptones (by gastric pepsin)	emulsified fats→ fatty acids + glycerol (by gastric lipase)
Small intestine	starch → dextrin dextrin → maltose (by pancreatic enzyme)	protein→ peptones (by pancreatic trypsin)	emulsified fats→ fatty acids + glycerol (by pancreatic enzyme and intestinal lipase)
	sucrose, lactose, maltose → glucose (by sucrase, lactase, maltase enzymes)	peptones → amino acids (by intestinal erepsin)	
	Glucose absorbed	Amino acids absorbed	Fatty acids + glycerol absorbed
	Absorbed glucose oxidized for energy → $CO_2 + H_2O$	Absorbed amino acid builds new tissue, repairs old tissue	Absorbed fatty acids + glycerol → new fat
	Unused stored as liver glycogen	Unused: nitrogen removed, forming urea	Oxidized for energy releasing $CO_2 + H_2O$
	Unused changed and stored as body fat	Carbon, hydrogen, oxygen → glucose	Unused stored as body fat
			Some fat + phosphorus → phospholipids

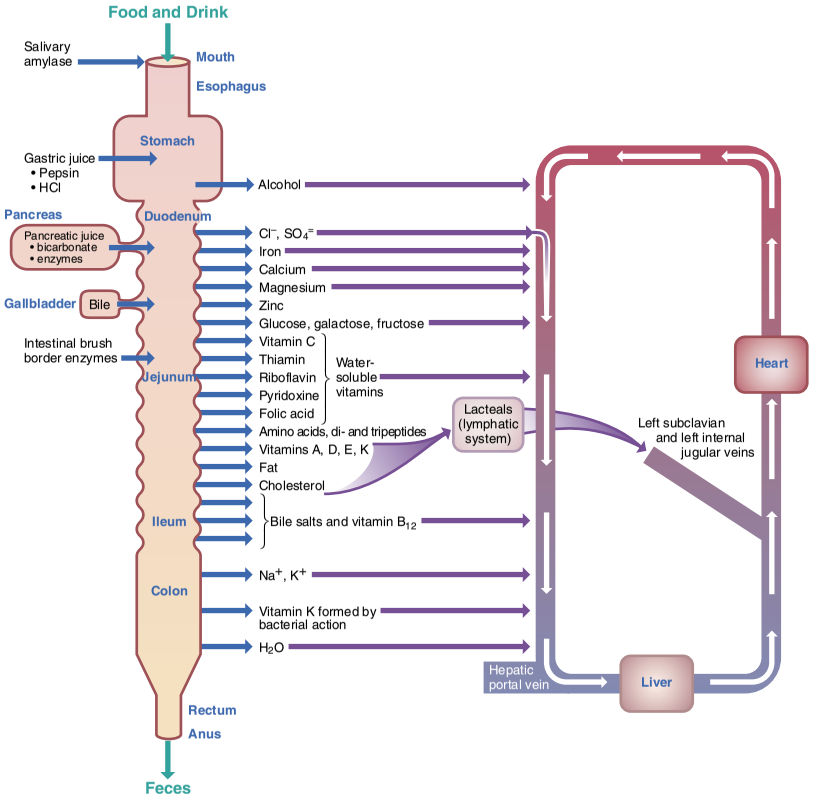


FIGURE 4-5 Digestive process of carbohydrate, protein, and fat. (*Cl^-,* chloride; *CO_2,* carbon dioxide; *HCl,* hydrochloric acid; *H_2O,* water; *K^+,* potassium; *Na^+,* sodium; *$SO_4^=$,* sulfate.) (Modified from Mahan LK: *Krause's food, nutrition, and diet therapy,* ed 12, Philadelphia, 2008, Saunders.)

of protein digestion in particular require the function of an intact neurologic and hormonal response. These responses allow release of digestive enzymes and other substances that allow full digestion and help propel food through the digestive tract.

Protease is the enzyme that aids protein digestion. Pepsin curdles milk in the process of milk digestion. In fact, cheese was first accidentally made when milk was stored in the stomachs of animals, before the days of glass, metal, or plastic containers. **Trypsin** is an enzyme released in the small intestine to help complete protein digestion. It specifically hydrolyzes peptides of arginine or lysine (amino acids; see Chapter 2). Once proteins are digested, absorption into the bloodstream from the small intestine can occur. Amino acids are less well absorbed than peptides. Peptides that are not absorbed are fermented by bacteria in the colon.

FAT

Fats, because they are insoluble in water, require special treatment in the GI tract before absorption can take place. No digestion of fats takes place in the mouth, and only finely emulsified fats (such as those found in butter, cream, and egg yolk) can start to be digested in the stomach. For the most part, fats must be emulsified by bile (produced in the liver and stored in the gallbladder for use in fat digestion) and bile salts before they are digested in the small intestine by enzymes from the pancreatic juice. Fats are changed to glycerol and fatty acids during digestion (see Figure 4-4).

Fatty foods are generally digested without difficulty, but they require a longer time for digestion than do carbohydrates. Softer fats are more completely digested and absorbed than are harder fats. Fried foods are not necessarily indigestible, but they are more slowly digested. The presence of carbohydrates in the diet is necessary for the complete oxidation of fats (the chemical step in releasing energy from fat) at the intracellular level (inside body cells); otherwise, ketone bodies accumulate and ketosis results.

HOW ARE MACRONUTRIENTS CONVERTED TO ENERGY?

When the body cells need energy, a series of complex metabolic reactions occur: the **Krebs cycle** (see Figure 4-4, which shows the central pathways of energy metabolism). Oxygen is necessary for the release of energy by the cells in the body. The process of combining oxygen with a molecule is called **oxidation.** A person needs hemoglobin to supply oxygen to the cells, and a low level of hemoglobin means oxygen is not available for energy production, which results in a tired feeling. An increased intake of air into the body, such as that achieved with aerobic exercise, tends to raise the body's rate of metabolism through the process of oxidation (see Chapter 6).

WHAT ROLE DOES EACH PART OF THE DIGESTIVE TRACT PLAY AND WHAT ARE COMMON ASSOCIATED PROBLEMS?

THE MOUTH

The teeth provide the first mechanical function of chewing, with the cutting action of the anterior teeth (incisors) and the grinding action of the posterior teeth (molars).

Chewing aids the digestion of food for a simple reason: the digestive enzymes act only on the surface of food particles, and thorough chewing increases the amount of food surface area available to these enzymes.

Another mechanical function is performed by saliva, which moistens food and prepares it for swallowing. A chemical function of the mouth is changing cooked starch to dextrin and then to maltose by the salivary enzyme amylase.

Physical disorders can begin where digestion starts—in the mouth, or oral cavity. One type of birth defect of the oral cavity is **cleft palate** (an opening or hole in the roof of the mouth sometimes extending to the lip, which may be referred to as have lip). Babies born with cleft palate have difficulty creating a suction seal around the mother's nipple or a bottle nipple, which leads to inadequate ingestion of breast milk or formula. Severe cases may require surgical correction. Babies with less severe forms of cleft palate, however, may benefit from special bottle nipples that do not require suction or from a slightly larger hole in the bottle nipple. Mothers who are motivated to continue nursing until the problem is resolved should be encouraged to do so with supplemental bottle feedings as needed (see Chapter 11 for more ideas).

Missing teeth, severe dental caries, or ill-fitting dentures can adversely affect food choices. Without adequate nutritional knowledge, omitting food groups may not seem important to a person with dental problems. Alternatives should be discussed, such as eating applesauce in place of fresh apples or eating cooked or soft vegetables in place of raw or hard-to-chew vegetables. Prevention of dental caries is addressed in Chapter 12.

Swallowing problems, referred to as **dysphagia,** are often related to stroke, head injury, cerebral palsy, and other conditions (Figure 4-6). Inability to swallow correctly may result in aspiration of food into the lungs. **Aspiration pneumonia** is a frequent

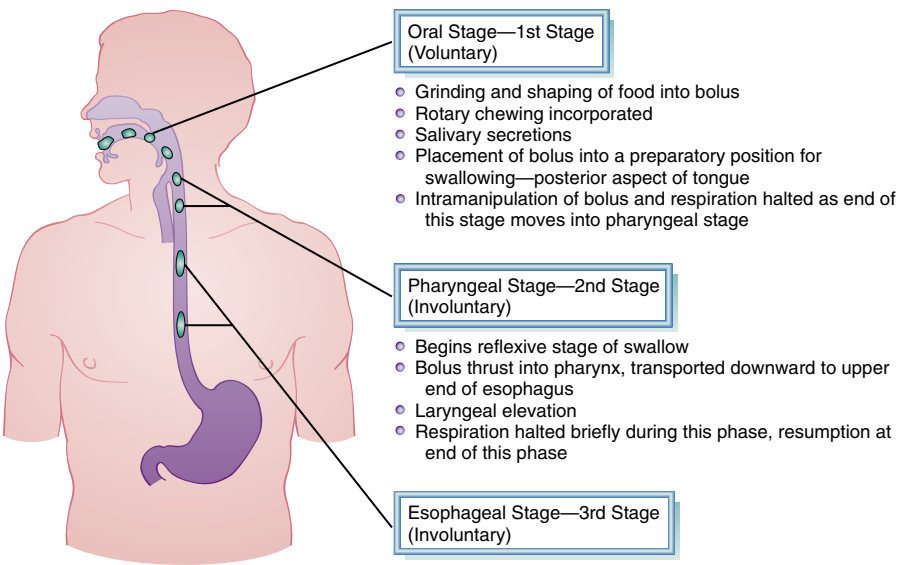


FIGURE 4-6 The stages of swallowing as they relate to appropriate food pathways.

Table 4-1 Food Consistency Considerations

TYPE OF DIET	EXAMPLE	POTENTIAL EFFECT ON ORAL FUNCTION
Thin foods and liquids	Soup broth, juice	More difficult to control within mouth, especially with limited tongue control (i.e., quickly runs to all areas of mouth); often promotes excessive food loss
Thick foods	Pudding, yogurt, applesauce	Improved control within oral cavity because of reduced flow and increased sensory input (i.e., weight and texture)
Pastelike or sticky foods	Peanut butter, thick cheese sauce	May be more difficult to move in oral cavity with limited tongue movement; may stick to the roof of the mouth, especially with a high, narrow palate
Slippery foods	Pasta, Jell-O	Often difficult to control and either triggers reflexive swallow too quickly or runs out of oral cavity before the swallow
Smooth textures	Pudding, pureed foods	Relatively easy to swallow; promotes minimal tongue and jaw movement, especially over time
Coarse textures	Creamed corn, ground foods, Sloppy Joe filling	Increases sensory input to stimulate more jaw and tongue movement; coarseness of food should be carefully graded
Varied textures	Soups with noodles or chunks of vegetables	Difficult to manage in oral cavity, especially with limited tongue movement or decreased oral sensitivity (i.e., liquid is swallowed and solid pieces remain in the mouth)
Scattering textures	Grated carrots, rice, coleslaw, corn bread	Very difficult to manage with limited tongue movement and decreased oral sensitivity
Crisp solids	Carrot sticks, celery sticks	Requires sophisticated biting and chewing to grind pieces into consistency that is safe to swallow
Milk-based substances	Milk, ice cream	Appears to coat mucous membranes in oropharyngeal cavity to interfere with swallowing
Broth	Meat broth, chicken broth	Appears to cut mucus in oropharyngeal cavity and facilitates swallowing
Dry foods	Bread, cake, cookie	May be difficult to chew or swallow with insufficient saliva
Whole, soft foods	Slice of bread	Requires the ability to bite off appropriately sized pieces

Courtesy of the Occupational Therapy Department of the J.N. Adam Developmental Center, Perrysburg, NY.

complication of dysphagia. Dysphagia requires a review of the swallowing process to determine the best means of feeding. A speech pathologist is trained to help assess swallowing problems. An x-ray examination called **videofluoroscopy** is used in conjunction with a barium swallow to objectively diagnose dysphagia. The swallowing problem is generally at the pharyngeal area. Liquids are usually the most difficult food to swallow for persons with dysphagia. Liquids that are of a nectar consistency can be used for mild swallowing problems, progressing to the thickness of honey, and as needed the thickness of pudding. Liquids can be thickened with a commercial product or with baby rice cereal. Feeding positions can also help (see Figure 15-4 and Table 15-5). Table 4-1 lists a variety of food consistency considerations. See Chapter 15 for institutional issues and guidelines for provision of altered meal consistencies.

In general, swallowing can be divided into the following three stages: (1) the voluntary stage, which initiates the swallowing process, or mechanical function; (2) the pharyngeal stage, which is involuntary and involves the passage of food through the pharynx to the esophagus; and (3) the esophageal stage, which involves passage of food through the esophagus to the stomach through peristaltic wave contractions.

Fact & Fallacy

FALLACY Washing food down with water is a good habit.

FACT Food must be masticated (chewed) thoroughly so that it can be mixed with saliva, which aids digestion. However, a glass of water at mealtime is beneficial to the digestive process as long as it does not take the place of mastication. ■

THE ESOPHAGUS

The esophagus transfers food from the oral cavity to the stomach. This process is complicated and can go awry with neurologic or neuromuscular disorders. Respiration is generally only minimally stopped during the act of swallowing. Poorly chewed food, however, increases the risk of obstruction of the airway, especially for persons with an impaired swallowing reflex, in whom oxygen deprivation can occur because breathing and swallowing cannot be done simultaneously.

In **achalasia** the lower part of the esophagus fails to relax, and swallowing difficulty occurs. The individual senses fullness in the sternal region and may vomit; then there is danger that the contents of the esophagus may be aspirated into the respiratory passages. Weight loss may become a problem that requires nutritional intervention. Dilation of the esophagus or surgical intervention can improve the condition. Including semisolid foods can help a person manage this condition. One case of achalasia was attributed to Wernicke's encephalopathy (Kennedy and colleagues, 2007).

THE STOMACH

The presence of food in the stomach stimulates functioning of the digestive tract. Food is kept in motion by the muscular walls of the stomach, which bring it into contact with the gastric juice secreted by stomach cells. The fundus of the stomach acts as a temporary storage place for food.

Various gastric juice enzymes work in the stomach to digest the different macronutrients. Complex proteins are partially digested by pepsin (protease); milk protein is coagulated by renin, then is partially digested by pepsin. Emulsified fats are digested to fatty acids and glycerol by lipase. Hydrochloric acid aids these digestive enzymes and increases the solubility of calcium and iron. Mucus protects the lining of the stomach from the hydrochloric acid. Once solid food is reduced to a semiliquid state (chyme), it is passed from the stomach to the small intestine.

Functional disorders of the stomach (reflex disorders) involve a change in body functions without detectable changes in structural tissue. One example is **dyspepsia**

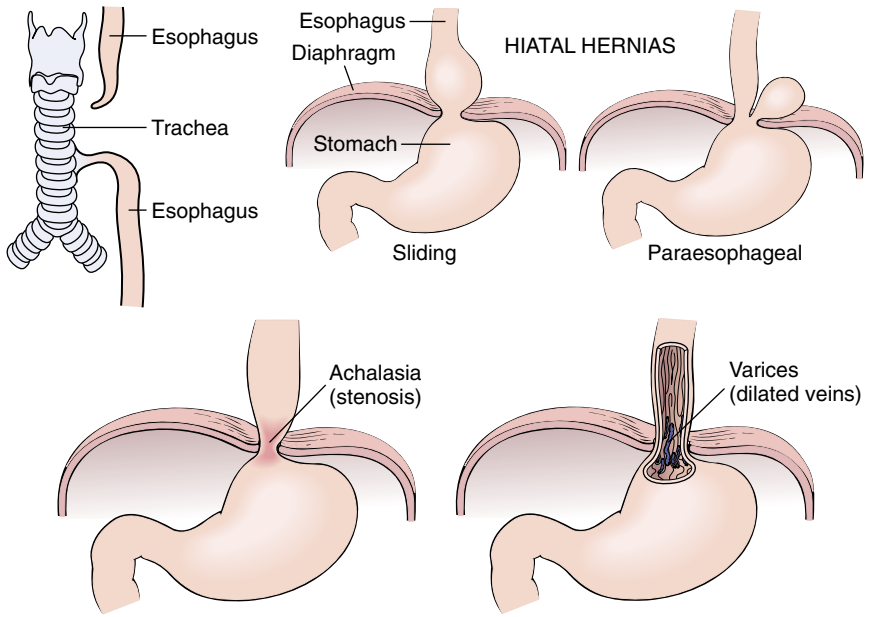


FIGURE 4-7 Sketch of hiatal hernia. (From Damjanov I: *Pathology for the health professions,* ed 3, St. Louis, 2006, Saunders.)

(indigestion). Alterations in the hydrochloric acid content of gastric juice is another functional disorder.

A **hiatal hernia** is a protrusion of a part of the stomach through the esophageal hiatus (opening) of the diaphragm (Figure 4-7). Persons with this disorder sometimes complain of heartburn because of the reflux of gastric contents into the esophagus. Medical treatment includes ingestion of antacids to neutralize or inhibit gastric secretions and possibly surgery. Small, frequent meals are recommended to reduce symptoms, although dietary modifications cannot eliminate the cause. No food is advised for approximately 3 hours before bedtime, and the person should remain in the upright position after eating. For the obese person, weight loss is indicated to help relieve pressure on the diaphragm. Any source of pressure on the abdomen, such as bandages or clothes that fit too tightly, should be eliminated.

Gastritis (acute or chronic) is an inflammation of the lining of the stomach that results in abdominal pain, nausea, and vomiting. It may be caused by food poisoning, overeating, excessive intake of alcohol, or bacterial and viral infections. A chronic condition may be related to other disease states. It often precedes the development of ulcers or cancer. Acute gastritis, which usually heals within a few days, is often treated first with antibiotics and neutralization of the stomach contents. The stomach is allowed to rest for a while, then the patient drinks clear fluids for the first day or two.

A **peptic ulcer** is an eroded lesion in the lining (mucosa) of the stomach (gastric ulcer) or duodenum (duodenal ulcer). Excess use of nonsteroidal antiinflammatory drugs (NSAIDs) can contribute to the erosion of the mucosal lining. In recent years *Helicobacter pylori* infection has been increasingly recognized as being involved in the

Table 4-2 Possible Dietary Treatment of Peptic Ulcers*

GUIDELINE	RATIONALE
Eat three regular meals or six small meals	Inhibits stomach distention
Avoid caffeine-containing beverages, decaffeinated coffee	Decreases gastric secretions
Avoid alcohol	Reduces damage to stomach lining
Avoid black pepper, chili powder, cloves, nutmeg, curry powder, mustard seed	Reduces irritation to stomach lining
Avoid aspirin	Reduces irritation of stomach lining
Avoid cigarette smoking	Promotes healing of ulcer
Eat in a relaxed atmosphere	Reduces stress

*Individualization is advised.

development of peptic ulcers. Symptoms include burning or gnawing pain in the pit of the stomach. While an ulcer is bleeding, no food is allowed; instead the patient may be given intravenous feedings of dextrose and amino acids. As the condition improves, the patient usually progresses from a full liquid diet to a regular diet with the omission of irritants based on individual tolerances. Common intolerances include caffeine, alcohol, and spicy foods, but some individuals have no adversity with these substances (Table 4-2).

The **dumping syndrome** is a condition related to stomach surgery. Surgery for ulcers is not uncommon. Obesity surgery may also result in the dumping syndrome (see Chapter 6). In the dumping syndrome the food "dumps" into the small intestine rapidly, causing severe cramping and pain. It has been found that the dumping syndrome may occur even years after **gastrectomy** (removal of the stomach or portions of it). Hypoglycemia can be a consequence. Individuals presenting with hypoglycemia and a history of stomach surgery may have the dumping syndrome. Seizures resulting from hypoglycemia may occur (Harder and colleagues, 2005). Treatment is aimed at drinking beverages separate from solid foods and consuming low-glycemic-load meals.

The condition of **gastroesophageal reflux disease (GERD)** is the opposite of achalasia, although it may be the cause of the strictures found with achalasia. Esophageal cancer is also related to uncontrolled GERD. In this condition the lower esophageal sphincter is incompetent and allows stomach matter to regurgitate into the esophagus. GERD is considered common in the elderly, but also does occur with young children. It may present various symptoms, such as heartburn, regurgitation, and obstructive sleep apnea (Friedman and colleagues, 2007).

Central obesity along with medications and fluctuation of hormonal level may play a causal role. Lowered esophageal sphincter competency has been associated with use of tobacco and intake of alcohol, chocolate, and high-fat meals. Some individuals have appeared to benefit with avoidance of alcohol, fatty foods, chocolate, coffee, mint, and carbonated beverages (Csendes and Burdiles, 2007). However, successful treatment of GERD, as evidenced by reduced acidity level of the esophagus, has only been shown in the research literature with weight loss, remaining upright after meals, and head elevation during sleep (Kaltenbach, Crockett, and Gerson, 2006). Dietary control of symptoms of GERD should be individualized because there

is limited evidence of the impact. This is in contrast to a finding that most documented interventions advised in two internal medicine clinics focused on dietary intervention and not the better-proven strategy of keeping the head elevated (Salyers and colleagues, 2007).

The effect of weight loss may be due to decreased abdominal pressure on the stomach. As such, additional treatment including small frequent meals to avoid stomach distention may be helpful and other factors that lower pressure on the sphincter, including avoiding tight pants and belts.

THE SMALL INTESTINE

The small intestine is 20 to 25 ft long and is made up of the **duodenum** (the upper section), the **jejunum** (the middle section), and the **ileum** (the lower section). The food mass from a meal remains in the intestine for 3 to 8 hours, although liquids and pure carbohydrate foods pass more quickly. The gallbladder, pancreas, and liver are all connected with the small intestine.

Chyme (digested food matter) mixes with digestive enzymes found in the small intestine and with pancreatic enzymes. Bicarbonate ions neutralize the chyme. Bile is excreted into the duodenum; it prepares unemulsified fats for digestion. Pancreatic enzymes that enter the small intestine complete starch and fat digestion and partially digest protein. The intestinal enzymes complete protein and carbohydrate digestion. Digested food moves with peristaltic waves through the small intestine, where absorption of food nutrients occurs. The pancreas also produces hormones such as insulin, which allows use of glucose as an energy source at the cellular level after absorption occurs. Unused food, waste materials, and water move to the large intestine.

Cholecystokinin is a hormone found in the small intestine. Along with promotion of satiety, this hormone also allows gallbladder contraction, regulates pancreatic enzyme secretion, promotes intestinal motility, and inhibits gastric acid secretion. Cholecystokinin further allows nerve transmission in the intestine.

Lactose intolerance, the inability to digest milk sugar (lactose), is caused by a low amount of the enzyme lactase, which is necessary for converting lactose into glucose and galactose in the GI tract. Symptoms include bloating, flatulence, cramping, and diarrhea. Different populations show variations in degrees of lactase deficiency, usually occurring after 5 years of age. Lactase deficiency is more common among persons of African, Asian, Mediterranean, Hispanic, and Native American heritage than among persons of Northern European heritage.

Lactase deficiency can occur with anyone who has GI distress such as from the intestinal flu. Severe cases of lactase deficiency require avoidance of all foods containing lactose (see Box 4-1 for a sample menu). Many grocery stores now carry 100% lactose-free milk. The milk will taste sweeter than regular milk because the lactose is broken down into simple sugars. There will be no long-term health problem if lactose is accidentally ingested, however, because the condition is an intolerance, not an allergy.

The person with lactose intolerance should be encouraged to try small amounts of milk products such as low-fat cheese or yogurt. These are often tolerated in mild forms of lactose intolerance. Repeated, small amounts of milk can increase the natural production of lactase by some individuals.

Box 4-1 Sample Menu ■ For a Lactose-Free Diet

Breakfast
½ c orange juice
½ c farina
1 egg, soft cooked
2 slices Vienna bread toasted
2 tsp milk-free margarine
1 tbsp jelly
2 tsp sugar
Coffee or tea

Lunch
2 oz sliced chicken
½ c rice
½ c green beans
½ sliced tomato on lettuce
2 tsp mayonnaise
1 slice Vienna bread
2 tsp milk-free margarine
½ c canned peaches
1 slice angel food cake
1 tsp sugar
Coffee or tea

Midafternoon Snack
1 c apple juice

Supper/Dinner
3 oz roast beef
½ c cubed white potatoes
¼ c beef broth gravy
½ c peas and carrots
¾ c tossed lettuce salad
1 tbsp oil and vinegar
1 slice Vienna bread
2 tsp milk-free margarine
Small banana
1 tsp sugar
Coffee or tea

Evening Snack
Popcorn

Fructose intolerance can cause significant GI symptoms, such as bloating, cramps, and osmotic diarrhea, which can improve with adherence to a low-fructose diet. Enlargement of the liver has been noted via a sonogram test with hereditary fructose intolerance (Pozzato and colleagues, 2005). Fructose malabsorption and lactose malabsorption have been associated with depression in women and low

serum levels of the amino acid tryptophan. A recent study reinforced this finding in a study of adolescents. The reduced tryptophan, needed for serotonin production, may be due to a complex formed between the malabsorbed sugars and the amino acid (Varea and colleagues, 2005). Such individuals may find benefit with reduced intake of the relevant sugars.

Even among adults with normal tolerance of fructose, excess intake can result in symptoms. The use of sweeteners based on high-fructose corn syrup, along with increased intakes of fruit juice and powdered fructose has significantly increased in the United States. A 12-oz can of soft drink typically contains 40 g of sugar, primarily in the form of high-fructose corn syrup. The equivalent amount of fruit juice contains about the same amount of fructose. A study of adults without fructose intolerance found more than half had symptoms of intolerance at greater than 25 g intake, and over two thirds had symptoms at intakes greater than 50 g (Beyer, Caviar, and McCallum, 2005).

Celiac disease, also called **nontropical sprue** or simply celiac, is a genetically based T-cell-driven autoimmune disorder with a prevalence of about 1% that leads to malabsorption. New, highly sensitive blood tests have led to the realization that celiac disease is one of the most common food intolerances in the world, typically affecting individuals with European ancestry. Persons with **autoimmune disorders** (disorders in which the body attacks itself) are at increased risk for celiac disease. An increased prevalence of celiac disease has recently been demonstrated in Northern European individuals with autoimmune **Addison's disease** (a condition of the adrenal glands with insufficient production of cortisol) as well as IgA deficiency (Betterle and colleagues, 2006).

Celiac disease is characterized by mild to severe destruction of intestinal villi from a protein known as **gliadin,** found in foods containing **gluten** (the portion of grain that is elastic, such as needed to make yeast breads). The grains, wheat, rye, and barley, naturally contain gluten. Common symptoms include diarrhea, **steatorrhea** (a condition of fatty stools), and weight loss due to malabsorption. Damage to the villi is significantly more frequent in the lower duodenum or upper jejunum regions. About half of patients with celiac disease have atrophy of the villi throughout the entire duodenum (Ravelli and colleagues, 2005).

Because minerals are primarily absorbed in the duodenum, conditions related to mineral deficiency can occur (see Chapter 3). Vitamin K–deficiency bleeding is a rare complication that occurs almost exclusively in patients with typical celiac disease manifestations and can be exacerbated with antibiotic treatment or other vitamin K antagonists (Djuric, Zivic, and Katic, 2007). Newly diagnosed individuals with celiac disease should have a multivitamin and mineral supplement.

Recent feeding studies have indicated oats do not contain gluten. However, oat intolerance may be a reason for atrophy of the villi and inflammation in celiac disease even with a strict gluten-free diet. Avoidance of foods containing oat is advised until at least 6 months after initial diagnosis of celiac. Clinical follow-up of patients with celiac disease who eat oats is advised. Oat products of U.S. origin are often contaminated with wheat because oats are carried in the same trucks as wheat.

Lactose intolerance often accompanies celiac disease because of the inflammatory condition of the intestinal tract with untreated celiac. The person's condition improves dramatically on a gluten-free diet. Once healing of the villi has occurred,

Box 4-2 Sample Menu ■ For a Gluten-Restricted Diet

Breakfast
½ c grapefruit juice
½ c corn grits
1 egg, soft cooked
Rice cake
1 tsp butter or margarine
1 tbsp grape jelly
1 c 1% milk (or lactose-reduced milk as needed)
2 tsp sugar
Coffee or tea

Lunch
2 oz sliced turkey
1 c rice
½ c green beans
½ sliced tomato on lettuce
1 tsp butter or margarine
Fresh apple
Puffed rice bar
1 c 1% milk (or lactose-reduced milk as needed)
Rice muffin
Coffee or tea

Supper/Dinner
3 oz roast beef
1 c cubed white potato
½ c cooked broccoli
¾ c tossed lettuce salad
1 tbsp oil and lemon juice
Rice muffin
2 tsp butter or margarine
1 c 1% milk (or lactose-reduced milk as needed)
Coffee or tea

lactose is usually tolerated again, but it may need to be introduced slowly. Dietary counseling must include a discussion of foods allowed, reading labels for even small amounts of gluten in various foods, and using alternative flours (e.g., rice, corn, and potato) in recipes. Other substitutes include tapioca and soybean and arrowroot flours. Even dried fruit may be a problem if the fruit comes in contact with a flour-dusted conveyor in food-packaging companies. There are many ways that gluten can get into the diet, such as using a toaster to make both wheat toast and gluten-free toast, along with toothpastes, postage stamps, medications, and flavorings added to foods. Box 4-2 provides a sample gluten-free diet. The gluten-free diet is very tedious, and referral to celiac organizations is highly recommended (see Appendix 1 on the Evolve website). Gluten peptides are rich in the amino acids proline and glutamine.

It may be possible, one day, to have enzymes available to break down the gluten peptide, allowing a less-restrictive diet (Gass and colleagues, 2007).

Persons who should be suspected of celiac disease include those who have the following:

- Elevated liver enzymes **(transaminases)**
- Short stature or delayed puberty
- Iron deficiency anemia
- Recurrent miscarriage or infertility
- Autoimmune diseases
- Inflammatory bowel disease (IBD) or GI symptoms (National Institutes of Health, 2004).

Tests advised to screen for celiac disease include the following:

- IgA antihuman tissue transglutaminase (TTG) and/or
- IgA endomysial antibody immunofluorescence (EMA)
- IgG-TTG or IgG-EMA is advised if there is an IgA deficiency
- Intestinal biopsy (multiple sites) is required for the final diagnosis*

Crohn's disease (regional enteritis) is another IBD, the cause of which is unknown. It is felt to be an autoimmune disease in which the body attacks itself. Crohn's disease can affect any part of the intestinal tract, but inflammation usually occurs in the terminal ileum. Diarrhea, abdominal cramps, fever, and weakness are common symptoms. Malnutrition is common and is likely caused by inadequate dietary intake, decreased absorption of nutrients, and excessive losses from the GI tract.

The goal of dietary treatment of Crohn's disease is to maintain good nutritional status, promote healing, and reduce inflammation. A well-balanced, high-calorie, high-protein diet is suggested. However, an **elemental diet,** which requires no digestion, may be used in the treatment of active Crohn's disease. The theory behind elemental diets is that inflammation of Crohn's disease may arise from an immunologic response to dietary protein antigens. A vitamin and mineral supplement that meets the dietary reference intake (DRI) (see the back of the book) is beneficial because of the malabsorption that occurs with Crohn's disease. The prescribed diet is low in residue, especially during the acute stages. Keeping a log of foods and symptoms may help in determining dietary intolerances. There is, however, limited research documenting the impact of diet on the prevention and management of the active stages of inflammation with Crohn's disease.

A study of adults with **short bowel syndrome (SBS),** with about 4 ft of small intestinal tract remaining after resection, were found to have severe malabsorption of all macronutrients, especially carbohydrates, with over half of all kcalories consumed being malabsorbed. They further had intake less than the Recommended Dietary Allowance (RDA) for most vitamins and the minerals iron, calcium, magnesium, and zinc. Parenteral nutrition (see Chapter 15) supplemented oral intake (Estívariz and colleagues, 2008).

An environmental reason for malabsorption and nutrient deficiencies is intestinal parasites. Parasitic infections contribute to childhood malnutrition through changes in digestion and absorption.

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*Normal histologic findings with positive antibodies are suggestive of early developing celiac disease (Salmi and colleagues, 2006).

THE LARGE INTESTINE

The large intestine consists of the cecum, the colon, the rectum, and the anal canal. Water is drawn out of the contents of the large intestine and absorbed, and solid feces are formed. Waste, including indigestible residue, undigested food particles, meat fibers, and decomposition products, is eliminated. Because no enzymes are produced in the large intestine, no digestion takes place there.

The large intestine is capable of absorbing water-soluble vitamins that are synthesized by the normal microflora. This includes thiamin, folate, biotin, riboflavin, and pantothenic acid (Said and Mohammed, 2006).

Diarrhea is the passage of frequent stools of liquid consistency. Persons experiencing severe diarrhea are generally told to abstain from consuming any food for up to 48 hours. This will give the intestinal tract a chance to rest. Intravenous solutions of dextrose may be required for severe cases of diarrhea to help replace fluids. Clear liquid may be given after this time. Once diarrhea has diminished, the patient can progress to a diet that is restricted in residue (insoluble fiber) and high in protein, calories, nutrients, and fluids. Box 4-3 shows how residue can be restricted using the food groups of the MyPyramid. These restrictions are gradually replaced by a regular normal diet as soon as the person is able to tolerate it.

One possible cause of diarrhea is excess intake of coffee and caffeine with their having a stimulating effect on intestinal motility that can lead to diarrhea. Excess intake of sugars from foods, beverages, or even medications can also cause diarrhea through an **osmotic effect** with the sugars drawing water into the bowel. In a study of four young and middle-age adults who consumed excess amounts of coffee and sugar, dietary changes were found to be effective in resolving their diarrhea (Scholten, van Leerdam, and Kuipers, 2006).

Steatorrhea usually indicates a more serious underlying organic disease. It may be seen in pancreatitis or after gastric or intestinal resection. It is often associated with diseases of the liver or gallbladder or with malabsorptive diseases such as celiac disease or regional enteritis. It sometimes occurs after GI radiation for cancer treatment (see Chapter 10). All of these disorders may involve problems with fat digestion

Box 4-3 Low-Residue Diet as Modified With Food Groups From the MyPyramid Food Guidance System

GRAINS
Emphasize refined grain products such as white bread, white rice, pasta, and cereals that are not whole grain.

VEGETABLES AND FRUITS
Emphasize those without skins or seeds such as canned fruits and fruit juice.

MILK
Drink or use 2 c or more as tolerated per day.

MEAT
Emphasize tender meats; avoid fried meats or those with gristle. Avoid legumes and nuts.

or absorption. It is generally diagnosed from a fecal fat test. A simple test of fat malabsorption is if the person's stools float in the toilet, because fat floats on water.

In diet planning for steatorrhea the emphasis is on low-fat foods. The treatment of steatorrhea may also involve the use of **medium-chain triglycerides (MCTs),** which are fats that contain 8 to 10 carbon atoms (as opposed to the 12 to 18 carbon atoms found in long-chain triglycerides [LCTs]). MCTs are used in the treatment of steatorrhea because they are more easily digested, absorbed, and transported than are LCTs. This can be accomplished with the use of commercially available products. The two principal forms of MCT are Portagen, which is a powdered formula that can be mixed and served as a supplement to meals, and MCT oil, which can replace vegetable oil in recipes.

Antibiotic treatment can cause diarrhea because it kills helpful and harmful bacteria. The intestinal tract normally contains certain types of bacteria that help digest food matter. A person in this situation will benefit from consuming yogurt with live bacterial culture (probiotics).

Constipation is a condition in which the waste matter in the large intestines or bowels is difficult to pass or the emptying time of the feces is so delayed that discomfort or uncomfortable symptoms result. A high-fiber diet (Box 4-4) and increased water intake are used in the treatment of constipation. Two liters of fluids daily are needed by most adults. Fiber provides bulk and water promotes softer stools, both of which help in elimination of fecal material. A variety of high-fiber foods from a variety of sources is recommended, with 20 to 35 g of fiber recommended for adults and "age plus 5" grams of fiber advised for children (see Chapter 12). If fiber intake is increased, it is imperative that fluid intake also increase. Figure 4-8 shows how fiber helps in the correction or prevention of constipation.

Prolonged constipation is called **obstipation.** Symptoms include nausea, heartburn, headache, general malaise, or distress in the rectum or intestine as a result of the nerves reacting when the rectum is distended by the contained matter.

Atonic constipation is characterized by the loss of rectal sensibility and weak peristaltic waves. It commonly occurs in elderly or obese persons, pregnant women, persons who abuse or overuse laxatives, and postoperative patients. Factors contributing to its occurrence include a low-fiber diet, irregular meals, inadequate fluid intake, lack of exercise, lack of time allowed for evacuation of stool, and prolonged use of chemical laxatives.

Encopresis is a condition of chronic constipation that affects children. Encopresis is characterized by a fecal impaction consisting of a semifitting "plug" of feces that allows more-liquid fecal material to seep around and soil the child's pants. Parents may not understand this physiology and may wonder if the problem is behavioral. A high-fiber diet with use of laxatives after a complete bowel clean-out may be helpful. Mineral oil, if used, should be used infrequently, because of associated malabsorption of food nutrients.

Irritable bowel syndrome (IBS), also called spastic colitis, is characterized by irregular contractions of the bowel, resulting in a cycle of diarrhea and constipation. This condition affects over 1 person in 10, and there is no clear understanding of its cause. Small intestinal bacterial overgrowth and sugar malabsorption (lactose, fructose, sorbitol) both play a role in IBS. Individuals with bacterial overgrowth

Box 4-4 Sample Menu ■ For a High-Fiber Diet

Breakfast
Raisins
½ c bran cereal
1 slice toast, 100% whole wheat
1 tbsp peanut butter
1 tsp jam
1 c 1% milk
1 tsp sugar
Coffee or tea

Lunch
Tuna sandwich on 2 slices toast, 100% whole wheat
1 c 4-bean salad
½ c green beans
Tomato slices
½ c canned peaches
Oatmeal cookie

Midafternoon Snack
Fresh orange

Supper/Dinner
½ c split pea soup
2 oz roast beef
1 baked potato with skin
½ c cooked carrots
1 c tossed salad
1 tbsp French dressing
1 slice bread, 100% whole wheat
1 tsp butter or margarine
Fig bar
1 c 1% milk
Coffee or tea

Evening Snack
½ c bran cereal
1 tsp sugar
½ c 1% milk

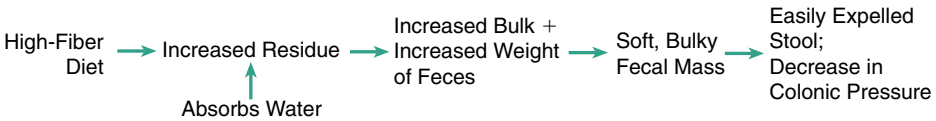


FIGURE 4-8 How a high-fiber diet helps correct and prevent constipation.

further have increased rates of sugar malabsorption (Nucera and colleagues, 2005). Probiotics may help with intestinal health and functioning.

As already described, gastrointestinal symptoms, including IBS, may be a symptom of celiac disease, and treatment with a gluten-free diet may be warranted. However, blood testing for celiac disease should be undertaken before the avoidance of gluten in order to help prevent false-negative test results.

The current primary treatment of IBS with a high–soluble fiber diet may thus be aimed at symptom management only. Soluble fiber absorbs water and has a thickening property. Soluble fiber allows for more stable transit time of fecal material through the GI tract. However, a high-fiber diet has been implicated in an increase in bloating and gas.

Other forms of constipation will benefit from either type of fiber (soluble or insoluble). Figure 4-8 shows how this is accomplished.

Inflammation of the bowels is related to the chronic conditions of **inflammatory bowel disease (IBD)** and **ulcerative colitis.** IBD may be helped by replacing arachidonic acid in the diet by either the omega-3 fatty acid EPA or oleic acid (Ramakers and colleagues, 2007). Ulcerative colitis is characterized further by ulceration of the mucosa of the large intestine. Symptoms of ulcerative colitis include rectal bleeding, diarrhea, fever, anorexia, dehydration, and weight loss. The cause of this disease is unknown. The omega-3 fats also have been found to reduce the severity of colitis through reduced inflammation (Whiting, Bland, and Tarlton, 2005). Resistant starch, such as found in potato starch, was found in a pig study to significantly alter colon health in a favorable way. Colon changes noted suggest benefit to humans, especially with inflammatory bowel condition (Nofrarías and colleagues, 2007). Emphasis on soluble fiber versus insoluble fiber can be of further help. For management of severe cases of ulcerative colitis a tube feeding of an elemental diet or total parenteral nutrition may be necessary (see Chapter 15).

Diverticulosis is a condition involving the formation of outpockets or small sacs (diverticula) protruding from the wall of the large intestines. They are found mainly in the sigmoid colon. Low-fiber diets favor the development of diverticulosis because intraluminal pressure is exerted against the colon wall instead of longitudinally, resulting in pouches (Figure 4-9). These outpockets do not disappear. Therefore a person with diverticulosis will always have diverticulosis but can experience **diverticulitis** (the inflammation stage associated with infection) in cycles.

A high-fiber diet is used for prevention and management of diverticulosis. The effect of fiber and liquids is expected to reduce the incidence and symptoms of diverticular disease by reducing pressure inside the intestinal tract. Until recently, the diet restricted intake of seeds, skins, and nuts. If these foods are consumed, thorough chewing should be advised.

Diverticulitis requires temporary management with a low-fiber diet to avoid inflammation of diverticula. Symptoms include abdominal pain, usually in the lower left quadrant and occasionally fever. Diverticulitis is a temporary condition of inflammation.

THE LIVER

The liver is involved with the metabolism and storage of the macronutrients carbohydrate, protein, and fat, as well as vitamins and minerals, after the process of digestion and absorption is completed.

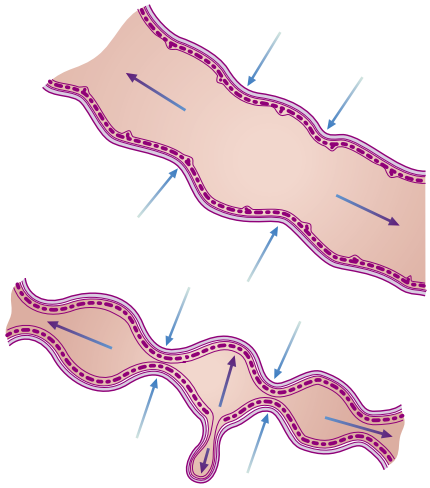


FIGURE 4-9 Mechanism by which low-fiber, low-bulk diets might generate diverticula. Where colon contents are bulky *(top)*, muscular contractions exert pressure longitudinally. If lumen is smaller *(bottom)*, contractions can produce occlusion and exert pressure against colon wall, which may produce diverticular ballooning.

The liver stores glucose in the form of glycogen, which can then be released back into the bloodstream as glucose. The liver can also make glucose from protein in the process called gluconeogenesis. The end products of protein digestion, amino acids, are formed back into complete protein by the liver. The liver can manufacture the nonessential amino acids (see Chapter 2). The liver produces lipids, such as cholesterol and triglycerides and bile salts, essential for fat digestion.

The liver detoxifies harmful substances—for example, by changing ammonia, created from protein metabolism, into urea, which can then be cleared into the urine by the kidneys. Life cannot exist without the functions of the liver.

Hepatitis is inflammation and injury to liver cells caused by infections, drugs, or toxins. Symptoms include anorexia, fatigue, nausea, vomiting, fever, diarrhea, and weight loss. The symptoms during the early stage of hepatitis make it difficult for the person to consume adequate nutrients. Tube feedings (see Chapter 15) may be required until the individual can tolerate the oral intake of food. Once oral intake is resumed, a diet high in calories, protein, vitamins, and minerals with moderate fat is planned. Several small meals are usually better tolerated than are three large ones.

Cirrhosis is a chronic liver disease, generally attributed to alcohol abuse, in which normal liver tissue is replaced by inactive fibrous tissue. Because liver tissue is not able to function normally, there may be **jaundice** (a buildup of bile in the body causing yellowing of the skin and eyes), a prolonged bleeding time, fatty infiltration of liver tissue, lower serum albumin levels, and other complications (depending on the severity of tissue-function impairment). Symptoms sometimes include nausea, vomiting, anorexia, **ascites** (accumulation of fluid in the abdomen), and **esophageal varices** (enlargement of the veins in the esophagus because of poor portal vein blood circulation).

Reduced levels of circulating branched chain amino acids, BCAA (leucine, isoleucine, and valine) and increased levels of the aromatic amino acids (phenylalanine

Table 4-3 Daily Food Allowances for 50-g Fat Diet

FOOD	AMOUNT	APPROXIMATE FAT CONTENT (g)
Skim milk	2 c or more	0
Lean meat, fish, poultry	6 oz or 6 equivalents	18
Whole egg or egg yolks	3 per week	3
Vegetables	3 servings or more, at least 1 or more dark leafy green or orange	0
Fruits	3 or more servings, at least 1 citrus	0
Breads, cereals	As desired	0
Fat	5-6 tsp fat or oil daily	25-30
Desserts and sweets	As desired from permitted list	0
	Total fat	46-51

and tyrosine; see Chapter 2) along with hyperinsulinemia are common metabolic alterations in liver cirrhosis, especially with a high-carbohydrate diet. A supplement of BCAA may be needed (Schulte-Frohlinde and colleagues, 2007).

The diet to meet health needs without adverse outcomes is a challenge. It is generally considered that a higher carbohydrate intake is warranted. This is in part due to lowered protein and fat tolerance. The diet for cirrhosis should be adequate in kcalories and nutrients to prevent further deterioration of the liver. As much as 300 to 400 g of carbohydrates may be necessary with a potential need for 45 to 50 kcal per kilogram of body weight to spare protein. To help control hyperinsulinemia, consuming several meals daily rather than three large ones is required to maintain lower-glycemic-load meals (see Chapter 2). The fat intake may need to be lowered because of malabsorption of fats. Table 4-3 shows daily food allowances for a 50-g, low-fat diet.

Fat deposits in the liver are found in alcoholic steatohepatitis. There is a similar condition that is not due to alcohol. The increasing prevalence of this liver disease, **nonalcoholic steatohepatitis (NASH),** has been related to the epidemic of obesity (see Chapter 5). In a study of mice, a diet deficient in the amino acid methionine and the B vitamin choline was shown to further result in fat accumulation in the liver and ultimate injury. This outcome is similar to NASH in humans (Rinella and colleagues, 2008).

When liver function becomes severely impaired, ammonia levels become abnormally high and toxic to brain tissue. Protein may be restricted to 35 to 50 g/day (see Box 4-5 for a sample menu). Providing carbohydrate in the form of sugar-based candy or sugar-based beverages can provide extra kcalories without protein. The amount of protein is gradually increased in increments of 10 to 15 g as liver function improves.

Vitamin and mineral supplementation is often necessary. Sodium and fluids are restricted if edema and ascites develop. Sodium is usually limited to 2000 mg/day. Fluids are restricted to 1000 to 1500 mL (30 mL equals 30 cc or 1 oz) per day, depending on the severity of the condition. Foods high in roughage (whole grains and vegetables and fruits with skin and seeds) may need to be restricted with esophageal varices to prevent rupture of these tiny blood vessels.

Box 4-5 Sample Menu ■ For a 35-g Protein Meal Diet*

Breakfast
½ c fruit or juice
½ c cereal with ½ c milk, sugar
1 slice toast with 1 tsp butter and jelly
Coffee or tea

Lunch
1 small potato with 1 tsp butter and/or mustard
½ c vegetable
Tossed salad with Italian dressing
Croutons for salad
½ c fruit
½ c milk

Supper/Dinner
1 oz meat or 1 egg
½ c rice
½ c vegetable
Fruit salad
1 slice bread dipped in flavored olive oil
½ c fruit
½ c milk
Coffee or tea

*On a 20-g protein meal pattern, 1 oz of meat and 1 c of milk would be omitted. Extra margarine, concentrated sweets, low-protein bread and pasta, and possibly carbohydrate supplements help to provide adequate kcalories in the diet.

Hepatic encephalopathy, also known as **hepatic coma,** is a condition of altered consciousness related to the buildup of toxic substances found with liver disease. This includes ammonia and other substances. Contributing factors include GI bleeding, excessive dietary protein, severe infection, and surgical procedures. Symptoms include confusion, irritability, delirium, and flapping tremors of the hands and feet.

There is a high incidence of low bone mineral density (BMD) in persons with liver diseases due to elevated intact parathyroid hormone (iPTH). It is suggested both BMD and iPTH examinations be undertaken before liver transplantation (Bai and colleagues, 2007).

THE GALLBLADDER

The gallbladder is involved in the digestion of fat through the release of stored bile. Painful conditions may occur related to the release of bile.

Cholelithiasis (gallstones) is a common condition in Western societies and in areas around the world. Risk factors include obesity, aging, pregnancy, and diabetes. Excess kcalories, simple sugar, and saturated fat promote gallstone formation. There are different compositions of stones and locations. Those found in the liver itself may be due to altered protein metabolism related to infection, whereas stones in the gallbladder are related to cholesterol content (Uchiyama and colleagues, 2007).

Sometimes the gallstones block the bile duct and interfere with the flow of bile. Symptoms include severe pain in the right upper quadrant as the gallbladder contracts and jaundice if the bile duct is obstructed. **Cholecystitis** is an inflammation of the gallbladder. It can be caused by a bacterial infection or stones in the gallbladder. Symptoms include acute pain in the upper right quadrant, nausea, belching, vomiting, fever, and jaundice if the bile duct is blocked.

During an acute attack of cholecystitis or cholelithiasis, food may be withheld for up to 24 hours. Food is introduced gradually, starting with a clear liquid diet. As food tolerance improves, progression to a minimum-fat diet that contains 50 g of fat or less can be consumed (see Table 4-3).

Excess fat intake will cause the gallbladder to contract, which can be very painful if gallstones are present. Therefore foods high in fat may not be tolerated, including foods such as sausages, bacon, and peanut butter. Other food intolerances, such as for onions, may exist in certain individuals. If stone removal by surgery or by ultrasonic or chemical dissolution is necessary, the patient should follow a low-fat diet until the procedure is performed.

After stone removal the patient should follow a low-fat diet for several weeks until fat digestion is normalized. Thereafter a normal diet is usually well tolerated and should be encouraged, although a 50-g fat diet is appropriate for long-term use.

THE PANCREAS

The pancreas produces digestive enzymes for metabolism of proteins, carbohydrates, and fats; bicarbonate ions to neutralize chyme; and hormones such as insulin (see Chapter 8).

Cystic fibrosis (also called cystic fibrosis of the pancreas) consists of an insufficiency or abnormality of some essential hormone or enzyme. Excessive thick mucus is produced by the exocrine glands and interferes with breathing and digestion.

Fats are poorly digested and absorbed, and a common symptom is frequent fatty, bulky, and odorous feces. Recurrent respiratory infections and excessive loss of sodium and chloride from the sweat glands are common. Pancreatic insufficiency may develop. The MCTs are more easily absorbed and therefore are the best source of fat in the diet for people with cystic fibrosis. Pancreatic enzyme tablets given at mealtimes, however, allow for more-normal intake of dietary fats and can therefore promote growth of children with cystic fibrosis.

The fat-soluble vitamins (A, D, E, and K) and a high-protein, high-kcalorie diet are the cornerstones of diet therapy for this condition. Children who have cystic fibrosis often have a good appetite, which allows for adequate intake of kcalories and protein.

Pancreatitis is inflammation of the pancreas. It is caused by digestion of pancreatic tissue by its own pancreatic digestive enzymes. The reason for this is not fully understood. Chronic alcoholism and triglyceride levels over 500 mg/dL are often associated with pancreatitis. Symptoms include abdominal pain, fever, malaise, nausea, and vomiting. Treatment is aimed at resting the pancreas. A low-fat diet is often implemented during acute pancreatitis. Pancreatic insufficiency may develop; it is treated by the administration of pancreatic enzyme at each meal.

Diabetes mellitus is related to inadequate amounts or use of insulin produced by the islets of Langerhans, found in the pancreas (see Chapter 8). Because this is a

complex disease, Chapter 8 has been devoted to a full discussion of its management.

WHAT ARE OTHER COMMON DIGESTIVE ISSUES AND SUGGESTIONS?

Poor Appetite

- Encourage good oral hygiene before and after meals.
- Promote a pleasant meal setting. Play soft music. Use candles if possible. Make meals visually attractive with a variety of food colors and textures.
- Note times when appetite is the best—often mornings—and provide larger portions or more nutritious foods at these times.
- Try well-seasoned foods. Sometimes salt or fat restrictions are discontinued to promote adequate intake.
- Provide calorie-dense foods such as ice cream, milkshakes, or liquid supplements.
- Evaluate reasons for poor appetite such as depression; use medications as needed.

Dry or Sore Mouth

- Avoid foods that are irritating such as coarse, salty, or hot-spiced foods.
- Provide soft, moist foods for ease in chewing. Moisten dry foods, such as dry toast, in beverages, or add gravy or cream sauces to foods.
- Include cold foods such as ice cream, sherbet, and iced beverages.
- Encourage good oral hygiene. Dry mouth can lead to dental decay.

Diarrhea

- Rule out causes such as fat malabsorption; ask if the person's stools "float." If so, pancreatic enzymes with meals can help with fat digestion and absorption.
- Rule out excess sugar alcohol intake (a form of sugar substitute such as sorbitol and mannitol).
- Rule out GI illness. If this is the cause, an initial clear liquid diet may be necessary for 24 hours or longer to provide bowel rest (see Chapter 15). Low-residue, lactose-free liquid supplements may be tolerated and needed for extended bowel rest.
- If intestinal irritation exists, initially restrict irritants such as caffeine, alcohol, spicy foods, skins and seeds of fruits and vegetables, bran and whole grains, and nuts.
- Increase soluble fiber such as bananas, oatmeal, and small legumes such as lentils. Appendix 8 on the Evolve website provides amounts of fiber in foods.
- Avoid lactose (milk sugar).
- Include plain, lemon, or vanilla yogurt with active bacterial cultures if diarrhea is induced from antibiotics.

Excess Gas Production (Flatulence and/or Belching)

- Ensure no swallowing of air by chewing with the mouth closed.
- Reduce fiber intake until symptoms abate; resume in small amounts to build up digestibility for decreased gas production by intestinal bacteria.

- Try a low-lactose diet.
- Avoid carbonated drinks.

WHAT IS THE ROLE OF CELLULAR METABOLISM?

Metabolism is the rate at which food calories are used as energy in the body cells. The formation of **adenosine triphosphate (ATP)** in the mitochondria of the body cells, through the Krebs cycle (see Figure 4-4), is the basis of energy production. A person with severe hypoglycemia (see Chapter 8) has impaired ATP production, leading to coma and death if not corrected promptly. A slow metabolic rate caused by **hypothyroidism** (a condition of low levels of thyroxine production) can result in obesity, and a high metabolic rate from hyperthyroidism can result in undesirable weight loss. Metabolism goes beyond use of kcalories, however. Numerous, complex biochemical changes occur within the cells in both anabolic and catabolic processes. A variety of vitamins and minerals are part of metabolic enzymes that allow the transformation of food material to be used as building material. If the pathways involved in cellular metabolism are disrupted because of a lack of certain metabolic enzymes, major health problems can occur.

For example, all infants are now screened for **phenylketonuria (PKU)** at birth. This is a condition in which the essential amino acid, phenylalanine, is not metabolized and causes brain damage. With identification of infants who have PKU at birth, the diet can be altered to limit the amount of phenylalanine in the diet to allow for normal brain function. Women with PKU need to limit phenylalanine intake during pregnancy (see Chapter 11).

Mitochondria, being the principal structural source of cellular energy, are receiving attention as to impact on health. Mitochondrial disorders are increasingly acknowledged as a major cause of neurodegeneration, including Alzheimer's disease, Parkinson's disease, amyotrophic lateral sclerosis (ALS) (Lou Gehrig's disease), and Huntington's disease—see Chapter 15 (Zeviani and Carelli, 2007). The association with neurodegeneration appears to be altered structure of the mitochondrial membrane causing increased permeability to ions and other substances, ultimately leading to energy failure and cell death. The primary factors involved in damaged mitochondrial membrane are increased levels of intracellular calcium and oxidative stress (Norenberg and Rao, 2007).

Creatine helps in cellular maintenance of ATP and its use. It is lost through the production of creatinine that is filtered through the kidneys (see Chapter 9). Creatine synthesis occurs with the intake of protein and especially the amino acids glycine, arginine, and methionine. Creatine supplementation is generally used by athletes but may have a role in neurodegenerative and other diseases related to its production (Brosnan and Brosnan, 2007).

WHAT IS THE ROLE OF WATER AND ELECTROLYTES IN DIGESTION AND CELLULAR METABOLISM?

WHAT IS THE NUTRITIONAL FUNCTION OF WATER?

Water is the principal constituent of the body. One half to three quarters of body weight is water. Most water is intracellular; the remainder is found in blood, in

lymph, in various secretions and excretions, and around cells. The water requirement for adults is 1 mL/kcal and for infants is 1.5 mL/kcal (1 oz equates to 30 mL or 30 cc). Another simple way to determine needs is that 1 oz is needed for every kilogram of body weight, or ½ oz per pound of body weight.

Fluid balance is essential; intake must equal output. Fluid requirements are closely related to salt requirements. Intake of increased amounts of water is needed under conditions of extreme heat or excessive sweating. However, salt-based foods should be consumed with high water intake to avoid a potentially deadly condition of hyponatremia (low levels of sodium in the blood—see Chapter 13).

Water is absorbed primarily in the colon. Regular intake of fluids is essential to maintain life. Dehydration is far more deadly in the short run than starvation from inadequate kcalories. Water requirements are increased for infants receiving high-protein formulas; comatose persons; those with fever, excess urination, or diarrhea; or those on high-protein diets. Water is normally lost through urine, in expired air, in feces, and through the skin. Water serves a number of functions in the body:

- Helping every organ to function properly
- Aiding digestion, absorption, circulation, and excretion
- Serving as a solvent for body constituents and as a medium for virtually all chemical changes in the body
- Carrying nutrients to and waste products from cells as part of the blood
- Participating in the regulation of body temperature
- Contributing to the lubrication of the moving parts of the body

Water can be found in varying quantities (anywhere from 10% to 98%) in foods; it is formed in the body's metabolic processes and is an end product of oxidation. The average diet with milk (87% water) contains about 1000 mL (1 L or 1 quart) of water daily. With the addition of 1 quart (4 cups) of water, the recommended 2000 mL for the average adult can be met. However, 6 to 8 cups of fluids are generally advised. Alcohol should not generally be counted as fluid because it promotes diuresis.

WHAT ARE ELECTROLYTES?

An electrolyte is a compound that, when dissolved in water, separates into charged particles (ions) capable of conducting an electric current. Within the body, electrolytes play an essential role in maintaining fluid and acid-base balance (a state of equilibrium in the body between acidity and alkalinity of body fluids [Figure 4-10]). Diet, however, is considered to play only a small role in maintaining an appropriate acid-base balance.

The chief electrolytic ions are sodium, potassium, calcium, magnesium, chloride, and phosphate. All body fluids contain electrolytes. The chief extracellular

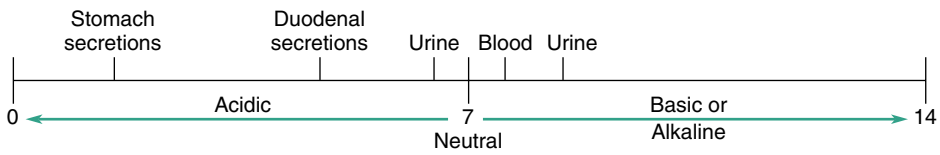


FIGURE 4-10 The pH of various body fluids.

electrolytes are sodium and chloride, whereas potassium, magnesium, and phosphate are found in large intracellular amounts.

Changes in the electrolyte composition of body fluids create electric charges, and these in turn are responsible for electrochemical reactions such as transmission of nerve impulses, contraction of muscles, and glandular cell secretions. Shifts in the electrolyte balance that cause either an excess or a deficiency of electrolytes may occur as the result of various disease conditions. Alterations in electrolyte balance can cause death. Therefore careful monitoring of the blood levels of electrolytes is necessary, especially during times of illness.

Correction of malnutrition, as with the initiation of nutrition support, can cause shifts in electrolyte balance. The refeeding syndrome (see Chapter 15 for details) is related to electrolyte shifts from extracellular to intracellular. Extracellular serum potassium levels, for example, can become low as potassium moves back into the cell.

WHAT IS THE ROLE OF THE ENDOCRINE SYSTEM IN METABOLISM?

The **endocrine system** is a major control system of the body. More than a dozen hormones that the body produces regulate metabolism and the use of nutrients. Insulin is the only hormone that lowers glucose levels. The hormones that raise glucose levels are referred to as **counterregulatory hormones,** because they work counter to insulin. Hormones help control energy intake and expenditure. One hormone produced in the GI tract during meals that signals satiety is cholecystokinin. The hormone leptin is secreted in relation to levels of body fat and helps to regulate food intake.

Some hormonal impacts on nutritional status are as follows:

Insulin. This hormone is produced in the pancreas and allows carbohydrates to be metabolized for energy by facilitating the entry of blood sugar (glucose) into the cells where the Krebs cycle takes place. Insulin also affects the metabolism of fat. Insulin stimulates protein synthesis and decreases protein degradation. Insulin deficiency decreases the body's ability to metabolize carbohydrates and fats, and it contributes to weight loss.

Glucagon. This is the primary hormone produced when the body perceives the blood glucose level is dropping too far. Glucagon is one of several hormones that promotes the breakdown of **glycogen** (stored sugar) in the liver to raise blood glucose levels. Insulin and glucagon are the primary hormones involved in maintaining **homeostasis** (the regulation of body functions or processes) of blood glucose levels.

Epinephrine (also referred to as adrenalin). This hormone is produced mainly by the adrenal glands and helps release stored sugar in the liver in response to low blood sugar or stress. Energy metabolism is increased in response to epinephrine because of the resultant increased heart rate and oxygen intake. Excess epinephrine may raise the blood glucose level too high if there is insufficient insulin for the metabolism of carbohydrates (see Chapter 8).

Cortisol. This hormone is also produced by the adrenal gland. It is generally produced in increased amounts during the early morning hours. As a result, blood sugar levels tend to run higher first thing in the morning (this is referred to as the dawn phenomenon; see Chapter 8). An increased production of insulin may occur in the

early morning hours to compensate for the dawn phenomenon, especially if large amounts of simple sugar are consumed. Steroid medications are similar to the cortisol hormone because they tend to increase the appetite and their use is related to weight gain and raised blood glucose levels. Cortisol production normally occurs with delayed meals to maintain adequate glucose levels; this may be the basis of why small, frequent meals help with weight management (see Chapter 6).

Growth hormone. This hormone is produced by the pituitary gland. It raises the rate of metabolism and is associated with protein anabolism, which produces a positive nitrogen balance. It is also referred to as being diabetogenic because it works against insulin in muscle tissue. Adolescents have an increased need for insulin because of increased levels of growth hormone. This hormone contributes to the dawn phenomenon as well.

Estrogen. This hormone is produced mainly in the ovaries and helps retain bone calcium, which results in a decreased risk of osteoporosis (see Chapters 12 and 13). Estrogen tends to cause blood glucose levels to rise because of its inhibiting effect on insulin. Premenstrual syndrome (PMS) (see Chapter 13) may be caused in part by lowered levels of estrogen after ovulation. Without estrogen, insulin is able to lower the blood sugar level more effectively. Lowered blood sugar levels can result in the irritability, hunger, and headaches that often are associated with PMS.

Thyroxine. This is one of the hormones produced in the thyroid that raises the rate of metabolism. A high level of thyroxine increases the metabolic rate in part because it increases oxygen consumption. The thyroid hormones also help regulate lipid (fat) metabolism. Low levels of thyroxine may be reflected in raised levels of blood cholesterol (see Chapter 7). Iodine binds to thyroxine, so measuring the amount of protein-bound iodine found in a blood sample is one technique for measuring the basal metabolic rate. The more iodine found bound to thyroxine, the more active the thyroid gland, therefore the greater the metabolic rate.

Ghrelin. This hormone is produced in the stomach. The mobilization of ghrelin is stimulated by nutritional deficiency and suppressed by nutritional abundance. Adrenalin and noradrenalin appear to stimulate the production of ghrelin (de la Cour, Norlén, and Håkanson, 2007). Adrenalin (epinephrine) and noradrenalin (norepinephrine) are released in response to hypoglycemia

Teaching Pearl

For a person familiar with motorcycles, it can be a good analogy related to blood glucose and glycogen stores. There is no gas gauge on the tank of a motorcycle. If the motorcycle accidentally runs out of fuel, the rider can flip a switch to a small reserve tank of fuel. If blood glucose levels fall, the body will "flip a switch" to allow access to a reserve source of glucose. The switch involves the production of glucagon, adrenalin, cortisol, and other hormones. The backup fuel is the glycogen stored in the liver, which is then released as glucose into the bloodstream. ■

WHAT IS THE DIFFERENCE BETWEEN FOOD ALLERGIES AND FOOD INTOLERANCE?

The general public often confuses **food intolerances** (which cause no immune reaction) and **food allergies,** which do cause an immune reaction. It is important to know

the difference. A person with milk allergy may become seriously ill from any trace of milk; a person with lactose intolerance may be able to tolerate small quantities of milk or low-lactose forms of milk such as yogurt and cheese. See Box 4-1 for a sample lactose-free diet.

CARBOHYDRATE INTOLERANCE

Lactose intolerance is found in greater frequency in nonwhite populations. However, it still does occur in the white population as well. As related to a case study of a German woman, it is recommend that a hydrogen breath test be undertaken with cases of chronic diarrhea even if there is no evidence of lactose intolerance (Allgayer, Mainos, and Dietrich, 2007).

Other sources of calcium should be promoted, including lactose-free milk, use of soybeans and soy products (Asian countries), or yogurt and cheese (Mediterranean and Middle Eastern regions); in some cultures calcium may be obtained from arthropods (e.g., grasshoppers in Hawaii).

Carbohydrate malabsorption needs to be ruled out in persons with nonspecific abdominal complaints. One study found a malabsorption rate of about one third of the population with lactose intolerance, two thirds with fructose intolerance, and almost all have an intolerance to sorbitol (Born and colleagues, 2006).

PROTEIN INTOLERANCE

Intolerance to protein is generally a genetic metabolic disorder (see Chapter 2) or related to impaired liver and renal function. There is limited evidence of intolerances due to impaired digestion. Protein allergies are far more common than genetic metabolic disorders.

FAT INTOLERANCE

Fat intolerance is often related to pancreatitis and gallstones. Alcoholism is commonly associated with pancreatitis and problems digesting fat. Vegetarians or others who normally follow a low-fat diet often report nausea and indigestion as a result of increased meat or fat intake. These are physiologic intolerances to fat. A low-fat meal containing up to 15 g of fat should be physiologically tolerated.

INTOLERANCE TO VEGETABLES AND FRUITS

Intolerances to vegetables and fruits are highly individual. The problem may not be the food as much as the style of eating. Thorough chewing and eating slowly will lessen symptoms of intolerance. Many people avoid legumes (dried beans) because of excessive flatulence. Such people may benefit by slowly increasing amounts eaten. Chewing thoroughly and including adequate fluid in the diet are important. Some people find a commercial enzyme preparation such as Beano to be helpful (although persons with an allergy to mold should avoid this product because it is derived from mold). Older persons often find that lettuce causes indigestion or abdominal pain. Again, small amounts of lettuce that are thoroughly masticated may help. Jerusalem artichokes contain a type of carbohydrate that humans cannot digest. Undigested carbohydrate allows bacteria to multiply in the GI tract, which leads to flatulence. Apple skin may be a problem for some people. The cause of intolerance may be a sudden increase in the fiber content of these

foods. Gradually increasing the amounts of fruits and vegetables eaten may be beneficial.

INTOLERANCE TO HOT, SPICY FOODS

An intolerance to hot, spicy foods is often associated with peptic ulcers, pancreatitis, and gallbladder disease. The intolerance may be physical or psychologic in the case of persons who believe they cannot tolerate spicy foods. Intolerance to spicy foods is not diagnostic of peptic ulcers.

FOOD ALLERGIES

A food allergy is a condition that develops when a person is hypersensitive to certain proteins found in food. It is an immune response that can be mildly annoying or severe enough to induce death through **anaphylactic shock** (a life-threatening condition in which the breathing passages can be blocked because of inflammation of the airways).

Food allergens and antigens are the proteins or other large molecules from food that induce an immune response. The **immunoglobulin E (IgE) antibody** is produced in response to these "foreign" substances in an attempt to rid the body of them. IgE causes the typical allergy symptoms. Symptoms affect the skin, nasal passages, and respiratory or GI tract. Hives, diarrhea, nausea, vomiting, cramps, headache, and asthma are common symptoms of food allergy. If the entire circulatory system is affected, shock occurs.

There are two major types of allergic reaction to foods: immediate and late. Immediate reactions are characterized by the rapid appearance of symptoms, often within minutes after the offending food has been eaten or on contact. The immediate allergic response is generally the more severe, and life-threatening, form of allergy. Late reactions are more subtle. Up to 48 hours may elapse between eating the allergenic food and the appearance of symptoms such as nasal congestion.

Skin testing may be used to confirm a diagnosis of food allergies. One means involves scratching or puncturing the skin with extracts of food. A skin reaction such as raised bumps around this area may be indicative of an immune response to the causative food extracts. The **radioallergosorbent test (RAST)** uses a blood sample. Both the skin test and the RAST can be incorrectly interpreted and therefore are not considered infallible. The skin test should be performed under medical supervision to avoid or safely treat anaphylactic shock that can ensue. Other means of diagnosis include a record of food intake and symptoms. An **elimination diet** may be used to identify individual food allergens. This diet contains a few carefully chosen foods, with common allergens omitted. It is followed for 1 to 2 weeks until symptoms abate. Foods are then readded, one at a time, each for a few days. If no symptoms are noted, another food is added for another couple of days. This procedure is continued to ensure tolerance and to identify those foods that are linked to the redevelopment of allergic symptoms.

Education is important once food allergies are documented. A person may know he or she has a milk allergy but may not think of all foods made with milk, such as cream soups, margarine with milk solids, cheese, and milk chocolate. Alternative terms for milk protein on the food label—for example, lactalbumin, lactoglobulin, casein, nonfat milk solids, or whey—may not be familiar to the patient. The services

Table 4-4 Egg-Free Diet

FOOD GROUP	FOODS ALLOWED	FOODS EXCLUDED
Beverages	All plain milks, creams, and buttermilks Cocoa, tea, coffee Carbonated beverages	Eggnogs, malted beverages Beverages "cleared" with egg or shells
Soups	Creamed meat, fish, and vegetable soups prepared without egg (such as egg noodles)	Any soups "cleared" with egg or shells, egg powder, dried egg, and albumin
Protein sources	All plain meats, fish, and poultry (some severely allergic individuals cannot eat the meat of egg-laying chickens) Cheese	All breaded or batter-dipped foods if egg was used in the mix Sausages, croquettes, or loaves using egg as a binding agent
Vegetables	Fresh, frozen, canned, raw, or cooked	None unless combined with egg
Fruit	All fresh, frozen, canned, or dried All juices	None
Breads and cereals	RyKrisp, corn pone, beaten biscuits, and plain crackers Any homemade breads without egg Any breakfast cereal Rice Pasta made without egg	Gingerbreads, griddle cakes, muffins, waffles, fancy breads, pretzels, saltines Commercial breads and rolls containing eggs or that have been brushed with egg
Fats	All butters, creams, homemade salad dressings without eggs	All others unless label shows made without egg, albumin, or egg powder
Combination	Any made without egg or egg products	Any made with egg or egg products; avoid biscuit toppings, thickened sauces Prepared mixes for pancakes, cakes, cookies (may contain egg powder), cream-filled pies, meringues, ice cream, sherbet
Sweets and snacks	Plain fruit-flavored gelatins Fruit pies Ices Cookies, frostings, cakes, and puddings made without eggs Popcorn, nuts, olives, pickles Sugars, hard candy	Some commercial candies that contain egg or albumin

Courtesy of the Bureau of Nutrition Services, Office of Mental Retardation and Developmental Disabilities, Albany, NY.

of a registered dietitian (RD) are helpful in patient education and may be required to avoid nutritional inadequacies when the patient has multiple food allergies. Tables 4-4 and 4-5 list common foods to be omitted on the egg-free diet and the milk-free diet.

The foods that most often cause allergic reactions are milk, fish, shellfish, nuts, berries, egg whites, chocolate, corn, wheat, pork, legumes (green peas, lima beans, and peanuts), and some fresh fruits, especially citrus such as oranges. Other food items may be associated with allergic responses. One of these is mustard, which has

Table 4-5 Milk-Free Diet

FOOD GROUP	FOODS ALLOWED	FOODS EXCLUDED
Beverages	Soft drinks	All milk and milk-containing beverages
	Soya milk products	
	Coffee, tea	
	Decaffeinated coffee	
Soups	Any broth-based soup with no milk products	All creamed soups
Protein sources	All fresh meats	Non-Kosher luncheon meats: bologna, salami, wieners, sausage, meat loaf, cold cuts
	Kosher luncheon meats, hot dogs, bologna, and salami labeled "Parve" (may be very spicy)	Poultry with stuffing
	All-beef hot dogs	Meat balls, meat loaves
	All poultry without stuffing	Cheese
	All fish	Yogurt
	Eggs	Breaded items that contain milk in batter or bread crumbs made with milk
	Dried beans, peas	
	Peanut butter	
Vegetables	Any fresh, canned, or frozen vegetables	All creamed vegetables
	Pasta	Any creamed sauces, including au gratin
	Rice	Mashed potatoes (unless made without milk)
Fruit	Any fresh, frozen, or canned fruit or juice	None
Breads and cereals	RyKrisp, homemade brands made without milk, rye breads	Other baked goods
	Italian breads	
Fats	Poultry, meat, and pure vegetable fats and oils	Butter
	Dressings made without milk or milk products	Cheese
	Margarine (without milk solids)	Gravy made with milk or cream
		Any salad dressings containing milk or milk products
Combination sweets and snacks	Any made without milk or milk products	Any dishes containing milk or milk products
	Plain fruit-flavored gelatin	Prepared mixes: waffle, cake, muffin, pancake
	Angel and sponge cakes	
	Fruit ices	Puddings, creams
	Jellies and jams	Ice cream, sherbet
	Sugars, hard candy	Milk chocolate candy

Courtesy of the Bureau of Nutrition Services, Office of Mental Retardation and Developmental Disabilities, Albany, NY.

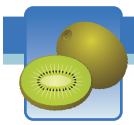
been associated with anaphylactic reactions or more local reactions. Mustard allergy has been noted in children (Lovik, 2005).

Individuals who are sensitive only to wheat products can follow a gluten-restricted diet (see Box 4-2) in which wheat, rye, and barley are omitted. However, the person with a wheat allergy may need to restrict only wheat. The American Dietetic Association can provide sources for allergy recipes (see Appendix 1 on the Evolve website). Many commercial products for allergy diets are available. Careful

reading of the labels on such products is necessary to detect any specific allergen to be omitted in the diet. Writing to food manufacturers to inquire about possible cross-contamination (such as dusting the food conveyor belt with flour) can be helpful. Often a person who is allergic to one food will be allergic to others in the same food family. For example, someone allergic to peanuts usually cannot eat peas or beans either, simply because they are members of the pea family.

The rate of peanut allergies in children doubled from 1997 to 2002. Peanut allergy is a particular problem for children. Children with combined food allergy and asthma are especially at risk for anaphylaxis fatality. Self-injectable epinephrine needs to be available at all times for such an individual, and early administration is required even when cutaneous symptoms are lacking (Shah and Pongracic, 2008). Other measures to prevent fatality include schools banning peanut products from schools to prevent problems. A less aggressive and potentially safe alternative to a complete peanut ban is ensuring hand washing with liquid soap, bar soap, or commercial wipes, not just plain water or antibacterial hand sanitizers. Contact surfaces such as tabletops and desks can be adequately cleaned using common household cleaning solutions, not dish soap. Airborne contact does not appear to be a problem (Perry and colleagues, 2004). Further, children who have peanut allergy should be discouraged from kissing or sharing eating utensils with someone who has ingested a peanut product, with the highest risk being immediately after consumption even with tooth brushing. Detectible levels of peanut allergen have not been found 1 hour after peanut intake (Maloney, Chapman, and Sicherer, 2006).

There is increased interest in prevention of allergic tendencies. One study found reduced risk of atopic eczema among high-risk children with increased intake of retinol, calcium, and zinc, along with previous perinatal exposure to probiotics from maternal ingestion (Laitinen and colleagues, 2005). However, there is insufficient evidence to recommend the addition of probiotics to infant feedings for prevention of allergic disease or food hypersensitivity. Variable outcomes related to reduction in clinical eczema in infants have been observed among various studies (Osborn and Sinn, 2007).



Cultural Considerations

Food allergies affect about 4% of the Korean population, and buckwheat allergy is one of the most severe food allergies in Korea (Lee and colleagues, 2005). ■

HOW DOES ALCOHOL AFFECT DIGESTION, ABSORPTION, AND METABOLISM?

Alcohol is toxic to the body when consumed in excess and thus impairs the entire process of digestion, absorption, and metabolism. Even a single episode of excess alcohol intake can cause duodenal erosions and bleeding with injury to the lining of the upper jejunum. This leads to malabsorption of macronutrients and vitamins. This can affect nutritional status by interfering with normal use of food nutrients.

Alcohol provides a kcalorie source (7 kcal/g) and can replace kcalories from food. Body weight may be normal due to the kcalories of alcohol even though appetite for food may be reduced. Malnutrition is a common finding in chronic alcoholics, with protein calorie malnutrition; deficiencies of the B vitamins B_1, B_3, B_6, and folate; increased incidence of anemia; and altered brain function. A low serum albumin level (a form of protein found in the blood and a measure of protein status) will be found when there is inadequate protein intake for the body's needs or if the liver is too damaged to metabolize protein. For the recovering alcoholic a diet rich in carbohydrate and protein with supplementation of vitamin B_1 and folate is advised.

Alcohol damages the villi in the intestinal system, leading to poor absorption of all nutrients. Wernicke-Korsakoff syndrome (also called Wernicke's encephalopathy) is a condition often caused by alcoholism and compounded by a deficiency of vitamin B_1 (thiamin). The result of this condition causes damage to the central nervous system, resulting in poor muscular coordination, double vision, impaired memory, and psychosis. Diarrhea is often associated with chronic alcohol abuse and may be related to pellagra (see Chapter 3). If diarrhea is noted with dermatitis and dementia, vitamin B_3 should be instituted.

A less well known problem with alcohol is its propensity to damage the pancreas. This damage can develop into secondary diabetes if the pancreas loses its ability to produce insulin (see Chapter 8).

In moderation, alcohol is generally considered beneficial. This is related to its positive effects on insulin resistance, high-density lipoprotein (HDL) cholesterol (also known as the "good" cholesterol), and reduced tendency to form blood clots. The American Heart Association notes reduced heart disease with moderate alcohol intake. However, even with moderate doses of alcohol there is decreased glucose metabolism in the human brain. This may reflect altered brain metabolism and fuel substrates. One such energy substrate may be acetate, which is found in increased levels during alcohol intoxication (Volkow and colleagues, 2006). Because alcohol intake decreases glucagon production, persons who take diabetes medication should consult their physicians for guidance on alcohol use. Moderate intake for men is two drinks or less per day and for women is one drink or less. One drink equates to 12 oz of beer, 4 oz of wine, or 1 oz of hard alcohol.

HOW IS ALCOHOL METABOLIZED?

Two principal enzymes are known to be involved in the metabolism of alcohol: alcohol dehydrogenase (ADH) and aldehyde dehydrogenase (ALDH). ADH is responsible for the metabolism of ethanol to acetaldehyde. ALDH catalyzes the conversion of acetaldehyde to acetate. Acetaldehyde is considered responsible for the facial flushing reactions often observed among Asians who have consumed alcohol.

WHAT ARE RISK FACTORS FOR DEVELOPMENT OF ALCOHOLISM?

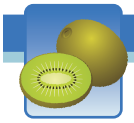
Research into the genetics of alcoholism is a relatively recent scientific endeavor. Persons who tout their ability to "hold their liquor" may in fact be predisposed to alcoholism. A study of 12- to 13-year-old adolescents supports this finding (Schuckit

and colleagues, 2005). A low response to alcohol and high rates of alcoholism have also been noted in Koreans (Duranceaux and colleagues, 2008).

Genetic and environmental factors contribute to alcohol dependence. One study found development of alcohol dependence over a 10-year period if there was a family history of alcoholism along with the motivation to drink being either to reduce negative emotions or to increase social interactions (Beseler and colleagues, 2008).

Depression and alcoholism have been connected, and both appear related to altered dopamine levels and adverse impact on neurotransmission (Joe and colleagues, 2008). Another hormone that has been associated with alcoholism is cortisol. This is a stress hormone and a marker of genetic risk for alcoholism. A review of cases of repeated convictions for driving under the influence of alcohol found lowered cortisol content of the saliva (Couture and colleagues, 2008).

Because of the concern about alcoholism, recommendations cannot be made to start drinking moderate amounts of alcohol unless it is known the person does not have alcoholic tendencies. As a better understanding of alcoholism develops, public health advice may change in the future. For now, individuals who already consume alcohol should be encouraged to drink moderate amounts for the best health outcomes.



Cultural Considerations

College athletes from Divisions I, II, and III have shown a high rate of consuming five or more drinks per occasion. This tends to be more pronounced in team sports than individual sports (Brenner and Swanik, 2007). Further, this high intake is found more frequently in college athletes than in nonathletes, and athletes have significantly more drinks per week. Drinking games facilitate excess drinking behaviors (Grossbard and colleagues, 2007). ■

WHAT IS THE ROLE OF THE NURSE OR OTHER HEALTH PROFESSIONAL IN PROMOTING POSITIVE NUTRITIONAL INTAKE AND METABOLISM?

The nurse or other health care professional in an institutional setting can indirectly promote the digestive process by providing a relaxed and unhurried atmosphere where patients can feel at ease to thoroughly chew their food. Direct intervention might include emphasizing the importance of thorough chewing.

The health care professional should be aware of possible issues of digestion such as swallowing problems and intestinal or gastric surgery and should be alert to signs of malabsorption such as chronic diarrhea and unexplained weight loss. Digestive or intestinal problems, such as chronic constipation, may also be improved with medical nutrition therapy.

The nurse and other health care professionals can have a positive role in the prevention of alcoholism by assessing family risk and helping persons suffering from alcoholism through involvement of the total health care team. (See Chapter 1 for more information on coordination of the health care team.) The planning and implementation of nutritional care must always be individualized.

Chapter Challenge Questions & Classroom Activities

1. What is the purpose of digestion?
2. What is absorption? In what part of the body does it take place?
3. In what form are all carbohydrates absorbed? All fats? All proteins?
4. Name the enzymes involved in the digestion of maltose and sucrose.
5. Why would a low-fiber rather than a high-fiber diet be helpful for someone with diverticulitis?
6. Why is a low-fat diet used to treat gallbladder disease?
7. Discuss class experiences of alcohol use and abuse on campus.

Practical Application

Trace the digestion of a meal composed of a ham sandwich on whole-wheat bread, a glass of low-fat milk, and a fresh apple. Describe the mechanical and chemical processes that occur, and name the enzymes involved.

Case Study

A.J. stopped by to visit his Nanna. He continued to worry about her with her having a colostomy after a severe bout of diverticulitis. He brought some groceries with him because he knew it was getting more difficult for her to drive to the grocery store. He had checked to make sure there were no nuts or seeds in some of the baked goods. And, of course, there were several cans of baked beans that he loved, "Grandma Brown's." He told his grandmother it was because he loved them so much, which was true, but what he didn't tell her was that he was worried about her cooking at the stove with an open flame. The canned baked beans could be heated in a microwave.

Critical Thinking Applications

1. Why shouldn't Nanna eat nuts and seeds?
2. Are there alternatives to nuts and seeds that Nanna can eat safely?
3. What are benefits of baked beans for diverticulosis?
4. What might be a concern of eating high-fiber foods with a colostomy?

REFERENCES

Allgayer H, Mainos D, Dietrich CF: 57-year-old female patient in early retirement with underweight and chronic-relapsing diarrhoea, *Z Gastroenterol* 45(2):183-186, 2007.

Bai XL, Liang TB, Wu LH, Li DL, Geng L, Wang WL, Shen Y, Zhang M, Zheng SS: Elevation of intact parathyroid hormone level is a risk factor for low bone mineral density in pretransplant patients with liver diseases, *Transplant Proc* 39(10):3182-3185, 2007.

Beseler CL, Aharonovich E, Keyes KM, Hasin DS: Adult transition from at-risk drinking to alcohol dependence: the relationship of family history and drinking motives, *Alcohol Clin Exp Res* 32(4):607-616, 2008.

Betterle C, Lazzarotto F, Spadaccino AC, Basso D, Plebani M, Pedini B, Chiarelli S, Albergoni M: Celiac disease in North Italian patients with autoimmune Addison's disease, *Eur J Endocrinol* 154(2):275-279, 2006.

Beyer PL, Caviar EM, McCallum RW: Fructose intake at current levels in the United States may cause gastrointestinal distress in normal adults, *J Am Diet Assoc* 105(10):1559-1566, 2005.

Born P, Sekatcheva M, Rösch T, Classen M: Carbohydrate malabsorption in clinical routine: a prospective observational study, *Hepatogastroenterology* 53(71):673-677, 2006.

Børsheim E, Kien CL, Pearl WM: Differential effects of dietary intake of palmitic acid and oleic acid on oxygen consumption during and after exercise, *Metabolism* 55(9):1215-1221, 2006.

Brenner J, Swanik K: High-risk drinking characteristics in collegiate athletes, *J Am Coll Health* 56(3):267-272, 2007.

Brosnan JT, Brosnan ME: Creatine: endogenous metabolite, dietary, and therapeutic supplement, *Annu Rev Nutr* 27:241-261, 2007.

Couture S, Brown TG, Ouimet MC, Gianoulakis C, Tremblay J, Carbonneau R: Hypothalamic-pituitary-adrenal axis response to stress in male DUI recidivists, *Accid Anal Prev* 40(1):246-253, 2008.

Csendes A, Burdiles P: Scientific foundations for medical treatment based on modifying diet, lifestyle habits, and patient attitudes in chronic gastroesophageal reflux disease, *Cir Esp* 81(2):64-69, 2007.

de la Cour CD, Norlén P, Håkanson R: Secretion of ghrelin from rat stomach ghrelin cells in response to local microinfusion of candidate messenger compounds: a microdialysis study, *Regul Pept* 143(1-3):118-126, 2007.

Djuric Z, Zivic S, Katic V: Celiac disease with diffuse cutaneous vitamin k-deficiency bleeding, *Adv Ther* 24(6):1286-1289, 2007.

Duranceaux NC, Schuckit MA, Luczak SE, Eng MY, Carr LG, Wall TL: Ethnic differences in level of response to alcohol between Chinese Americans and Korean Americans, *J Stud Alcohol Drugs* 69(2):227-234, 2008.

Elia M, Cummings JH: Physiological aspects of energy metabolism and gastrointestinal effects of carbohydrates, *Eur J Clin Nutr* 61(Suppl 1):S40-S74, 2007.

El-Sohemy A, Stewart L, Khataan N, Fontaine-Bisson B, Kwong P, Ozsungur S, Cornelis MC: Nutrigenomics of taste—impact on food preferences and food production, *Forum Nutr* 60:176-182, 2007.

Estívariz CF, Luo M, Umeakunne K, Bazargan N, Galloway JR, Leader LM, Ziegler TR: Nutrient intake from habitual oral diet in patients with severe short bowel syndrome living in the southeastern United States, *Nutrition* 24(4):330-339, 2008.

Friedman M, Gurpinar B, Lin HC, Schalch P, Joseph NJ: Impact of treatment of gastroesophageal reflux on obstructive sleep apnea-hypopnea syndrome, *Ann Otol Rhinol Laryngol* 116(11):805-811, 2007.

Gass J, Bethune MT, Siegel M, Spencer A, Khosla C: Combination enzyme therapy for gastric digestion of dietary gluten in patients with celiac sprue, *Gastroenterology* 133(2):472-480, 2007.

Grabenhorst F, Rolls ET, Bilderbeck A: How cognition modulates affective responses to taste and flavor: top-down influences on the orbitofrontal and pregenual cingulate cortices, *Cereb Cortex*18(7):1549-1559, 2008.

Grossbard J, Geisner IM, Neighbors C, Kilmer JR, Larimer ME: Are drinking games sports? College athlete participation in drinking games and alcohol-related problems, *J Stud Alcohol Drugs* 68(1):97-105, 2007.

Guenthner CJ, McCaughey SA, Tordoff MG, Baird JP: Licking for taste solutions by potassium-deprived rats: specificity and mechanisms, *Physiol Behav* 93(4-5):937-946, 2008.

Harder J, Mikesch K, Mohr L, Blum HE: Seizures following Billroth II gastrectomy, *Dtsch Med Wochenschr* 130(11):574-576, 2005.

Joe KH, Kim DJ, Park BL, Yoon S, Lee HK, Kim TS, Cheon YH, Gwon DH, Cho SN, Lee HW, Namgung S, Shin HD: Genetic association of DRD2 polymorphisms with anxiety scores among alcohol-dependent patients, *Biochem Biophys Res Commun* 371(4):591-595, 2008.

Kaltenbach T, Crockett S, Gerson LB: Are lifestyle measures effective in patients with gastroesophageal reflux disease? An evidence-based approach, *Arch Intern Med* 166(9):965-971, 2006.

Kennedy R, Hunt S, Ahmad J, Menezes C, Clements WB, Kennedy JA: Wernicke's encephalopathy after laparoscopic cardiomyotomy for achalasia, *JPEN J Parenter Enteral Nutr* 31(4):324-325, 2007.

Keskitalo K, Tuorila H, Spector TD, Cherkas LF, Knaapila A, Silventoinen K, Perola M: Same genetic components underlie different measures of sweet taste preference, *Am J Clin Nutr* 86(6):1663-1669, 2007.

Khodadadi I, Griffin B, Thumser A: Differential effects of long-chain fatty acids and clofibrate on gene expression profiles in cardiomyocytes, *Arch Iran Med* 11(1):42-49, 2008.

Laitinen K, Kalliomäki M, Poussa T, Lagström H, Isolauri E: Evaluation of diet and growth in children with and without atopic eczema: follow-up study from birth to 4 years, *Br J Nutr* 94(4):565-574, 2005.

Lee SY, Oh S, Lee K, Jang YJ, Sohn MH, Lee KE, Kim KE: Murine model of buckwheat allergy by intragastric sensitization with fresh buckwheat flour extract, *J Korean Med Sci* 20(4):566-572, 2005.

Lovik M: Mustard—an important food allergen? *Tidsskr Nor Laegeforen* 125(6):736-738, 2005.

Maloney JM, Chapman MD, Sicherer SH: Peanut allergen exposure through saliva: assessment and interventions to reduce exposure, *J Allergy Clin Immunol* 118(3):719-724, 2006.

Mennella JA, Pepino MY, Reed DR: Genetic and environmental determinants of bitter perception and sweet preferences, *Pediatrics* 115(2):e216-e222, 2005.

National Institutes of Health, Consensus Development Conference on Celiac Disease, June 28-30, 2004. Retrieved April 5, 2008, from http://consensus.nih.gov/2004/2004CeliacDisease118html.htm.

Nofrarías M, Martínez-Puig D, Pujols J, Majó N, Pérez JF: Long-term intake of resistant starch improves colonic mucosal integrity and reduces gut apoptosis and blood immune cells, *Nutrition* 23(11-12):861-870, 2007.

Norenberg MD, Rao KV: The mitochondrial permeability transition in neurologic disease, *Neurochem Int* 50(7-8):983-997, 2007.

Nucera G, Gabrielli M, Lupascu A, Lauritano EC, Santoliquido A, Cremonini F, Cammarota G, Tondi P, Pola P, Gasbarrini G, Gasbarrini A: Abnormal breath tests to lactose, fructose and sorbitol in irritable bowel syndrome may be explained by small intestinal bacterial overgrowth. *Aliment Pharmacol Ther* 21(11):1391-1395, 2005.

Osborn DA, Sinn JK: Probiotics in infants for prevention of allergic disease and food hypersensitivity, *Cochrane Database Syst Rev* (4):CD006475, 2007.

Perry TT, Conover-Walker MK, Pomés A, Chapman MD, Wood RA: Distribution of peanut allergen in the environment, *J Allergy Clin Immunol* 113(5):973-976, 2004.

Pozzato C, Curti A, Radaelli G, Fiori L, Rossi S, Riva E, Cornalba G: Abdominal ultrasonography in inherited diseases of carbohydrate metabolism, *Radiol Med* 109(1-2): 139-147, 2005.

Ramakers JD, Mensink RP, Schaart G, Plat J: Arachidonic acid but not eicosapentaenoic acid (EPA) and oleic acid activates NF-κB and elevates ICAM-1 expression in Caco-2 cells, *Lipids* 42(8):687-698, 2007.

Ravelli A, Bolognini S, Gambarotti M, Villanacci V: Variability of histologic lesions in relation to biopsy site in gluten-sensitive enteropathy, *Am J Gastroenterol* 100(1):177-185, 2005.

Rinella ME, Elias MS, Smolak RR, Fu T, Borensztajn J, Green RM: Mechanisms of steatohepatitis in mice fed a lipogenic methionine choline deficient (MCD) diet, *J Lipid Res* 49(5):1068-1076, 2008.

Rolls ET: Brain mechanisms underlying flavour and appetite, *Philos Trans R Soc Lond B Biol Sci* 361(1471):1123-1136, 2006.

Said HM, Mohammed ZM: Intestinal absorption of water-soluble vitamins: an update. *Curr Opin Gastroenterol* 22(2):140-146, 2006.

Salmi TT, Collin P, Järvinen O, Haimila K, Partanen J, Laurila K, Korponay-Szabo IR, Huhtala H, Reunala T, Mäki M, Kaukinen K: Immunoglobulin A autoantibodies against transglutaminase 2 in the small intestinal mucosa predict forthcoming coeliac disease, *Aliment Pharmacol Ther* 24(3):541-552, 2006.

Salyers WJ Jr, Mansour A, El-Haddad B, Golbeck AL, Kallail KJ: Lifestyle modification counseling in patients with gastroesophageal reflux disease. *Gastroenterol Nurs* 30(4):302-304, 2007.

Scholten P, van Leerdam ME, Kuipers EJ: Chronic diarrhoea: the importance of an accurate medical history, *Ned Tijdschr Geneeskd* 150(8):405-408, 2006.

Schuckit MA, Smith TL, Beltran I, Waylen A, Horwood J, Davis JM; The ALSPAC Study Team: Performance of a self-report measure of the level of response to alcohol in 12- to 13-year-old adolescents, *J Stud Alcohol* 66(4):452-458, 2005.

Schulte-Frohlinde E, Wagenpfeil S, Willis J, Lersch C, Eckel F, Schmid R, Schusdziarra V: Role of meal carbohydrate content for the imbalance of plasma amino acids in patients with liver cirrhosis, *J Gastroenterol Hepatol* 22(8):1241-1248, 2007.

Shah E, Pongracic J: Food-induced anaphylaxis: who, what, why, and where? *Pediatr Ann* 37(8):536-541, 2008.

Uchiyama K, Kawai M, Tani M, Terasawa H, Tanimura H, Yamaue H: Pathogenesis of hepatolithiasis based on the analysis of components of intrahepatic stones. *Hepatogastroenterology* 54(78):1798-1804, 2007.

Varea V, de Carpi JM, Puig C, Alda JA, Camacho E, Ormazabal A, Artuch R, Gómez L: Malabsorption of carbohydrates and depression in children and adolescents, *J Pediatr Gastroenterol Nutr* 40(5):561-565, 2005.

Villalba JJ, Provenza FD, Hall JO: Learned appetites for calcium, phosphorus, and sodium in sheep, *J Anim Sci* 86(3):738-747, 2008.

Villalba JJ, Provenza FD, Hall JO, Peterson C: Phosphorus appetite in sheep: dissociating taste from postingestive effects, *J Anim Sci* 84(8):2213-2223, 2006.

Volkow ND, Wang GJ, Franceschi D, Fowler JS, Thanos PP, Maynard L, Gatley SJ, Wong C, Veech RL, Kunos G, Kai Li T: Low doses of alcohol substantially decrease glucose metabolism in the human brain, *Neuroimage* 29(1):295-301, 2006.

Whiting CV, Bland PW, Tarlton JF: Dietary n-3 polyunsaturated fatty acids reduce disease and colonic proinflammatory cytokines in a mouse model of colitis, *Inflamm Bowel Dis* 11(4):340-349, 2005.

Zeviani M, Carelli V: Mitochondrial disorders, *Curr Opin Neurol* 20(5):564-571, 2007.

chapter 5

Insulin Resistance and the Metabolic Syndrome

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Chapter Topics

Insulin Resistance and the Metabolic Syndrome
The Role of Hyperinsulinemia in the Metabolic Syndrome
Risk Factors, Prevention, and Management of the Metabolic Syndrome
Causes and Management of Gout
Causes and Management of the Polycystic Ovary Syndrome
The Role of the Nurse or Other Health Care Professional in Prevention and Management of the Metabolic Syndrome

Objectives

After completing this chapter, you should be able to:

- Describe the metabolic syndrome.
- Identify individuals at risk for the metabolic syndrome.
- Recognize an appropriate lifestyle plan for preventing and managing insulin resistance.
- Explain the application of the Dietary Guidelines in managing insulin resistance.

Terms to Identify

Acanthosis nigricans
Alanine transaminase (ALT)
Androgen
Central obesity
C-peptide
C-reactive protein (CRP)
Cutaneous papillomas
Dyslipidemia
Endothelial
Ferritin
Glucagon
Glucose intolerance
Gout
Hirsutism
Hyperglycemia
Hyperinsulinemia
Hypertension
Hypoglycemia
Impaired fasting glucose
Impaired glucose tolerance
Insulin resistance
Lipoprotein lipase
Metabolic obesity
Metabolic syndrome
Nitric oxide
Nonalcoholic fatty liver disease (NAFLD)
Polycystic ovary syndrome (PCOS)
Postprandial
Prediabetes
Purine
Reactive hypoglycemia
Steatosis
Thrifty gene

INTRODUCTION

It has been about 15 years since the metabolic syndrome received official recognition. It was considered a theory before then. The **metabolic syndrome**, also known as the insulin resistance syndrome, was initially called Syndrome X by Gerald Reaven in 1988 with insulin resistance as the common denominator.

Obesity, associated with the metabolic syndrome, is now an epidemic throughout the world. The medical community faces an emerging epidemic of health problems found with the metabolic syndrome, including type 2 diabetes developing among children and adolescents and early cardiovascular morbidity and mortality. In a group of obese children, 40% were found to have hyperinsulinemia (see below), and over 10% had **impaired glucose tolerance** (elevated blood glucose level) based on an oral glucose tolerance test. The metabolic syndrome was found in 30% of children under 12 years of age (Viner and colleagues, 2005).

An estimated 41 million individuals in the United States have **prediabetes** (high levels of blood glucose, but not in the diabetes range [see Chapter 8], a risk factor found with the metabolic syndrome). About one third of persons with insulin resistance go on to develop type 2 diabetes. The World Health Organization (WHO) has estimated that there will be around 300 million persons with diabetes by 2025. It is anticipated that Asia will be at the forefront of high rates of diabetes in years to come because of a genetic tendency for insulin resistance along with changing lifestyles. One study found Chinese adolescents currently have metabolic syndrome at a rate of less than half of the estimated 10% of U.S. adolescents. However, among overweight Chinese adolescents living in the United States the rate of insulin resistance is the same (Li and colleagues, 2008). The rate of insulin resistance in some populations is as high as 60% but is generally lower in the United States at large, with an estimated 25% of the population with insulin resistance.

Insulin resistance is sometimes referred to as the common gene theory. This is because it is the underlying cause of many chronic health problems. Costs associated with the metabolic syndrome run into billions of dollars to the U.S. economy in lost work hours alone (Sullivan and colleagues, 2007).

This chapter provides an overview of the metabolic syndrome. Other chapters in Section Two expand on the specific health problems associated with this syndrome, including central obesity, coronary heart disease, and diabetes, with the resulting adverse effects on the kidneys. Research is expanding on other health conditions associated with the metabolic syndrome, such as certain forms of cancer. As this section points out, the health problems associated with insulin resistance are mainly realized through environmental factors, with diet playing a large role.

WHAT IS THE METABOLIC SYNDROME?

Insulin resistance describes a condition in which the body cells resist the action of insulin, leading to poor use of blood glucose and altered metabolism of lipids at the cellular level. Insulin resistance generally results in increased production of insulin in the body's attempt to override the resistance at the cell level. This is referred to as **hyperinsulinemia** (excess insulin in the blood). Various causes have been suggested, from hormonal and enzymatic factors to issues of inflammation, fluidity of

cell membranes, and problems with cellular structures such as mitochondrial dysfunction. It is now well recognized that lifestyle and diet exert their influence on individuals with a genetic tendency toward insulin resistance. Obesity and lack of physical activity are known to worsen the genetic predisposition to insulin resistance.

The **metabolic syndrome** is related to insulin resistance. As a syndrome there must be at least three factors present. The primary factors found with the metabolic syndrome are the following:

1. **Central obesity** (waist size equivalent to greater than 40 inches in men; greater than 35 inches in women)
2. **Hypertension** (high blood pressure)
3. **Dyslipidemia** (altered blood lipids with high levels of triglycerides and low levels of high-density lipoprotein (HDL) cholesterol; see also Chapter 7)

There are several definitions, and health conditions, used to diagnose the metabolic syndrome, the differences being primarily for accurate reporting of research outcomes. It has been suggested the term be applied to persons without type 2 diabetes or cardiovascular disease with the goal to prevent these conditions. The metabolic syndrome can be a better predictor of future diabetes than fasting blood glucose (FBG) levels alone (Lorenzo and colleagues, 2007). The National Cholesterol Education Program's (NCEP's) Adult Treatment Panel (ATP) III definition of metabolic syndrome uses the easily measured clinical finding of increased waist size. Similar criteria of the ATP III guidelines are used by the American Association of Clinical Endocrinologists (see below). The 2005 International Diabetes Federation (IDF) definition of the metabolic syndrome was designed to be useful worldwide. It is similar to the definition of the NCEP. WHO has another, but similar, definition. Four primary elements identified by the IDF are as follows:

- Central obesity
- Dyslipidemia
- Hypertension
- **Glucose intolerance** (fasting glycemia greater than or equal to 5.6 mmol/L; greater than 100 mg/dL)

The American Association of Clinical Endocrinologists uses the following risk factors for diagnosing the metabolic syndrome, with three factors required:

- Obesity or overweight body mass index (BMI) greater than 25 (the BMI is a mathematical formula used to describe level of body fatness; especially with central obesity or **metabolic obesity**—carrying weight in the abdomen; see measurements above or having a high waist-to-hip ratio; see Chapter 6 for use of BMI)
- Elevated triglycerides: 150 mg/dL (1.69 mmol/L)
- Low HDL cholesterol:
  - Men less than 40 mg/dL (1.04 mmol/L)
  - Women less than 50 mg/dL (1.29 mmol/L)
- Elevated blood pressure greater than or equal to 130/85 mm Hg
- 2-hour postglucose challenge greater than 140 mg/dL to 199 mg/dL (prediabetes)
- Fasting glucose between 110 and 126 mg/dL (6.15 and 7.05 mmol/L; prediabetes)

Other risk factors:

- Family history of type 2 diabetes, hypertension, or cardiovascular disease (CVD)
- Polycystic ovary syndrome (PCOS) —see section later in this chapter
- Sedentary lifestyle
- Advancing age
- Ethnic groups having high risk for type 2 diabetes or CVD

Diagnosis depends on clinical judgment of a health provider based on risk factors.

Medical diagnosis with high fasting levels of glucose is referred to as **impaired fasting glucose.** A person with normal fasting glucose levels but elevated postprandial glucose level is referred to as having impaired glucose tolerance.

Other conditions are being attributed in some manner to the metabolic syndrome. Increased inflammation as evidenced by elevated levels of the laboratory value high-sensitivity **C-reactive protein (CRP)** is found with the metabolic syndrome. In obese children and adolescents elevated CRP appears related to the cause of diabetes development (Yang and colleagues, 2006).

Another laboratory value that may be used in diagnosing insulin resistance is to measure the level of hyperinsulinemia present. This can be determined with a high level of insulin production in relation to FBG level (FBG/insulin ratio less than 7). Fasting insulin level was found to be the best predictor of the metabolic syndrome among a study of European and African women, although for other conditions found with the metabolic syndrome dyslipidemia was more associated with European heritage and hypertension with African heritage (Gower and colleagues, 2007). An indirect measure of insulin production is **C-peptide** level.

Acanthosis nigricans is a skin condition with dark patches that is related to diabetes (see Figure 5-1, *A,* and Chapter 8). **Cutaneous papillomas,** or "skin tags," are also found with insulin resistance and type 2 diabetes (Figure 5-1, *B*). This is due to hormonal changes found with the metabolic syndrome. A decreased plasma level of the hormone adiponectin was found associated with insulin resistance in nondiabetic relatives of an African American family with a strong family history of diabetes (Osei, Gaillard, and Schuster, 2005).

Nerve disease is known to occur with uncontrolled diabetes. It appears there is an increased risk of nerve disease even without diabetes, but with low levels of HDL-C. This has been noted as a form of neuropathy with reduced length of dendrite nerve fibers (Pittenger and colleagues, 2005).

Mild and moderate renal insufficiency (see Chapter 9) is relatively common in the United States. Chronic renal insufficiency is now considered a public health priority, and the number of components of the metabolic syndrome is proportional to the prevalence of chronic renal insufficiency (Zoccali, Caridi, and Cambareri, 2007).

Increased rates of depression have long been known among persons with diabetes. Newer evidence is linking increased inflammation, as found with the metabolic syndrome, with depression. It appears there is a changed metabolism of the amino acid tryptophan related to altered enzyme functioning, resulting in less serotonin production. This altered metabolism of tryptophan seems to be the cause of major depression, postnatal depression, and anxiety states commonly found with conditions associated with the metabolic syndrome (Maes and colleagues, 2007).

FIGURE 5-1 **A,** Acanthosis nigricans causes dark patches to occur on the skin, often in the underarm area as shown, or on the neck. **B,** Cutaneous papillomas, or "skin tags," are also commonly found with insulin resistance and diabetes.

A study of persons with Meniere's disease found the majority had hyperinsulinemia. It is suggested a 5-hour glucose tolerance test using 100-g glucose load and insulin levels be routinely included when investigating Meniere's disease (D'Avila and Lavinsky, 2005).

Certain cancers have been associated with the metabolic syndrome. Known cancers related to the metabolic syndrome include cancers of the breast, pancreas, liver, and colon and uterine (endometrial) cancer. Newer research has linked prostate and ovarian cancers with the metabolic syndrome (see Chapter 10).

Another health problem that has been connected with the metabolic syndrome and insulin resistance includes **nonalcoholic fatty liver disease (NAFLD)**—a condition of fat buildup in the liver (Brea and colleagues, 2005). This is a major form of chronic liver disease in adults and children. It is one of the consequences of the current obesity epidemic and can progress to nonalcoholic steatohepatitis (NASH), characterized by **steatosis** (fatty degeneration), inflammation, and progressive fibrosis, ultimately leading to cirrhosis and end-stage liver disease. The factors implicated in this progression are poorly understood. NASH is closely associated with obesity

and the metabolic syndrome. An elevated liver enzyme, **alanine transaminase (ALT)** (a marker of NAFLD), was observed in about 5% of adolescents of African heritage, in over 7% of white adolescents, and in 11% of Mexican American adolescents. Males had the highest levels, at over 12%, with females at 3.5%. A high waist circumference, evidence of inflammation, and high triglyceride levels were associated. Screening for NAFLD is advised for adolescents exhibiting evidence of the metabolic syndrome (Fraser and colleagues, 2007).

WHAT IS THE ROLE OF HYPERINSULINEMIA IN THE METABOLIC SYNDROME?

REACTIVE HYPOGLYCEMIA

A person with a genetic predisposition to insulin resistance tends to have an altered insulin response. With insulin resistance there is often a delayed production of meal-related insulin. This can result in a transient state of **hyperglycemia** (high levels of blood glucose). When the body does respond to the hyperglycemia, it is often with excess insulin production over a prolonged period. Persons with insulin resistance have been noted to produce up to 10 times the amount of insulin to control blood glucose levels as compared with other insulin-sensitive individuals. This hyperinsulinemia can result in symptoms of **hypoglycemia** (low levels of blood glucose; see Chapter 8) if meals are delayed.

The symptoms of **reactive hypoglycemia** are common among persons with insulin resistance, but medically the condition is rarely diagnosed. The blood glucose criteria for diagnosis of reactive hypoglycemia are more stringent than for persons with diabetes on medication. Physicians generally will not make the diagnosis unless blood glucose levels are below 50 mg/dL. Symptoms of hypoglycemia, however, may occur years before the onset of diabetes and are likely because of hyperinsulinemia and excess release of counterregulatory hormones (see Chapter 4).

Counterregulatory hormones correct hypoglycemia by causing the liver to release its stored sugar, called glycogen. The symptoms that occur because of these hormones, however, can be unpleasant. Altered **glucagon** (a counterregulatory hormone that is the first one produced in response to low levels of blood glucose) secretion has been noted in reactive hypoglycemia. Glucagon in excess leads to feelings of nausea. Glucagon release is inhibited with hyperinsulinemia. It may be for this reason that persons with insulin resistance experience the symptoms of hypoglycemia as the body needs to release other counterregulatory hormones such as adrenalin (epinephrine). Adrenalin causes an increased heart rate and physical tremors, which is an unpleasant and potentially frightening experience if the person has not associated it with the need to eat a carbohydrate source.

The symptoms of hypoglycemia affect the quality of life. However, most persons with hypoglycemia symptoms are not in an immediate health emergency. Severe hypoglycemia requiring medical assistance is usually limited to persons taking insulin or insulin-stimulating medications such as the sulfonylurea medications (see Chapter 8).

OBESITY

Hyperinsulinemia is found with central obesity. It is still, however, a bit of a chicken-and-egg question. Which came first? Hyperinsulinemia and central obesity

FIGURE 5-2 Recreated blood sample with triglyceride level greater than 8000 mg/dL showing separation of blood and fat.

are known to worsen insulin resistance. However, it may be that the genetic predisposition to insulin resistance is what first sets up excess production of insulin in relation to carbohydrate intake. Some health care professionals suggest that hyperinsulinemia encourages the gain of abdominal weight in the first place. This is the basis of the low-carbohydrate diets (see Chapter 6).

With regard to dyslipidemia (see Chapter 7), it has been clearly shown that the enzyme **lipoprotein lipase** (an enzyme that helps the breakdown of triglycerides) is altered in the presence of hyperinsulinemia. This results in reduced breakdown of triglycerides, leading to high serum triglyceride levels. Thus elevated triglyceride levels in the blood are generally associated with hyperinsulinemia, especially if the person also has central obesity. This occurs even in childhood, with triglyceride levels correlating with insulin levels in children (Reinehr, Kiess, and Andler, 2005). Triglycerides can reach very high levels. Once the level is over 3000 mg/dL, distinct visual demarcation can be found between the red blood and the white fat in the blood (Figure 5-2).

Reduction of hyperinsulinemia generally improves dyslipidemia. It may be helpful for persons with type 2 diabetes and CVD to understand the common connections of insulin resistance and hyperinsulinemia. Because atherosclerosis (see Chapter 7) generally is noted before the diagnosis of diabetes, it is believed that hyperinsulinemia related to insulin resistance promotes the plaque buildup.

HYPERTENSION

Hypertension is now a well-recognized aspect of insulin resistance and the metabolic syndrome. There are still unanswered questions regarding the specific mechanism related to hypertension and the underlying cause of insulin resistance. The role of

FIGURE 5-3 Hypertension is commonly found with excess abdominal weight.

hyperinsulinemia is being suggested as the link, as a result of altered vasodilation. In a study of rats it was found acute hyperglycemia and hyperinsulinemia caused constriction of blood vessels that may be related to hypertension (Zamami and colleagues, 2008). Advice to follow a low-glycemic index diet may contribute to management of hypertension (Kopp, 2005). A person with central obesity and hypertension likely has insulin resistance (Figure 5-3).

WHAT ARE THE RISK FACTORS FOR INSULIN RESISTANCE AND HOW CAN IT BE PREVENTED AND MANAGED?

The Pima Indians of Arizona are the classic example of why it is believed genetic predisposition and environmental conditions allow for the development of the metabolic syndrome. The Pima Indians in the southwestern United States have the highest reported occurrence of obesity and type 2 diabetes mellitus in the world. This situation developed only about 100 years ago with the abrupt changes in lifestyle accompanying the rerouting of the Gila River to provide irrigation waters for California. Because these Pimas could no longer grow their own foods and their activity levels went down, their lifestyles and dietary intake drastically changed. This has resulted in an epidemic of obesity and diabetes. However, this is in contrast to the low rates of obesity and diabetes among the Pimas living in Mexico (Valencia and colleagues, 2005). The lower rate of diabetes among the Mexican Pimas is attributed to their higher physical activity levels and maintenance of a more traditional diet that emphasizes high-fiber foods and low reliance on meat and processed foods.

Teaching Pearl

Before restaurants, corner grocery stores, refrigeration, and transportation, populations that endured famine conditions generation after generation either survived or did not survive. This is referred to as the **thrifty gene** and is a positive thing during times of famine because weight loss does not easily occur (see Chapter 6). It is not so positive in times of plenty when it is easy to gain weight. This is believed to be the basis of the genetic tendency for the metabolic syndrome. ■

There is evidence that the risk of the metabolic syndrome may be set in utero. Large babies who were exposed prenatally to their mothers' gestational diabetes (see Chapters 8 and 11) or obesity have been noted to be at increased risk for developing the metabolic syndrome in later childhood (Boney and colleagues, 2005). Excess kilocalorie intake during pregnancy is suspected to predispose the infant to later development of the metabolic syndrome (Armitage and colleagues, 2005). Therefore counseling women during pregnancy to avoid excess weight gain and screening for gestational diabetes with appropriate management may help reduce the rate of diabetes for future generations. See Chapter 11 for pregnancy guidelines.

On the other hand, low birth weight also is associated with later development of the metabolic syndrome. This may be due to lack of nutrients prenatally, leading to altered development of insulin-sensitive tissues and the pancreas, where insulin is produced. Thus optimal nutrient delivery and weight gain during pregnancy with avoidance of excess or deficiency of intake appears to best prevent the metabolic syndrome.

Lifestyle beyond reduced physical activity has also been implicated. It has been found that current smokers who smoke more than or equal to 20 pack-years have a significantly increased risk of developing metabolic syndrome, high triglyceride level, and low HDL-C level. Smoking cessation is beneficial in reducing insulin resistance (Chen and colleagues, 2008).

HIGH-RISK POPULATIONS

Genetically, certain population groups are known to have high rates of insulin resistance. Native Americans, in general, have a high prevalence of type 2 diabetes.

A study of self-identified younger Native American women who did not have diabetes observed about one in four had the metabolic syndrome and one in five had prediabetes. Excess body weight and a family history of type 2 diabetes were significantly associated with having the metabolic syndrome. Older age, reduced levels of HDL cholesterol, and low cardiorespiratory fitness were also associated with the diagnosis of prediabetes (Thompson and colleagues, 2007).

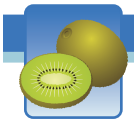
Persons of Asian heritage have been identified as being at high risk for insulin resistance and the development of diabetes. Asian populations may become more susceptible to the metabolic syndrome as a Western diet and lifestyle are adopted. WHO Expert Consultation has advised a BMI (see Chapter 6) of 22 to 25 among the Asian population to reduce the adverse health outcomes of the metabolic syndrome (Rakugi and Ogihara, 2005). Among a group of Japanese women it was found both

glycemic index and glycemic load, with a usual meal intake emphasizing white rice, is associated with the metabolic syndrome (Murakami and colleagues, 2006). On the other hand, a high intake of dietary fiber is associated with lower body weight among Japanese women (Murakami and colleagues, 2007). Research indicates a lower waist measurement is optimal for persons of Japanese heritage (equivalent to less than 33 inches for men and less than 31 inches for women). For shorter-statured persons of Japanese heritage, an alternative measure of risk is a waist-to-height ratio. One equation is waist (cm) × 100/height (cm) for the goal of less than 51 for men and less than 52 for women (Shimajiri and colleagues, 2008).

In a study of Asian Indians in the United States, BMI less than 25 was associated with absence of all risk factors for the metabolic syndrome. At the overweight range of BMI greater than 25, but without obesity (see Chapter 6), prevalence of the metabolic syndrome was about 34% (Misra, Endemann, and Ayer, 2006).

South Pacific Islanders also are at high risk for insulin resistance. Other known groups with high rates of the insulin resistance syndrome include persons of African and Spanish (i.e., Hispanic and Latino) heritage. A study of Mexican Americans found a family history of diabetes most strongly associated with individual traits of hyperglycemia and low HDL-C (Nelson and colleagues, 2007).

Although there is a general trend for higher rates of insulin resistance among persons with a heritage from regions nearer the equator, there are exceptions to this because insulin resistance is known to occur in all ethnic groups. In a study of Norwegians the frequency of having the metabolic syndrome was found to increase from about 10% in young adults to over half in adults 60 years of age and older (Hildrum and colleagues, 2007). In a study of French families the metabolic syndrome also was found to increase with age (Maumus and colleagues, 2005).



Cultural Considerations

Native Hawaiians have been advocating a return to more traditional diets and lifestyles. This is a result, in part, of the recognition of a high prevalence of chronic illnesses, including diabetes, obesity, hypertension, heart disease, and cancer. Family is very important to native Hawaiians, along with respect for one's ancestors. As part of this, traditional foods are viewed with respect. Arguments or negative comments about traditional foods, such as poi, are frowned on as being disrespectful to ancestors. Attempts to improve the health of native Hawaiians is best done from a family perspective, rather than an individual one, and should include exercise, cooking, and eating together. ■

PREVENTION OF THE METABOLIC SYNDROME

Even though there may be an increased genetic risk for insulin resistance and the development of the metabolic syndrome, there are ways to minimize this. Lifestyle changes have shown prevention of diabetes by over 40% among persons with prediabetes (Orchard and colleagues, 2005). One study found that individuals who increased their level of physical activity were about 65% less likely to develop diabetes (Laaksonen and colleagues, 2005). Individuals are advised to include at least

150 minutes of physical activity per week to reduce the risk of developing the metabolic syndrome (Ford and colleagues, 2005).

Encouraging adolescents to increase their physical activity is particularly important given the the lure of indoor sedentary activities. Among U.S. adolescents providing self-reports, combined use of television, computer, and video games increased the risk of metabolic syndrome in a dose-dependent manner (Mark and Janssen, 2008). The prevalence of metabolic syndrome in adolescents has nearly doubled over the last decade (Jolliffe and Janssen, 2007).

Another lifestyle factor associated with the metabolic syndrome is lack of sleep. Sleep deprivation decreases insulin sensitivity through hormonal changes such as increased cortisol levels (González-Ortiz and Martínez-Abundis, 2005). Adults who sleep only 5 to 6 hours are more likely to be overweight or obese, and the cause appears related to reduced levels of the hormone leptin in relation to the level of body fat. A regular sleep habit of about 8 hours is advised to help in weight management (Chaput and colleagues, 2007).

Following the 2005 Dietary Guidelines for Americans has been related to reduced prevalence of the metabolic syndrome (Fogli-Cawley and colleagues, 2007). This includes limiting saturated and trans fat intake in particular, while increasing high-fiber foods and decreasing intake of excess sugars, including fruit juices, and increasing physical activity. Good fluid intake can also be beneficial by allowing optimal cellular function.

MANAGEMENT STRATEGIES

Macronutrients

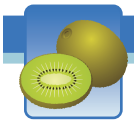
Controversy continues about the optimal diet composition of macronutrients for management of the metabolic syndrome. It has been noted that a higher-carbohydrate diet raises triglyceride levels significantly, whereas the monounsaturated fats help lower triglyceride levels. The higher-carbohydrate diet can adversely lower HDL cholesterol more than the higher intake of fats via monounsaturated form. This finding was also found with individuals without insulin resistance (Berglund and colleagues, 2007).

The consensus continues to build toward a higher amount of total fat in the diet, with the American Heart Association advocating 35% kcalories from fat with the emphasis on monounsaturated fats (see discussion of the Therapeutic Lifestyle Changes diet in Chapter 7). The high–monounsaturated fat diet with olive oil was shown to be more beneficial than carbohydrates in reducing insulin resistance as evidenced by lowered **postprandial** (after meal) insulin and blood glucose levels and improved HDL cholesterol level (Paniagua and colleagues, 2007).

All experts in the field support reduction in intake of saturated fat, trans fats, and polyunsaturated fats. Persons with insulin resistance or diabetes are especially adversely affected by trans fatty acids (Risérus, 2006). In a study of men and women who were participants in the Framingham Heart Study, higher intake of polyunsaturated fats of the n-6 form increased triglyceride levels and decreased the size of low-density lipoprotein (LDL) cholesterol remnants, which are associated with increased risk of heart disease (see Chapter 7) (Lai and colleagues, 2006).

Although total carbohydrate intake needs to be moderated in managing the metabolic syndrome, including whole grains in a low-kcalorie diet has shown to produce greater loss of abdominal fat and reduced inflammation among obese adults with the metabolic syndrome than for those who simply reduced kcalorie intake (Katcher and colleagues, 2008). High–glycemic index choices are the primary form of carbohydrate to limit. Consumption of one or more soft drinks per day has been associated with increased likelihood of developing metabolic syndrome (Dhingra and colleagues, 2007). Avoiding excess intake of high-fructose corn syrup as found in commercially sweetened drinks and other products can help control triglyceride levels (Basciano, Federico, and Adeli, 2005). Excess sucrose in the diet has been linked with the development of insulin resistance (Chaudhary, Boparai, and Bansal, 2007). Aiming for six low–glycemic load meals daily to lower insulin release is advised.

Optimal intake of protein continues to be debated. A higher intake of protein within a low kcalorie diet, especially with an exercise regimen, has been shown to improve LDL cholesterol and triglycerides better than a low-fat, high-carbohydrate diet. The effect was most evident with a ratio greater than or equal to 1.5:1 carbohydrate to protein intake (Meckling and Sherfey, 2007). Before advocating high protein intake it is advised to verify renal function. A person with impaired kidney function is at increased risk of harm with high-protein diets. Kidney stones have also been associated with high intake of animal protein sources (see Chapter 9).



Cultural Considerations

Following traditional ethnic diets to achieve the goal of optimal health is supported by *The Genetics of Coronary Artery Disease in Alaska Natives (GOCADAN)* study. Consumption of omega-3 fatty acids from fish and sea mammals (e.g., seals and whales) was found related to lower blood pressure, reduced dyslipidemia with lower triglyceride levels and higher HDL cholesterol levels, glucose tolerance, and lower fasting insulin level. Saturated fat led to increased triglyceride levels and, along with trans fats, was found to be associated with higher blood pressure (Ebbesson and colleagues, 2007). ■

Vitamins and Minerals

Including high-fiber foods as advised by the 2005 Dietary Guidelines and the MyPyramid may help control insulin resistance because of the variety of trace minerals bound up with the fiber. A number of minerals have been implicated in insulin resistance. Among persons with diabetes altered levels of copper have been noted (Aguilar and colleagues, 2007).

Magnesium has received a lot of attention for its role in the metabolic syndrome. Hyperinsulinemia, as generally found with insulin resistance, promotes excess loss of magnesium. Severe magnesium deficiency has been shown to cause a clinical inflammatory syndrome that can be controlled by increasing intake of magnesium (Rayssiguier and Mazur, 2005). As dietary magnesium intake decreases, there is an increased prevalence of the metabolic syndrome (Ford and colleagues, 2007; Long-

street and colleagues, 2007). This is likely due to altered function of metabolic enzymes at the cellular level along with increased inflammation.

There is some evidence suggesting that magnesium intake from food (dark green leafy vegetables, legumes, whole grains, milk, and fish) is more associated with normal blood pressure than magnesium obtained via supplements and that magnesium promotes weight loss (Champagne, 2008). Potassium also is important in the control of blood pressure. The Dietary Approaches to Stop Hypertension (DASH) diet (see Chapter 7) promotes increased intake of fruits, vegetables, and dairy for the benefit of potassium, magnesium, and calcium in managing blood pressure. Avoiding processed foods high in sodium further helps to control blood pressure.

Vitamin levels also have been implicated. Obese children and adolescents with low vitamin D status appear to be at increased risk of developing impaired glucose metabolism regardless of body weight (Alemzadeh and colleagues, 2008).

Oxidative damage to mitochondrial DNA may be linked to the development of insulin resistance. Appropriate intake of vitamin C foods and other antioxidant sources such as nuts with vitamin E can be beneficial in this regard.

High levels of iron as noted with elevated serum **ferritin** (the storage form of iron) have been implicated in inflammation and the metabolic syndrome. Moderately elevated serum ferritin levels are not associated (Ryu and colleagues, 2008).

MEDICATION ISSUES

There are multiple factors that can influence risk for the metabolic syndrome. It has been noted that persons with schizophrenia who take the medications clozapine or olanzapine are at increased risk for insulin resistance and should be monitored (Henderson and colleagues, 2005). Thiazide medications are often used to treat hypertension but can worsen insulin resistance as a result of depletion of potassium levels (Reungjui and colleagues, 2007).

Medications that serve a positive role include insulin sensitizers such as metformin, sold under the brand name of Glucophage. For PCOS, medications to reduce **androgen** (male type of hormones) levels in combination with provision of estrogen can restore regular menstrual cycles and reduce acne and hirsutism found with this syndrome (Homburg, 2005).

Other medications exist to control insulin resistance, and more are expected to be developed. The insulin-sensitizing medication rosiglitazone was studied with severely insulin-resistant obese women who had PCOS. It was found that this medication improved insulin resistance and glucose tolerance, decreased ovarian androgen production, normalized insulin levels, and helped restore spontaneous ovulation (Sepilian and Nagamani, 2005).

WHAT IS GOUT AND WHAT ARE ITS RISK FACTORS AND MANAGEMENT?

Gout is the medical condition related to high levels of uric acid. It is a form of arthritis. The buildup of uric acid causes crystals to form and collect in joints, commonly in the feet and toes, which leads to severe pain. Damage to the kidneys is known to

occur with uric acid deposition in this organ. Uric acid alters **endothelial** (the lining of blood vessels) function and inhibits **nitric oxide** (a substance produced by the body) bioavailability. With reduced availability of nitric oxide, insulin is less able to promote cellular glucose uptake. This may be how gout is linked to insulin resistance (Nakagawa and colleagues, 2006).

Historically, higher uric acid levels are believed to have been helpful to maintain adequate blood pressure levels when intake of sodium was too low. As the Westernized diet, with increased salt use, has become increasingly prevalent, there has been an increase in both hypertension and gout (Johnson and colleagues, 2005).

Data from the Third National Health and Nutrition Examination Survey (1988-1994) showed a relationship between soft drink consumption and serum uric acid level. Serum uric acid levels increased with increasing sugar-sweetened soft drink intake. All levels of intake increased uric acid, but did so proportionally. Diet soda had no effect (Choi and colleagues, 2008). This finding may be more likely with men than with women (Gao and colleagues, 2007).

Risk factors for gout include genetic factors, excess alcohol consumption, a high intake of **purine** (a form of protein found in high amounts in organ meats and legumes), the metabolic syndrome, use of diuretics, and chronic renal failure (Roddy, Zhang, and Doherty, 2007). Abdominal obesity is associated with uric acid levels, and both are risk factors for the metabolic syndrome (Onat and colleagues, 2006).

Traditional medical nutritional therapy for gout has been aimed at lowering intake of purines as found in legumes and other protein-based foods. However, moderate amounts of legumes may be tolerated and help meet the goal for increased intake of fiber and magnesium. Data from the Third National Health and Nutrition Examination Survey showed that total protein intake was not related to the serum uric acid levels, although meat and seafood intake does appear to increase levels. Milk and yogurt intake has been related to lower levels of uric acid (Choi, Liu, and Curhan, 2005).

Generally the use of medications such as allopurinol and colchicine is the primary intervention in the management of gout. With the newer recognition of gout as part of the metabolic syndrome, the goals of medical nutrition therapy (MNT) for managing insulin resistance may be more effective. Slow weight loss, avoidance of excess alcohol, and good fluid intake also can be of help.

WHAT IS THE POLYCYSTIC OVARY SYNDROME AND WHAT IS ITS MANAGEMENT?

Polycystic ovary syndrome (PCOS) can be related to hyperinsulinemia. As a syndrome its definition includes three factors: cysts in the ovaries; increased amounts of male type of hormones, leading to menstrual irregularity and infertility; and **hirsutism,** or male-pattern hair growth. It is generally believed that PCOS has genetic roots, such as found with insulin resistance. One study of brothers of women with PCOS found they had dyslipidemia and insulin resistance (Sam and colleagues, 2008).

Women with PCOS are at high risk for impaired glucose tolerance and type 2 diabetes. This is especially true of minority women. A 2-hour oral glucose tolerance test (see Chapter 11) for screening women with PCOS at high risk for diabetes, rather than fasting glucose levels alone, can better identify health risk.

Women with PCOS generally benefit from the same goals of MNT to control insulin resistance as described earlier in the chapter. As discussed previously, an increased intake of monounsaturated fats is a positive goal in the management of the metabolic syndrome and can help beneficially increase levels of the hormone cholecystokinin. Small, frequent meals with low-glycemic index can be very helpful in controlling PCOS. A 4% to 5% weight loss among women with PCOS was found to improve lipid, glucose, and insulin profiles; however, inflammation was not reduced as assessed by CRP levels (Moran and colleagues, 2007).

Fact & Fallacy

FALLACY Children instinctively know how to make food choices to stay healthy.

FACT Children need the guidance of adults in selecting foods. The insulin resistance syndrome includes many chronic diseases, such as obesity, heart disease, and high blood pressure, that can start in childhood as a result of poor food choices. Using the MyPyramid to teach children to eat more high-fiber plant foods, such as vegetables, fruits, and legumes (beans), is appropriate. ■

WHAT IS THE ROLE OF THE NURSE OR OTHER HEALTH PROFESSIONAL IN THE PREVENTION AND MANAGEMENT OF THE INSULIN RESISTANCE SYNDROME?

The nurse or other health professional should be aware of the common occurrence and the risk factors for the metabolic syndrome. The nurse can help identify at-risk individuals through review of family history and health correlates of insulin resistance. Prompt identification can help to prevent early heart disease and diabetes.

The nurse or other health care professional can provide lifestyle guidance. This might entail encouraging low-sugar beverages, such as seltzer water or iced tea, or recommending that a pitcher of water with lemon slices be kept in the refrigerator to increase its appeal. To encourage intake of vegetables and fiber, use of mayonnaise-based dressings made of monounsaturated fat sources or using olive oil to sauté vegetables can be suggested. To lower glycemic index of meals, it can be advised to "Eat fruit; don't drink it." It should be clarified, however, that 4 oz of juice (15 g of carbohydrates) is generally well tolerated; advice might be to drink juice the "European way" (mixed with seltzer water). Reviewing food labels for fiber content is a practical strategy that can empower individuals to reduce their risk of the metabolic syndrome. Increased physical activity should be promoted; walking, dancing, or other forms of exercise can be encouraged. For individuals with mobility issues, even chair exercises can be of help. Adolescents might be encouraged to play basketball or skip rope to help stem the epidemic of obesity and diabetes in our youth.

Chapter Challenge Questions & Classroom Activities

1. If you are working with an individual who has central obesity and hypertension, is this individual at risk of diabetes? What laboratory values can help determine this risk?
2. Ask students to raise their hands if they have experienced symptoms of hypoglycemia, such as feeling weak, shaky, or irritable, that are resolved with food.
3. Have students volunteer, as desired, their family history of insulin resistance correlates. Estimate the percentage of students in class who are at risk for the metabolic syndrome.
4. Assess the following menu for the questions that follow:

Breakfast	Lunch	Dinner
Banana	Hot dog on roll	Cheeseburger
Corn flakes	Mustard and relish	French fries
Whole milk	Chocolate chip cookies	Coleslaw
Sugar	Coke	Milkshake
Toast, butter, and jelly		

Judge these meals based on a typical adult's needs according to the new MyPyramid.
Identify the foods or beverages high in sugar and saturated fat.
What suggestions would you make to change this menu to lower the risk of developing the metabolic syndrome?

Case Study

Tony was in for his annual check-up at the doctor's office. He had a history of diabetes, hypertension, and dyslipidemia. All his numbers looked good, except for a high CRP number. He didn't quite understand what it meant about inflammation but was once again reminded of the benefit of eating sardines, herring, and salmon, as well as beans and greens. He decided to drop by to see his father-in-law, who loved to share a can of sardines with him. He would have his on a slice of whole-grain toast to please his dietitian when he next saw her, and would record it in his food log. His weight was coming down nicely, and now he had to buy pants with a 38-inch waist.

Critical Thinking Applications

1. How does CRP relate to the metabolic syndrome?
2. What other health conditions does Tony have that are found with an elevated CRP and the metabolic syndrome?
3. What is in fatty fish, beans, greens, and whole grains that help to lower inflammation?
4. If Tony has gout, what advice would be appropriate about eating sardines?
5. How can eating meals with low glycemic load be of health benefit to Tony?
6. What are the numbers Tony is trying to achieve for health based on his health conditions?

REFERENCES

Aguilar MV, Saavedra P, Arrieta FJ, Mateos CJ, González MJ, Meseguer I, Martínez-Para MC: Plasma mineral content in type-2 diabetic patients and their association with the metabolic syndrome, *Ann Nutr Metab* 51(5):402-406, 2007.

Alemzadeh R, Kichler J, Babar G, Calhoun M: Hypovitaminosis D in obese children and adolescents: relationship with adiposity, insulin sensitivity, ethnicity, and season, *Metabolism* 57(2):183-191, 2008.

Armitage JA, Taylor PD, Poston L: Experimental models of developmental programming: consequences of exposure to an energy rich diet during development, *J Physiol* 565(pt 1):3-8, 2005.

Basciano H, Federico L, Adeli K: Fructose, insulin resistance, and metabolic dyslipidemia, *Nutr Metab* 2(1):5, 2005.

Berglund L, Lefevre M, Ginsberg HN, Kris-Etherton PM, Elmer PJ, Stewart PW, Ershow A, Pearson TA, Dennis BH, Roheim PS, Ramakrishnan R, Reed R, Stewart K, Phillips KM; DELTA Investigators: Comparison of monounsaturated fat with carbohydrates as a replacement for saturated fat in subjects with a high metabolic risk profile: studies in the fasting and postprandial states, *Am J Clin Nutr* 86(6):1611-1620, 2007.

Boney CM, Verma A, Tucker R, Vohr BR: Metabolic syndrome in childhood: association with birth weight, maternal obesity, and gestational diabetes mellitus, *Pediatrics* 115(3):e290-e296, 2005.

Brea A, Mosquera D, Martin E, Arizti A, Cordero JL, Ros E: Nonalcoholic fatty liver disease is associated with carotid atherosclerosis: a case-control study, *Arterioscler Thromb Vasc Biol* 25(5):1045-1050, 2005.

Champagne CM: Magnesium in hypertension, cardiovascular disease, metabolic syndrome, and other conditions: a review, *Nutr Clin Pract* 23(2):142-151, 2008.

Chaput JP, Després JP, Bouchard C, Tremblay A: Short sleep duration is associated with reduced leptin levels and increased adiposity: results from the Quebec family study, *Obesity* 15(1):253-261, 2007.

Chaudhary DP, Boparai RK, Bansal DD: Effect of a low magnesium diet on in vitro glucose uptake in sucrose fed rats, *Magnes Res* 20(3):187-195, 2007.

Chen CC, Li TC, Chang PC, Liu CS, Lin WY, Wu MT, Li CI, Lai MM, Lin CC: Association among cigarette smoking, metabolic syndrome, and its individual components: the metabolic syndrome study in Taiwan, *Metabolism* 57(4):544-548, 2008.

Choi HK, Liu S, Curhan G: Intake of purine-rich foods, protein, and dairy products and relationship to serum levels of uric acid: the Third National Health and Nutrition Examination Survey, *Arthritis Rheum* 52(1):283-289, 2005.

Choi JW, Ford ES, Gao X, Choi HK: Sugar-sweetened soft drinks, diet soft drinks, and serum uric acid level: the Third National Health and Nutrition Examination Survey, *Arthritis Rheum* 59(1):109-116, 2008.

D'Avila C, Lavinsky L: Glucose and insulin profiles and their correlations in Ménière's disease, *Int Tinnitus J* 11(2):170-176, 2005.

Dhingra R, Sullivan L, Jacques PF, Wang TJ, Fox CS, Meigs JB, D'Agostino RB, Gaziano JM, Vasan RS: Soft drink consumption and risk of developing cardiometabolic risk factors and the metabolic syndrome in middle-aged adults in the community, *Circulation* 116(5):480-488, 2007.

Ebbesson SO, Tejero ME, Nobmann ED, Lopez-Alvarenga JC, Ebbesson L, Romenesko T, Carter EA, Resnick HE, Devereux RB, MacCluer JW, Dyke B, Laston SL, Wenger CR, Fabsitz RR, Comuzzie AG, Howard BV: Fatty acid consumption and metabolic syndrome components: the GOCADAN study, *J Cardiometab Syndr* 2(4):244-249, 2007.

Fogli-Cawley JJ, Dwyer JT, Saltzman E, McCullough ML, Troy LM, Meigs JB, Jacques PF: The 2005 Dietary Guidelines for Americans and risk of the metabolic syndrome, *Am J Clin Nutr* 86(4):1193-1201, 2007.

Ford ES, Kohl HW III, Mokdad AH, Ajani UA: Sedentary behavior, physical activity, and the metabolic syndrome among U.S. adults, *Obes Res* 13(3):608-614, 2005.

Ford ES, Li C, McGuire LC, Mokdad AH, Liu S: Intake of dietary magnesium and the prevalence of the metabolic syndrome among U.S. adults, *Obesity* 15(5):1139-1146, 2007.

Fraser A, Longnecker MP, Lawlor DA: Prevalence of elevated alanine aminotransferase among US adolescents and associated factors: NHANES 1999-2004, *Gastroenterology* 133(6):1814-1820, 2007.

Gao X, Qi L, Qiao N, Choi HK, Curhan G, Tucker KL, Ascherio A: Intake of added sugar and sugar-sweetened drink and serum uric acid concentration in US men and women, *Hypertension* 50(2):306-312, 2007.

González-Ortiz M, Martínez-Abundis E: Impact of sleep deprivation on insulin secretion, insulin sensitivity, and other hormonal regulations, *Metab Syndr Relat Disord* 3(1):3-7, 2005.

Gower BA, Ard JD, Hunter GR, Fernandez J, Ovalle F: Elements of the metabolic syndrome: association with insulin sensitivity and effects of ethnicity, *Metab Syndr Relat Disord* 5(1):77-86, 2007.

Henderson DC, Cagliero E, Copeland PM, Borba CP, Evins E, Hayden D, Weber MT, Anderson EJ, Allison DB, Daley TB, Schoenfeld D, Goff DC: Glucose metabolism in patients with schizophrenia treated with atypical antipsychotic agents: a frequently sampled intravenous glucose tolerance test and minimal model analysis, *Arch Gen Psychiatry* 62(1):19-28, 2005.

Hildrum B, Mykletun A, Hole T, Midthjell K, Dahl AA: Age-specific prevalence of the metabolic syndrome defined by the International Diabetes Federation and the National Cholesterol Education Program: the Norwegian HUNT 2 study, *BMC Public Health* 7(147):220, 2007.

Homburg R: Polycystic ovary syndrome in adolescence: new insights in pathophysiology and treatment, *Endocr Dev* 8:137-149, 2005.

Johnson RJ, Titte S, Cade JR, Rideout BA, Oliver WJ: Uric acid, evolution and primitive cultures, *Semin Nephrol* 25(1):3-8, 2005.

Jolliffe CJ, Janssen I: Development of age-specific adolescent metabolic syndrome criteria that are linked to the Adult Treatment Panel III and International Diabetes Federation criteria, *J Am Coll Cardiol* 49(8):891-898, 2007.

Katcher HI, Legro RS, Kunselman AR, Gillies PJ, Demers LM, Bagshaw DM, Kris-Etherton PM: The effects of a whole grain-enriched hypocaloric diet on cardiovascular disease risk factors in men and women with metabolic syndrome, *Am J Clin Nutr* 87(1):79-90, 2008.

Kopp W: Pathogenesis and etiology of essential hypertension: role of dietary carbohydrate, *Med Hypotheses* 64(4): 782-787, 2005.

Laaksonen DE, Lindstrom J, Lakka TA, Eriksson JG, Niskanen L, Wikstrom K, Aunola S, Keinanen-Kiukaanniemi S, Laakso M, Valle TT, Ilanne-Parikka P, Louheranta A, Hamalainen H, Rastas M, Salminen V, Cepaitis Z, Hakumaki M, Kaikkonen H, Harkonen P, Sundvall J, Tuomilehto J, Uusitupa M; Finnish Diabetes Prevention Study: Physical activity in the prevention of type 2 diabetes: the Finnish diabetes prevention study, *Diabetes* 54(1):158-165, 2005.

Lai CQ, Corella D, Demissie S, Cupples LA, Adiconis X, Zhu Y, Parnell LD, Tucker KL, Ordovas JM: Dietary intake of n-6 fatty acids modulates effect of apolipoprotein A5 gene on plasma fasting triglycerides, remnant lipoprotein concentrations, and lipoprotein particle size: the Framingham Heart Study, *Circulation* 113(17):2062-2070, 2006.

Li Y, Yang X, Zhai F, Kok FJ, Zhao W, Piao J, Zhang J, Cui Z, Ma G: Prevalence of the metabolic syndrome in Chinese adolescents, *Br J Nutr* 99(3):565-570, 2008.

Longstreet DA, Heath DL, Panaretto KS, Vink R: Correlations suggest low magnesium may lead to higher rates of type 2 diabetes in indigenous Australians, *Rural Remote Health* 7(4):843, 2007.

Lorenzo C, Williams K, Hunt KJ, Haffner SM: The National Cholesterol Education Program—Adult Treatment Panel III, International Diabetes Federation, and World Health Organization definitions of the metabolic syndrome as predictors of incident cardiovascular disease and diabetes, *Diabetes Care* 30(1):8-13, 2007.

Maes M, Mihaylova I, Ruyter MD, Kubera M, Bosmans E: The immune effects of TRYCATs (tryptophan catabolites along the IDO pathway): relevance for depression—and other conditions characterized by tryptophan depletion induced by inflammation, *Neuro Endocrinol Lett* 28(6): 826-831, 2007.

Mark AE, Janssen I: Relationship between screen time and metabolic syndrome in adolescents, *J Public Health* 30(2): 153-160, 2008.

Maumus S, Marie B, Siest G, Visvikis-Siest S: A prospective study on the prevalence of metabolic syndrome among healthy French families: two cardiovascular risk factors (HDL cholesterol and tumor necrosis factor-alpha) are revealed in the offspring of parents with metabolic syndrome, *Diabetes Care* 28(3):675-682, 2005.

Meckling KA, Sherfey R: A randomized trial of a hypocaloric high-protein diet, with and without exercise, on weight loss, fitness, and markers of the metabolic syndrome in overweight and obese women, *Appl Physiol Nutr Metab* 32(4):743-752, 2007.

Misra KB, Endemann SW, Ayer M: Measures of obesity and metabolic syndrome in Indian Americans in northern California, *Ethn Dis* 16(2):331-337, 2006.

Moran LJ, Noakes M, Clifton PM, Wittert GA, Belobrajdic DP, Norman RJ: C-reactive protein before and after weight loss in overweight women with and without polycystic ovary syndrome, *J Clin Endocrinol Metab* 92(8):2944-2951, 2007.

Murakami K, Sasaki S, Okubo H, Takahashi Y, Hosoi Y, Itabashi M: Dietary fiber intake, dietary glycemic index and load, and body mass index: a cross-sectional study of 3931 Japanese women aged 18-20 years, *Eur J Clin Nutr* 61(8):986-995, 2007.

Murakami K, Sasaki S, Takahashi Y, Okubo H, Hosoi Y, Horiguchi H, Oguma E, Kayama F: Dietary glycemic index and load in relation to metabolic risk factors in Japanese female farmers with traditional dietary habits, *Am J Clin Nutr* 83(5):1161-1169, 2006.

Nakagawa T, Hu H, Zharikov S, Tuttle KR, Short RA, Glushakova O, Ouyang X, Feig DI, Block ER, Herrera-Acosta J, Patel JM, Johnson RJ: A causal role for uric acid in fructose-induced metabolic syndrome, *Am J Physiol Renal Physiol* 290(3):F625-F631, 2006.

Nelson T, Perez A, Alcaraz J, Talavera G, McCarthy JJ: Family history of diabetes, acculturation, and the metabolic syndrome among Mexican Americans: Proyecto SALSA, *Metab Syndr Relat Disord* 5(3):262-269, 2007.

Onat A, Uyarel H, Hergenç G, Karabulut A, Albayrak S, Sari I, Yazici M, Keleş I: Serum uric acid is a determinant of metabolic syndrome in a population-based study, *Am J Hypertens* 19(10):1055-1062, 2006.

Orchard TJ, Temprosa M, Goldberg R, Haffner S, Ratner R, Marcovina S, Fowler S; Diabetes Prevention Program Research Group: The effect of metformin and intensive lifestyle intervention on the metabolic syndrome: the Diabetes Prevention Program randomized trial, *Ann Intern Med* 142(8):611-619, 2005.

Osei K, Gaillard T, Schuster D: Plasma adiponectin levels in high risk African-Americans with normal glucose tolerance, impaired glucose tolerance, and type 2 diabetes, *Obes Res* 13(1):179-185, 2005.

Paniagua JA, de la Sacristana AG, Sánchez E, Romero I, Vidal-Puig A, Berral FJ, Escribano A, Moyano MJ, Peréz-Martinez P, López-Miranda J, Pérez-Jiménez F: A MUFA-rich diet improves postprandial glucose, lipid and GLP-1 responses in insulin-resistant subjects, *J Am Coll Nutr* 26(5):434-444, 2007.

Pittenger GL, Mehrabyan A, Simmons K, Amandarice , Dublin C, Barlow P, Vinik AI: Small fiber neuropathy is associated with the metabolic syndrome, *Metab Syndr Relat Disord* 3(2):113-121, 2005.

Rakugi H, Ogihara T: The metabolic syndrome in the Asian population, *Curr Hypertens Rep* 7(2):103-109, 2005.

Rayssiguier Y, Mazur A: Magnesium and inflammation: lessons from animal models, *Clin Calcium* 245-248, 2005.

Reinehr T, Kiess W, Andler W: Insulin sensitivity indices of glucose and free fatty acid metabolism in obese children and adolescents in relation to serum lipids, *Metabolism* 54(3):397-402, 2005.

Reungjui S, Roncal CA, Mu W, Srinivas TR, Sirivongs D, Johnson RJ, Nakagawa T: Thiazide diuretics exacerbate

fructose-induced metabolic syndrome, *J Am Soc Nephrol* 18(10):2724-2731, 2007.

Risérus U: Trans fatty acids and insulin resistance, *Atheroscler Suppl* 7(2):37-39, 2006.

Roddy E, Zhang W, Doherty M: The changing epidemiology of gout, *Nat Clin Pract Rheumatol* 3(8):443-449, 2007.

Ryu SY, Kim KS, Park J, Kang MG, Han MA: [Serum ferritin and risk of the metabolic syndrome in some Korean rural residents], *J Prev Med Pub Health* 41(2):115-120, 2008.

Sam S, Coviello AD, Sung YA, Legro RS, Dunaif A: Metabolic phenotype in the brothers of women with polycystic ovary syndrome, *Diabetes Care* 31(6):1237-1241, 2008.

Sepilian V, Nagamani M: Effects of rosiglitazone in obese women with polycystic ovary syndrome and severe insulin resistance, *J Clin Endocrinol Metab* 90(1):60-65, 2005.

Shimajiri T, Imagawa M, Kokawa M, Konami T, Hara H, Kyoku I, Sone E, Ishigame M, Kikuoka H: Revised optimal cut-off point of waist circumference for the diagnosis of metabolic syndrome in Japanese women and the influence of height, *J Atheroscler Thromb*15(2):94-99, 2008.

Sullivan PW, Ghushchyan V, Wyatt HR, Wu EQ, Hill JO: Productivity costs associated with cardiometabolic risk factor clusters in the United States, *Value Health* 10(6): 443-450, 2007.

Thompson JL, Herman CJ, Allen P, Helitzer DL, Wilson ND, Whyte AN, Perez GE, Wolfe VK: Associations between body mass index, cardiorespiratory fitness, metabolic syndrome, and impaired fasting glucose in young, urban Native American women, *Metab Syndr Relat Disord* 5(1):45-54, 2007.

Valencia ME, Weil EJ, Nelson RG, Esparza J, Schulz LO, Ravussin E, Bennett PH: Impact of lifestyle on prevalence of kidney disease in Pima Indians in Mexico and the United States, *Kidney Int Suppl* 97:S141-S144, 2005.

Viner RM, Segal TY, Lichtarowicz-Krynska E, Hindmarsh P: Prevalence of the insulin resistance syndrome in obesity, *Arch Dis Child* 90(1):10-14, 2005.

Yang SP, Gong CX, Cao BY, Yan C: [Relationship between serum high-sensitivity C-reactive protein and obesity and impaired glucose metabolism in children and adolescents], *Zhonghua Er Ke Za Zhi* 44(12):933-936, 2006.

Zamami Y, Takatori S, Iwatani Y, Yamawaki K, Miyashita S, Yabumae N, Takayama F, Mio M, Kawasaki H: [Effect of postprandial hyperglycemia and hyperinsulinemia on vascular responsiveness], *Yakugaku Zasshi* 128(3):419-424, 2008.

Zoccali C, Caridi G, Cambareri F: [The chronic renal failure epidemic: an underestimated public health problem], *G Ital Nefrol* 24(Suppl 38):3-7, 2007.

chapter

6

Obesity and Healthy Weight Management

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Chapter Topics

Health Problems Found With Overweight and Obesity
Weight Standards
Rates of Overweight and Obesity
Causes and Theories of Obesity Etiology
Prevention of Obesity
Treatment Strategies for Obesity
Review of the Popular Weight-Loss Diet Approaches
The Impact of Bariatric Surgery
The Role of Physical Activity in Weight Management
The Role of the Nurse and Other Health Care Professionals in the Prevention and Management of Obesity

Objectives

After completing this chapter, you should be able to:

- Describe obesity and discuss its prevention and treatments.
- Recognize healthy weight management practices.
- Relate the importance of physical activity to healthy weight management.

Terms to Identify

Adipocytokines
Adiponectin
Adipose tissue
Aerobic exercise
Anaerobic exercise
Apple shaped
Asterixis
Bariatric surgery
Body mass index (BMI)
Cholecystectomy
Cholelithiasis
Class I obesity
Class II obesity
Class III obesity
Conjugated linoleic acid (CLA)
Cortisol
C-reactive protein (CRP)
Dehydroepiandrosterone (DHEA)
Desirable weight
Distal gastric bypass biliopancreatic diversion (DBP)
Dopamine
Duodenal switch (DS)
Energy balance
Extreme obesity
Gastric banding
Gastrojejunostomy
Ghrelin
Glucocorticoid
Healthy weight
Hemeralopia
Hypothyroidism
Ideal body weight
Incretin

Interleukin 6 (IL-6)
Leptin
Lipogenic
Lipolysis
Meals, Ready to Eat (MREs)
Metabolic obesity
Myelopathy
Nystagmus
Obesity
Osteoarthritis
Overweight
Papilledema
Pear shaped
Prader-Willi syndrome
Rhabdomyolysis
Roux-en-Y gastric bypass
Sleep apnea
Satiety
Underweight

INTRODUCTION

The World Health Organization has referred to obesity as a "global epidemic" since the 1990s, but the significant rise in obesity began to appear in the 1980s. The incidence of obesity and overweight in the United States currently affects about two thirds of the adult population (Figure 6-1). The Healthy People 2010 goal of 15% obesity rate is not expected to be met if current trends continue. It is anticipated that white persons will have a rate in the 30% range, along with African American men. African American women are expected to have an obesity rate of over 50% by this time (Wang, Colditz, and Kuntz, 2007).

Promotion of physical activity is critical in the prevention of obesity. Historically, when people had to forage for their food, they expended energy. It has been estimated that Native Americans ran 60 miles a day while hunting. Our sedentary lifestyles, in combination with an increased intake of simple carbohydrates and saturated fat, appear to be the driving force behind the development of obesity. Physical activity promotes an increase in energy expenditure and allows better weight stability than control of food intake (Levitsky and colleagues, 2005).

Increased intake of kilocalories (kcalories or kcal) through larger food portions and high intake of sugar-based beverages (see Figures 6-2 and 1-1) along with reduced physical activity is the driving force in the obesity epidemic. With decreased intake of fiber-based foods, the ability to recognize the feeling of fullness is diminished. Add to this a fast pace of eating, and the result is a pattern of overeating with resultant weight gain.

Hormonal imbalances also are known to play a role in obesity. This can be related to suppressed metabolism as found with **hypothyroidism** (a condition of inadequate production by the thyroid gland of the hormone thyroxine—see later section). Other hormones play a role in hunger and appetite as well as **satiety** (the recognition of satisfaction). Increasing evidence suggests that obesity is a complex disorder involving regulating appetite and energy metabolism.

There are various approaches aimed at weight loss, most with little long-term success. The most successful approach is to prevent weight gain. It is far easier to prevent obesity than it is to correct it. Learning to trust internal hunger and satiety

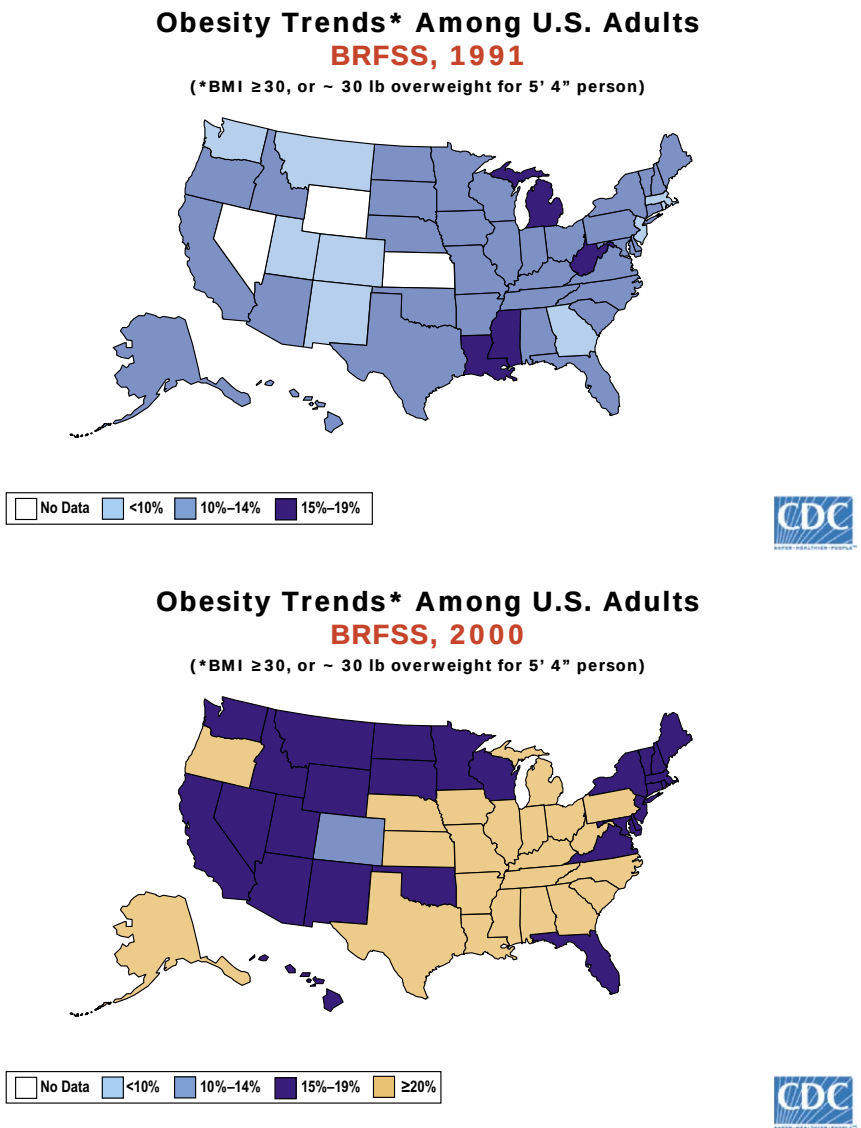


FIGURE 6-1 Increasing prevalence of obesity among U.S. adults, 1991-2007. (From *The surgeon general's call to action to prevent and decrease overweight and obesity,* Rockville, Md, 2007, U.S. Department of Health and Human Services.)

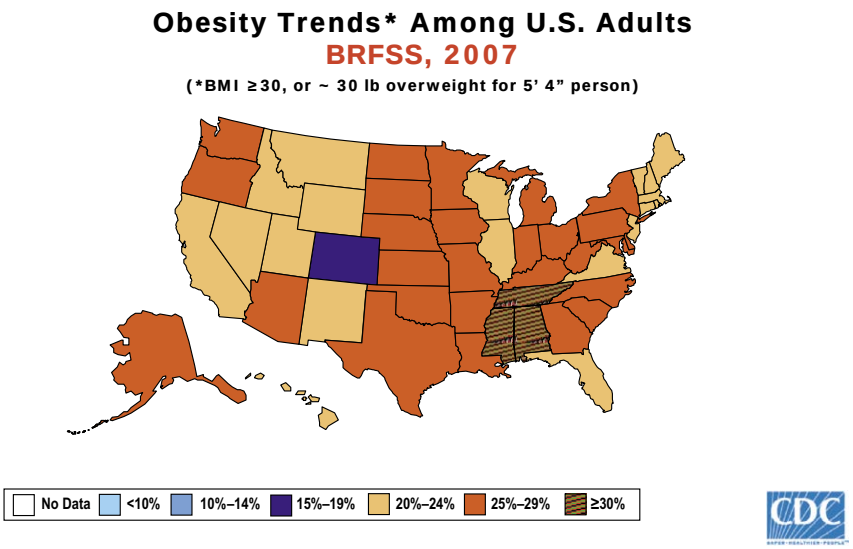


FIGURE 6-1—cont'd

FIGURE 6-2 1 oz traditional snack-size potato chips as shown on saucer plate (carbohydrate of 1 slice bread, 2 teaspoons fat), 2 oz current small snack-size potato chips as shown on salad plate (2 slices bread and 4 teaspoons fat equivalent), 3.5 oz current larger snack-size potato chips as shown on dinner plate (3.5 slices bread and 7 teaspoon fat equivalent).

cues can be very effective in managing weight, as long as the diet routinely focuses on high-fiber foods with moderate amounts of fat and sugar. This is especially true with a slow-paced way of eating.

For overweight children and adults the ability to eat based on true physiologic hunger and satiety cues can be relearned from an innate ability that infants are born with. This is the basis of the nondieting approach to weight control described later in this chapter. Changes that are made should be ones that can be realistically maintained rather than a person being on a diet, and then off a diet.

Because there is no one genetic makeup, no one diet can be expected to address the needs of all individuals. Assessment of current nutritional intake and family health history can help determine the best course of action to slow weight gain among those who are moderately overweight and help reverse the problem of obesity.

Emphasis on legumes, leafy greens, and other low-carbohydrate vegetables, with moderate amounts of whole grains and fruit, low-fat or skim milk, and lean meats such as fish and chicken, along with moderate intake of nuts and oils, is the foundation of a healthy diet. MyPyramid.gov provides individualized meal patterns and tools for tracking food intake and physical activity (see Appendixes 1 and 2 on the Evolve website).

Fact & Fallacy

FALLACY A person with central obesity should not eat potatoes and bread.

FACT It is true that many persons with the insulin resistance syndrome have better outcomes on a lower-carbohydrate diet. Most, however, do well with 40% to 50% of total kcalories or just under 200 g of carbohydrates for a 1500-kcal level (½ cup potato equals the carbohydrate content of 1 slice of bread at 15 g carbohydrates—see also Chapter 2). ■

WHAT ARE SOME HEALTH PROBLEMS FOUND WITH OVERWEIGHT AND OBESITY?

It is the excess fat in the abdominal area, as found with the metabolic syndrome and atherosclerosis (see Chapters 5 and 7), that is linked with health problems. The term **metabolic obesity** is suggested in reference to excess body fat in the abdominal area. Metabolic obesity is more prominent in white men, African American women, Asian Indians, and Japanese (Hamdy, Porramatikul, and Al-Ozairi, 2006). Metabolic obesity is associated with hypertension, cardiovascular disease, diabetes, kidney disease, and certain cancers (Flegal and colleagues, 2007).

Other issues with obesity include the following:

- **Osteoarthritis** (a degenerative joint disease)
- **Cholelithiasis** (gallstones)
- **Sleep apnea** (repeated bouts of nonbreathing during sleep)

WHAT STANDARDS ARE USED TO DETERMINE WEIGHT GOALS?

The term **overweight** refers to an excess of body weight 10% greater than the standard, whereas **obesity** is used to describe an excess of body weight 20% or more than the standard. Although weight alone does not indicate the degree of body fat, an individual is still classified by many health professionals as obese if weight is 20% or more than the standard weight for height. Extreme obesity is an excess of 30% of the standard weight. A person is **underweight** if he or she is 10% below recommended weight for height.

The **Body mass index (BMI)** is considered one of the simpler tools that more accurately determine appropriate body weight. The BMI has replaced an older standard, the Metropolitan Life Height and Weight Tables, because of inherent shortcomings such as ethnic bias and emphasis on mortality with death statistics rather than

morbidity with a variety of health problems. The BMI is now the preferred standard for determining appropriate body size. Its formula was developed over a hundred years ago by a mathematician named Quetelet. As only a mathematician can, he realized that dividing a person's weight in kilograms by the square of the height in meters (kg/m^2) gives a better sense of body proportion. An alternative calculation to derive the BMI is $lb/in^2 \times 703$ (Kushner and Jackson Blatner, 2005). The BMI has its own shortcomings, because it does not take into account body composition. A bodybuilder, for example, may have a high BMI number but is not obese because body fat levels are low.

An **ideal body weight** equates to a BMI between 19 and 25 with an upper limit of 27—see Appendix 9 on the Evolve website for a BMI nomogram. Someone who is underweight has a BMI of less than 19. A BMI of 15 equates to 20% underweight, which is a dangerously low level that can result in death (see Chapters 12 and 13 for information on eating disorders). In populations at high risk of the metabolic syndrome, a BMI of 21 or less is advised (James, 2008). A BMI under 30 may be acceptable if there are no health problems.

Three classes of obesity, based on BMI, are now being used:

Class I obesity: BMI greater than 30
Class II obesity: BMI greater than 35
Class III obesity: BMI greater than 40 (also now referred to as **extreme obesity**).

Achieving a weight that is conducive to physical health and psychologic health is part of healthy weight management. For a person who is already obese, **desirable weight** is generally higher than ideal weight as described above. For this reason, the term **healthy weight** is increasingly gaining acceptance. Other factors such as age, general health status, and potential for achieving and maintaining weight loss are considered when determining desirable weight.

A person who loses 5% of excess weight will often improve health outcomes related to laboratory values of blood cholesterol, glucose, or blood pressure measurements. A weight loss of 10% is considered highly successful if sustained, and weight loss of 15% or more is far less common but certainly possible with sustained positive changes in lifestyle.

Rapid weight loss is not advised for anyone, but especially not for the elder population (see Chapter 13). Slow weight loss of approximately ½ to 1 lb per week is more likely to be permanent and therefore falls within the boundaries of healthy weight management. Although this may not seem like a lot of weight to lose, 1 lb per week is over 50 lb yearly. A 25- to 50-lb annual weight loss is far more likely to be a permanent weight loss than the often promoted and advertised 100 lb or more with various commercial diets.

Teaching Pearl

A variety of physiologic mechanisms will send a person foraging for food if the body feels that it is being overly starved. If it were easy to lose weight, the human race would not be in existence in the twenty-first century, because of the innumerable times of famine that have occurred historically. ■

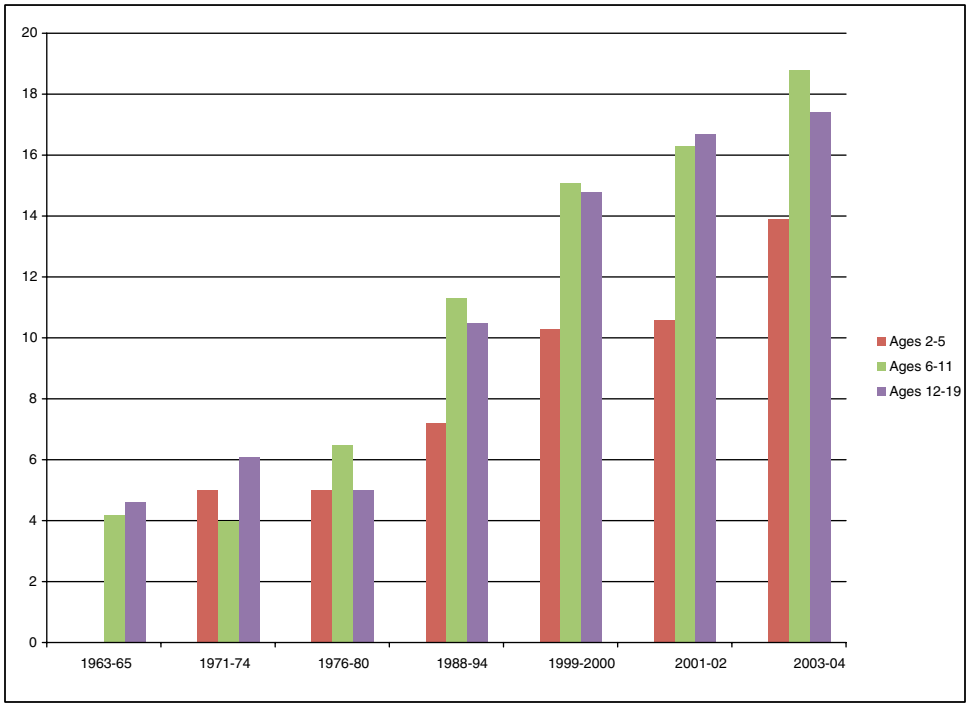


FIGURE 6-3 Prevalence of overweight among children and adolescents ages 2-19 years, for selected years 1963-65 through 2003-2004, data from NHANES. (Data from National Health and Nutrition Examination Survey [NHANES]).

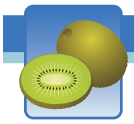
OTHER BODY FAT MEASUREMENTS

More precise methods of determining body fat percentage include the following:

- Skinfold measurements taken at different body sites (see Figure 1-9)
- The bioelectric impedance machine, which sends an imperceptible electric current through the body; results vary based on levels of hydration, because water is the medium through which the electrical current flows
- Underwater weighing (usually done only at research centers)

WHAT ARE THE RATES OF OVERWEIGHT AND OBESITY?

Figure 6-3 shows the increased rate of obesity among children and adolescents from 1963 to 2004. Regions where obesity was once thought impossible are now showing the effects of excess caloric intake such as in Asia. There are higher amounts of obesity among minority populations. This may be related to increased rates of insulin resistance in these populations along with environmental factors.



Cultural Considerations

Due to the high rate of 75% combined overweight or obese among African American women, a review of a variety of magazines was undertaken that found the vast majority of magazine articles advised behavioral changes with an individual solution focus for weight. Mainstream magazines were twice as likely to suggest specific strategies such as less fast food, eating lower-fat foods, and eating smaller portions. African American women's magazines were more likely to cover fad diets and to suggest readers rely on religion in their diet plans (Campo and Mastin, 2007). Another study comparing a university setting versus church-based weight loss program found the church group exhibited less disordered eating attitudes and experienced significantly greater weight loss than the group at the university setting. Treatment setting appears to play an important role in treatment adherence and sample characteristics (Sbrocco and colleagues, 2005). African American women believe their cultural background contributes to their weight gain more than white women do, and African American women prefer one-on-one counseling or group meetings with other women led by physicians or dietitians and note the importance of including cultural food messages, whereas white women tend to prefer commercial weight loss programs from their previous weight loss efforts (Blixen and colleagues, 2006). Focus groups conducted with African American women compared women who were successful at weight loss maintenance versus women who lost weight but regained it. Weight loss maintainers lost over 20% of body weight and related their success to positive support from others, active opposition to cultural norms, and strategies in place to continue with their weight loss goals. However, weight loss maintainers noted their being perceived as sick or too thin at their new weight.

All of the African American women noted a struggle with hairstyle management during exercise (Barnes and colleagues, 2007). This is a potential barrier to exercise that may not be recognized by the health care professional recommending increased physical activity because hair management can be a time-consuming endeavor for women of African heritage. Interventions for weight loss among African American women should incorporate family-centered approaches and weight loss maintenance strategies (Setse and colleagues, 2008). ■

WHAT ARE THE KNOWN CAUSES AND THEORIES OF OBESITY?

Many factors can affect weight in an individual: eating habits, cooking methods, family customs, emotional problems, peer pressure, food advertising, and food availability all have influence on caloric intake, whereas factors such as age, gender, heredity, body composition, hormonal makeup, physical activity, and even occupation all affect energy expenditure (Figure 6-4).

KCALORIE IMBALANCE

Obesity is generally thought to occur as a result of long-term positive **energy balance** for individual needs. In other words, weight gain occurs when caloric intake exceeds expenditure (Table 6-1) over an extended period. This was the basis for the low-fat message beginning in the 1980s. Because 1 g fat has 9 kcal as compared with 1 g carbohydrates at 4 kcal, it was logical to conclude that kcalorie intake would go down when carbohydrate replaced fat kcalories (Figure 6-5). What was not considered is that sugar intake could continue to increase off-setting the kcalorie savings from less fat.

Increased use of high-fructose corn syrup (HFCS), after the embargo on sugarcane from Cuba, coincided with the obesity epidemic. Widespread use of HFCS in

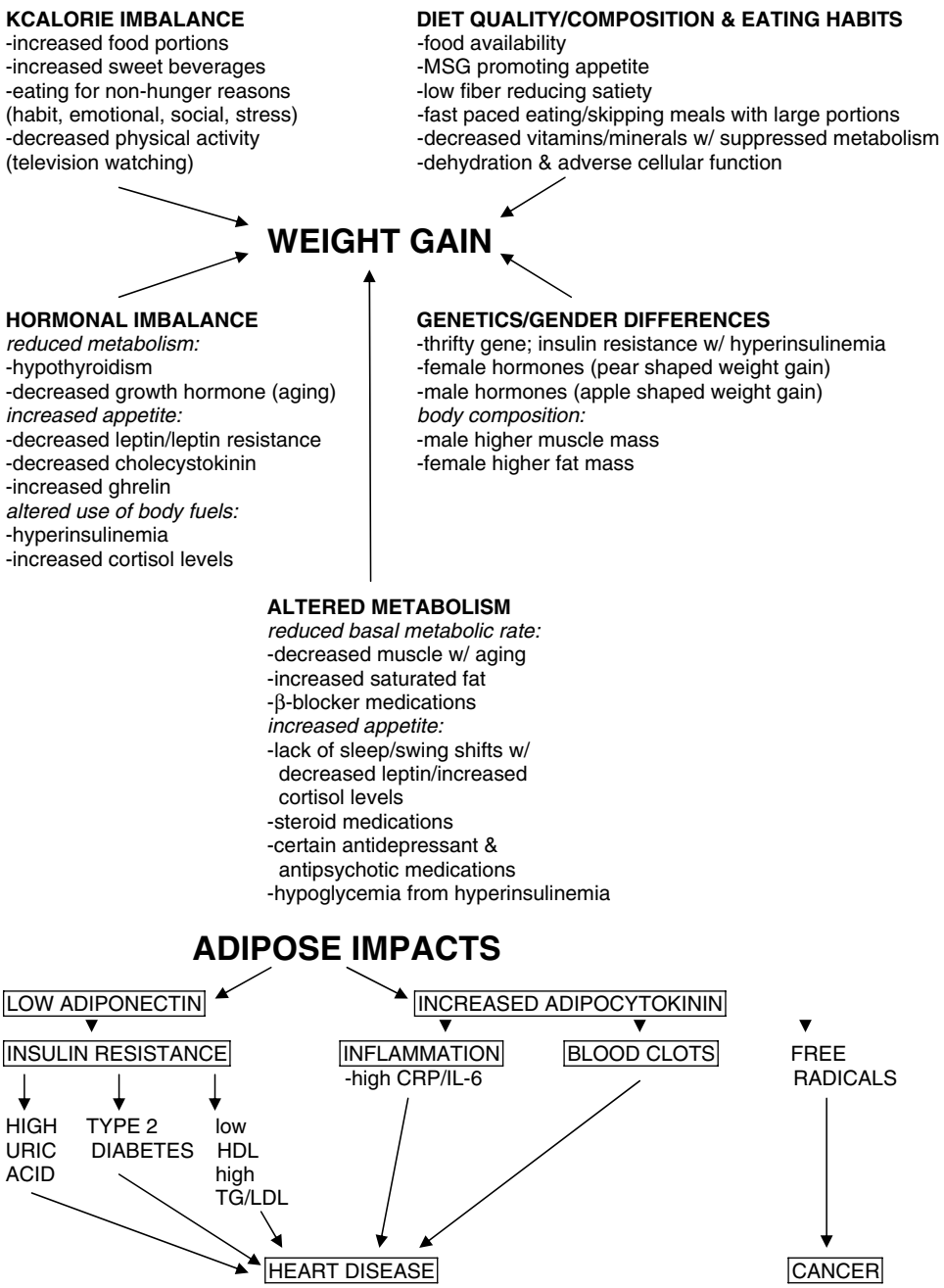


FIGURE 6-4 Causes and interactions of obesity and health conditions. *CRP,* C-reactive protein; *HDL,* high-density lipoprotein; *IL-6,* interleukin-6; *LDL,* low-density lipoprotein; *MSG,* monosodium glutamate; *TG,* triglyceride.

Table 6-1 Kilocalories Expended per Hour for Various Types of Activities

TYPE OF ACTIVITY	kcal/hr*
Sedentary Activities Reading, writing, eating, watching TV or movies, listening to radio, sewing, playing cards; typing, office work, and other activities done while sitting that require little or no arm movement or that require moderate arm movement; and activities done while sitting that require more vigorous arm movement	0-100
Light Activities Preparing and cooking food, doing dishes, dusting, handwashing small articles of clothing, ironing, walking slowly, personal care, miscellaneous office work and other activities done while standing that require some arm movement, and rapid typing and other activities done while sitting that are more strenuous	110-160
Moderate Activities Making beds, mopping and scrubbing, sweeping, light polishing and waxing, laundering by machine, light gardening and carpentry work, walking moderately fast, other activities done while standing	170-240
Vigorous Activities Heavy scrubbing and waxing, handwashing large articles of clothing, hanging out clothes, stripping beds, other heavy work, walking fast, bowling, golfing, gardening	250-350
Strenuous Activities Swimming, playing tennis, running, bicycling, dancing, skiing, playing football	350 or more

From U.S. Department of Agriculture (USDA): *Food and your weight,* Home and garden bulletin No. 74, Washington, DC, USDA.
*A range of caloric values is given for each type of activity to allow for differences in activities and in persons. Of the sedentary activities, for example, typing uses more kilocalories than watching TV. Some persons will use more kilocalories in carrying out either activity than others; some persons are more efficient in their body actions than are others. Values closer to the upper limit of a range will give a better picture of kilocalorie expenditures for men, and those near the lower limit a better picture for women.

beverages has been linked to rising obesity rates, but this is most likely due to larger portions of sugar-based beverages consumed (see Figure 1-1) and the HFCS they contain, and not due to a physiologic cause. A study in Canada found, overall, there were half as many preschool-age children who were overweight by age 5 years who did not drink sugar-based drinks as compared with those preschool children who had sweetened drinks four or more times in a week. In this same age-group, children from low-income homes who regularly drank sugar-based drinks were found to be more than three times as likely to be overweight by the age of 5 years compared with children living in higher-income homes who were not regularly consuming sugar-based drinks (Dubois and colleagues, 2007). In a study of women, when a caloric beverage was consumed with the meal, energy intake was about 100 kcal greater than when a noncaloric beverage or no beverage was consumed (DellaValle, Roe, and Rolls, 2005). Replacing all sweet beverages with drinking water has been associated with a decrease in total energy of 200 kcal/day. Satiety was still found to occur such that increasing kcalories from other sources did not happen (Stookey and colleagues, 2007).

Portion sizes are likely the driving force behind obesity. Large portions will promote hyperinsulinemia among those who genetically tend to have insulin resis-

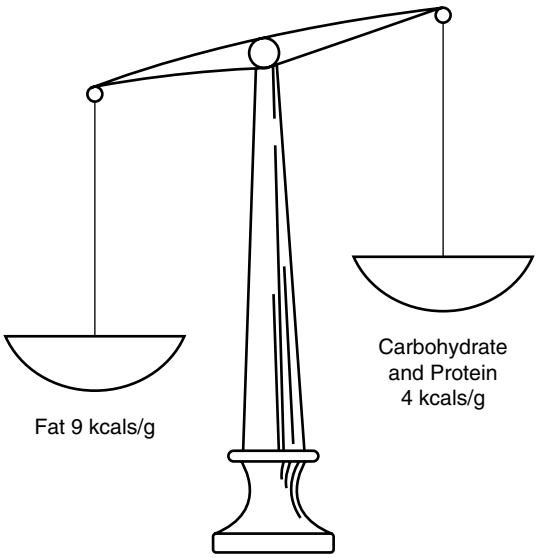


FIGURE 6-5 Carbohydrate versus fat calorie concentrations.

tance. Typical portion sizes in a self-selected study of young adults in a college setting found portions to be significantly larger from those selected by young adults in a similar study conducted two decades ago (Schwartz and Byrd-Bredbenner, 2006).

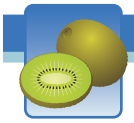
Kcalorie needs are altered based on level of physical activity. The **Meals, Ready to Eat (MREs)** in the military are planned for 3500 to 5000 kcal, which is similar to the estimated intake of the old-time loggers before the advent of power tools. Persons nowadays who have desk jobs require far fewer kcalories to maintain their weight. Most adults require about 2000 kcal for weight management, as reflected in the Dietary Reference Intakes (DRIs) on food labels and in the MyPyramid guidelines (see Chapter 1). The reduced physical activity associated with watching television for 2 or more hours daily increased odds of overweight by 50% for adolescents (Fleming-Moran and Thiagarajah, 2005). Reduced activity not only limits kcalorie expenditure, it promotes insulin resistance, thereby promoting hyperinsulinemia.

DIET QUALITY AND COMPOSITION

Type of dietary fat has been found to affect metabolism differently. The monounsaturated fat oleic acid (see Chapter 2; Table 2-5) was found to increase daily energy expenditure in men, and increase fatty acid oxidation in women, whereas there was a decrease with the saturated fat palmitic acid (see Chapter 2) in the diet (Kien and Bunn, 2008). Increases in dietary palmitic acid have been found to significantly decrease fat oxidation and daily energy expenditure by as much as 275 kcal equivalent, whereas substitution with oleic acid has the opposite effect (Kien, Bunn, and Ugrasbul, 2005). The omega-3 and polyunsaturated n-6 fatty acids have been related

to reduced fat cell size, whereas the saturated fatty acids significantly increase fat cell size and number. The n-9 fats were related to reduced numbers of fat cells (Garaulet and colleagues, 2006).

Inadequate intake of trace minerals, such as magnesium, affects cellular metabolism. Vegetables, legumes, fruits, and whole grains are high in vitamins and minerals and contribute to the feeling of satiety and weight regulation.



Cultural Considerations

A study of over 200 children and adolescents 9 to 18 years of age who lived in homeless shelters in Minnesota found over half of the children reported not enough food in the house and 1 in 4 reported going to bed hungry. Inadequate intake of fruits, vegetables, and dairy were noted along with a variety of vitamins and minerals. A number of strategies to cope with food insecurity were identified, including eating disliked foods and overeating when at the homes of family members or friends. Risk of overweight and actual overweight was found in about one half of the children. Overeating when food is available may explain why there is a hunger-obesity connection among the poorest Americans (Smith and Richards, 2008). ■

EATING HABITS

Increased chewing of foods due to their level of hardness has been associated with smaller waist size (Murakami and colleagues, 2007). This may be due more to the increased chewing than to the actual degree of hardness. Individuals who eat slowly, by chewing more, typically note earlier satiety with consequent reduced intake of food.

Frequency of eating also plays a role. Young children in the United States who eat less often during the day consume larger portion sizes than children who eat more often during the day. Among infants, total kcalorie intake varies based on needs, suggesting an innate ability to regulate kcalorie intake. By toddler age, this self-regulation was found to be less effective. This suggests environmental cues tend to override physiologic cues of hunger and satiety (Fox and colleagues, 2006). Adults who eat smaller, more frequent meals also typically have better weight management. This is in part due to suppressed production of the hormone cortisol (see section below), which is released if blood glucose levels begin to drop. Avoiding long intervals without eating helps to keep blood glucose level stable, thereby suppressing release of cortisol.

Teaching Pearl

If you let a fire burn down to its embers and then put a log on top, it is not going to burn very well. If, instead, you put a handful of twigs on the fire throughout the day, you keep the fire roaring. This is somewhat like our metabolism. Small, frequent meals are best able to promote cellular metabolism and promote weight stabilization. ■

GENDER DIFFERENCES

Gender has a role in weight. Hormonally women tend to carry weight in their hips and thighs and men in their abdominal region. Men generally have an easier time

losing weight when they diet, and this is believed due to their higher level of muscle mass, which is more active tissue than is **adipose tissue** (body fat). There even appears to be a gender difference in food preferences. Obese women have been noted to have a higher intake of carbohydrates, whereas obese men generally have been found to have a higher intake of fat (Duvigneaud and colleagues, 2007).

Sex-linked steroids (see section below) found in adipose tissue help to regulate location of body fat. The ratio of estrogen to androgens helps determine **pear-shaped** (carrying weight in the thighs, as typically found with women) versus **apple-shaped** (central obesity, as found more frequently with men and the metabolic syndrome) patterns of body fat (Wake and colleagues, 2007).

GENETIC REASONS

The most common genetic cause of obesity is **Prader-Willi syndrome.** This is a complex disorder localized to chromosome 15 and is related to an inability to control food intake. This is believed due to elevation of the hormone ghrelin (see below).

Some population groups may have survived over the centuries because of an ability to preserve body mass during times of famine and to gain body mass easily during times of plenty. This ability would have been particularly important, historically speaking, in the hunter-gatherer lifestyle, which was dominant before agricultural development, and having this ability is referred to as having the thrifty gene. This theory helps to explain the occurrence of the metabolic syndrome and development of central obesity when there is exposure to conditions associated with a Westernized lifestyle (increased food intake and reduced physical activity).

ALTERED METABOLISM

In obesity, body proteins have been found to be altered. Plasma tryptophan concentrations are decreased due to increased tryptophan breakdown from chronic immune activation and altered enzyme functioning. Furthermore, these metabolic changes with tryptophan may promote reduced serotonin levels and cause mood disturbances, depression, and impaired satiety, ultimately leading to increased caloric uptake and obesity. The lowered tryptophan levels can be considered the driving force for food intake (Brandacher and colleagues, 2007).

Teaching Pearl

One rich source of tryptophan is milk. However, although some milk is good, excess can lead to weight gain. It was found that children who drink more than 3 servings a day of milk increased their BMI more compared with those drinking a maximum of 3 cups daily (Berkey and colleagues, 2005). Within a low kcalorie diet in type 2 diabetes, higher intake of milk sources equated with the greatest loss of weight (Shahar and colleagues, 2007). ■

The protein taurine is important for increased resting energy expenditure. Obesity tends to lower body content of taurine because of altered enzyme function-

ing. Supplementing with taurine may be helpful in controlling obesity (Tsuboyama-Kasaoka and colleagues, 2006).

Appropriate hydration best allows cellular metabolism. Dehydration impairs the use of insulin and is related to insulin resistance (Schliess and Häussinger, 2003).

Fact & Fallacy

FALLACY A person trying to lose weight should drink as much water as possible.

FACT Although adequate hydration is important for cellular metabolism and can help promote energy and a feeling of fullness that are helpful in the goal of increasing physical activity and satiety, excess water can lead to hyponatremia, which is counterproductive (see Chapter 13). A simple rule of thumb is that urine should be pale yellow. If it is dark, more water is needed; if the urine is clear, less water should be consumed. ■

HORMONAL IMBALANCES

Insulin is medically defined as being **lipogenic** (from *lipo,* meaning fat, and *genic,* meaning genesis or creation), and it inhibits **lipolysis** (breakdown of body fat). Persons with insulin resistance, as found with the metabolic syndrome, will tend to have hyperinsulinemia with a high carbohydrate intake. The basis of weight gain among persons with insulin resistance and hyperinsulinemia is that lean tissue (muscle) versus adipose tissue (body fat) has a different level of resistance. Insulin resistance is found with lean tissue. Adipose tissue has high insulin sensitivity (Sebert and colleagues, 2005). Therefore the use of glucose is impaired at the cellular level of lean tissue but not with adipose tissue. There appears to be enhanced conversion of kcalories to body fat storage from hyperinsulinemia, resulting in less kcalories available for physical energy needs. This can set up a cycle of reduced physical activity but increased eating because of the feeling of hunger, resulting in weight gain (Lustig, 2006b). The situation is worsened once a person is overweight. In normal-weight individuals, postprandial insulin release appears to promote the sensation of satiety, but there is a suppressed effect in overweight individuals. This may be due to insulin resistance in the central nervous system (Flint and colleagues, 2007). Hyperinsulinemia during pregnancy is associated with increased gestational weight gain and increased postpartum weight retention (Scholl and Chen, 2002).

Obesity is considered a state of **leptin** (a hormone that suppresses appetite) resistance with weight gain being driven by hyperinsulinemia. Three mechanisms are believed to be central to the role of hyperinsulinemia with leptin resistance:

- Kcalories going toward body fat storage
- Interference with leptin's function of appetite reduction
- Promotion of food as a reward to the system due to altered metabolism of **dopamine** (a neurotransmitter in the central nervous system) (Lustig, 2006a).

In a study related to questions of swing-shift work schedules, it appears that the level of leptin is artificially decreased at times of awakening and is believed to contribute to the prevalence of obesity in swing-shift populations (Shea and colleagues, 2005). Inadequate amounts of sleep are found in overweight and class I or II obese

individuals. A cause-and-effect relationship has not been established, but lack of sleep and the associated overweight is suspected to result from changes in leptin and other hormonal levels (Vorona and colleagues, 2005).

Causes of central obesity, as found with the metabolic syndrome, include **glucocorticoid** (hormones released by the adrenal gland) excess. With insulin resistance and hyperinsulinemia, excess **cortisol** (the primary glucocorticoid hormone that catabolizes protein) production is promoted in order to prevent hypoglycemia through the process of gluconeogenesis—see Chapter 2. This may be the factor behind weight gain with chronic skipping of meals. Adequate amounts of deep sleep are needed to help suppress cortisol release. This may also contribute to weight gain among individuals with swing-shift work schedules. A minimum of 6 hours of continuous sleep is needed, and most persons need 8 to 9 hours of sleep to function at peak levels.

Adipose tissue is further recognized to function as an endocrine gland producing its own hormones. Some of these substances are termed **adipocytokines** and may promote maintenance of body fat once it has accumulated. Adipocytokine hormones promote the following (see Figure 6-4):

- Inflammation
- Clot formation
- Free radicals

Adipose tissue inflammation is suspected as the cause of obesity-related health problems. Markers of chronic inflammation such as **C-reactive protein (CRP)** and **interleukin 6 (IL-6)** are found with insulin resistance, obesity, and low levels of an antiinflammatory hormone, **adiponectin.** Adipose tissue further produces free fatty acids that contribute to insulin resistance (Schinner and colleagues, 2005). The hormonal impact of adipose tissue may explain why it is more difficult to lose weight than it is to gain weight initially.

As the level of central obesity increases, adiponectin levels go down, high-density lipoprotein (HDL) cholesterol level is decreased, and low-density lipoprotein (LDL) cholesterol and triglyceride levels are increased (Kwon and colleagues, 2005). This may be the connection with obesity and atherosclerosis, because the early stage of atherosclerosis is found with low serum levels of adiponectin (Pilz and colleagues, 2005). Low levels of this hormone have also been associated with type 2 diabetes and elevated uric acid levels (Gonzalez-Sanchez and colleagues, 2005).

Weight loss appears to raise levels of adiponectin, allowing for improved insulin sensitivity and lowered levels of inflammation. It can be predicted that the higher the baseline CRP level, the greater the rise in adiponectin levels associated with weight loss (Kopp and colleagues, 2005). Through its role as an antiinflammatory agent, adiponectin improves insulin sensitivity and lipid levels.

Ghrelin is a peptide hormone that promotes appetite and is primarily produced by the stomach. Another hormone that promotes satiety is **cholecystokinin,** and higher amounts are noted in response to protein intake (Bowen, Noakes, and Clifton, 2006). This may be part of the reason that a higher protein intake helps regulate hunger. Adequate intake of dietary fat also is needed to promote cholecystokinin production.

Dehydroepiandrosterone (DHEA), an adrenal steroid, is known to decrease body fat and appears to play a role against insulin resistance and atherosclerosis. It has been suggested that the positive effects of DHEA may be a result of stimulation

of adiponectin secretion from adipose tissue (Karbowska and Kochan, 2005). Consultation with a physician is advised with regard to use of DHEA.

Thyroid function affects weight. Insufficient levels of the thyroid hormones triiodothyronine (T_3) and thyroxine (T_4) cause a decrease in basal metabolic rate that can lead to weight gain. A deficiency in growth hormone leads to increased levels of body fat. This may contribute to increase body weight as adults age.

Fact & Fallacy

FALLACY Aspartame, or NutraSweet, causes obesity and is a poison.

FACT The brand-name sugar substitute NutraSweet is made up of two amino acids: aspartic acid and phenylalanine. The controversy over health has to do with how these two amino acids are joined together, which is how the sweet flavor results. The compound that joins the amino acids together is similar to methyl alcohol, which in large amounts is clearly a poison. However, just as with alcohol, the liver is able to metabolize this compound safely. Only in extremely large amounts is there a possible health risk, although some individuals seem to develop headaches with NutraSweet intake. The caution on the labels regarding phenylalanine is related to those persons with phenylketonuria, a congenital metabolic problem. There is a theory, yet unproven, that the sensation of sweetness by the taste buds induces insulin production. For someone who is concerned about this sweetener, other choices can be made, such as drinking water or seltzer and choosing low-sugar foods or foods with alternative sweeteners such as Splenda; see Chapter 8 for more on sugar substitutes. ■

OTHER POTENTIAL CAUSES OF OBESITY

Monosodium Glutamate

There is a wealth of research showing that monosodium L-glutamate (MSG) causes obesity to develop in rat models. How MSG may influence obesity in humans is largely unknown. However, rats given MSG develop problems with the interaction between nerve and hormonal systems. Because the sympathetic nervous system plays a role in energy expenditure, this may be the connection between MSG and obesity.

MSG added to a typical diet for rats increased their food intake, resulting in increased levels of glucose, triglycerides, and insulin. In this study, however, rats that were fed a high-fiber diet along with the added MSG continued to have a normal intake of food (Diniz and colleagues, 2005). It can be deduced from this that MSG apparently causes an increased appetite, which can be at least partly normalized with high-fiber foods and exercise.

Medications

Antipsychotic medications, in particular clozapine and olanzapine, often induce weight gain. The second-generation antipsychotics have been found to induce weight gain to a larger extent than traditional neuroleptic medications used with schizophrenia. Health care professionals need to be aware of the problem of weight gain associated with some antipsychotic medications. The tricyclic antidepressants and mood stabilizers come next in terms of associated weight gain. The old antipsychotics involve less gain of weight.

The β-blocker propranolol was shown in a large dose to decrease resting metabolic rate (RMR) by 60 to 80 kcal/day. This reduced RMR appeared related to decreased levels of norepinephrine—a hormone that increases heart rate and is involved with sympathetic neuron functions (Monroe and colleagues, 2001).

Subdermal implantable contraceptives have caused weight gain in some women. A single-rod subdermal contraceptive caused a weight increase in over 3% of women studied by Funk and colleagues (2005).

Fact & Fallacy

FALLACY Obesity is caused by lack of willpower.

FACT Many overweight persons do not consume a total amount of kcalories in excess of what their thinner counterparts consume. There can be metabolic differences between the obese and the thin person such that the obese person may be better able to conserve kcalories consumed. Research continues to help fully establish the metabolic differences and factors contributing to obesity. ■

WHAT ARE SOME PREVENTION STRATEGIES FOR OBESITY?

Promoting healthy food choices and regular physical activity should begin in childhood. The greatest contributing factor in determining kcalorie intake by preschool children was found to be the amount of food served at meals. Parents and caretakers of children need to avoid providing excess amounts of foods to preschoolers in order to help stem the epidemic of childhood obesity (Mrdjenovic and Levitsky, 2005). Another study by the same researchers found that the greater the intake of sugar-based beverages, the greater the weight gain in children. A higher intake of sweet beverages also tended to reduce intake of milk from children's diets (Mrdjenovic and Levitsky, 2003).

Beverages are often the issue behind excess weight gain. A liter of carbonated soft drink, fruit juice, or fruit punch equates to over ½ cup of pure sugar, or about 400 kcal. This level of kcalories is expected to cause a weight gain of almost 1 lb per week if in excess of the individual's needs. Parents and other caregivers should promote water or seltzer water as a beverage, with a maximum of 1 cup of fruit juice and 3 to 4 cups of milk daily. Soft drink intake should generally be discouraged among children. The 2005 Dietary Guidelines promote reduced intake of sweetened beverages. Childhood weight gain involves many issues. It is paramount to have the child maintain positive self-esteem and feel empowered to make appropriate food choices. Parents can assist by promoting vegetables, fruits, whole grains, and other high-fiber foods such as legumes to promote satiety while facilitating appropriate growth and development of the young child. Lean meats and use of unsaturated fats as found in nuts and peanut butter may be of further help to control hunger and limit caloric intake. Limiting the availability of foods high in saturated fat and sugar within the home can be helpful. This helps to avoid food battles by removing the stimulus.

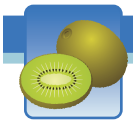
The food environment needs to reflect the 2005 Dietary Guidelines to incorporate whole grains and at least 4 cups of vegetables and fruits in the daily diet for adults. Fast-food restaurants are offering a greater selection of vegetables and fruits. At

home, for families on the run, microwaving frozen vegetables is quick and easy. Increased availability of whole grains is expected as a result of the newer guidelines. The MyPyramid addresses the issue of individualization of menu planning based on age, gender, and physical activity.

The promotion of increased physical activity is of special importance to children. It is a positive strategy to stabilize weight gain and further promotes bone growth and a sense of well-being. School-based programs can be of help. A national intervention trial (Child and Adolescent Trial for Cardiovascular Health [CATCH]) aimed at prevention of obesity found that a structured program of physical activity and offerings of healthy foods at the elementary level helped prevent Hispanic children from gaining excess weight. Among the girls studied, the intervention group gained only 2% over a 2-year period versus 13% in a control group without the intervention, and the boys gained 1% versus 9%, respectively (Coleman and colleagues, 2005).

School-based physical education needs to be a priority to stop the epidemic of childhood obesity. Involvement in sports can play an important role in encouraging children to be physically active. Our work environment needs to be designed to promote physical activity. Stairwells need to be designed for safety and ease to promote their use, or reward incentives might be employed to discourage use of the elevator. Dancing is a fun form of physical activity at any age. A variety of activities such as walking, swimming, playing basketball, housecleaning, yard work, or even doing chair exercises for the physically disabled can help prevent excess weight gain.

These strategies, once started in childhood, can continue into adulthood. If the adult has learned to like a variety of plant-based, high-fiber foods and sugar-free drinks such as water, obesity is less likely to occur as caloric requirements decrease from having a sedentary job or being incapacitated from illness or from aging. It is often too late to start this process after obesity has already set in. Box 6-1 outlines the Surgeon General's Priorities for Action in order to address the epidemic of obesity.



Cultural Considerations

Results show that effective weight management programs can be implemented within communities. In one study in Calcium, New York, it was found that the advice to include low-fat dairy products with a physical activity in a weight management programs was effective. Community participants who were successful walked approximately 3500 to 4000 steps daily (Wyatt and colleagues, 2008). ■

WHAT ARE SOME TREATMENT STRATEGIES FOR OBESITY?

WEIGHT LOSS ISSUES

The 1980s brought forth the goal of lowering fat intake as a simple public health guideline aimed at lowering the rate of obesity. The guideline was 30% fat intake, as still found on food labels. The theory was that by reducing the more concentrated kcalorie source, fat, that weight loss would naturally ensue. However, many individuals took the message literally, such that commercial products that were low-fat or even fat-free were interpreted as being low in kcalories despite the sugar quantity.

Box 6-1 Surgeon General's Priorities for Action

The Surgeon General identifies the following activities as national priorities for immediate action. Individuals, families, communities, schools, worksites, health care, media, industry, organizations, and government must determine their role and take action to prevent and decrease overweight and obesity.

COMMUNICATION

The nation must take an informed, sensitive approach to communicate with and educate the American people about health issues related to overweight and obesity. Everyone must work together to:

- Change the perception of overweight and obesity at all ages. The primary concern should be one of health and not appearance.
- Educate all expectant parents about the many benefits of breastfeeding.
  - Breastfed infants may be less likely to become overweight as they grow older.
  - Mothers who breastfeed may return to prepregnancy weight more quickly.
- Educate health care providers and health profession students in the prevention and treatment of overweight and obesity across the life span.
- Provide culturally appropriate education to schools and communities about healthy eating habits and regular physical activity, based on the Dietary Guidelines for Americans, for people of all ages. Emphasize the consumer's role in making wise food and physical activity choices.

ACTION

The nation must take action to assist Americans in balancing healthful eating with regular physical activity. Individuals and groups across all settings must work in concert to:

- Ensure daily, quality physical education in all school grades. Such education can develop the knowledge, attitudes, skills, behaviors, and confidence needed to be physically active for life.
- Reduce time spent watching television and in other similar sedentary behaviors.
- Build physical activity into regular routines and playtime for children and their families. Ensure that adults get at least 30 minutes of moderate physical activity on most days of the week. Children should aim for at least 60 minutes.
- Create more opportunities for physical activity at worksites. Encourage all employers to make facilities and opportunities available for physical activity for all employees.
- Make community facilities available and accessible for physical activity for all people, including the elderly.
- Promote healthier food choices, including at least five servings of fruits and vegetables each day, and reasonable portion sizes at home, in schools, at worksites, and in communities.
- Ensure that schools provide healthful foods and beverages on school campuses and at school events by:
- Enforcing existing U.S. Department of Agriculture regulations that prohibit serving foods of minimal nutritional value during mealtimes in school food service areas, including vending machines.
- Adopting policies specifying that all foods and beverages available at school contribute toward eating patterns that are consistent with the Dietary Guidelines for Americans.
- Providing more food options that are low in fat, calories, and added sugars such as fruits, vegetables, whole grains, and low-fat or nonfat diary foods.
- Reducing access to foods high in fat, calories, and added sugars and to excessive portion sizes.
- Create mechanisms for appropriate reimbursement for the prevention and treatment of overweight and obesity.

From *The surgeon general's call to action to prevent and decrease overweight and obesity, section 4: vision for the future,* Rockville, Md, 2001, U.S. Department of Health and Human Services.

In their attempt to lower the amount of fat in a food product, food companies had to replace the volume and flavor benefit of fat with another ingredient, often sugar. Consequently, many low-fat food products had more kcalories than the original items. Both from a kcalorie aspect, and that of hyperinsulinemia from higher carbohydrate intake among individuals with insulin resistance, the outcome of a low-fat approach often resulted in weight gain. As Americans often go for extreme measures, the rebound effect was for a very-low-carbohydrate diet, discounting the fat content of many of the high-protein foods advocated.

Currently a more moderate approach is again being practiced, primarily due to the inherent difficulty of adhering long term to a very low carbohydrate intake. Diets high in protein but either low in carbohydrate, with less than 90 g/day, or modest in carbohydrate have been more beneficial to weight loss than traditional low-fat diets of less than 25% of kcalories. Low-kcalorie weight-loss diets moderate in carbohydrate (35% to 50% of kcalories), moderate in fat (25% to 35% of kcalories), and protein at 25% to 30% of kcalories intake appears most beneficial (Schoeller and Buchholz, 2005).

The Recommended Dietary Allowance (RDA) for minimum carbohydrate intake has been set at 130 g/day. Several minimeals with about 15 g of carbohydrates each, with emphasis on high-fiber foods such as legumes, whole grains, vegetables, and fruits, is low enough in carbohydrates for even the most insulin-resistant person (refer to Chapter 5). Most individuals lose weight with 30 g of carbohydrate in each of six meals, with an upper limit of 200 g daily. Increased intake of lean protein sources, up to 30% of kcalories, appears to be well tolerated. Up to 35% of caloric intake from fat is acceptable if the emphasis is on monounsaturated fats such as olive oil and most nuts. The guideline for saturated and polyunsaturated fat intake is a maximum of 10% each in one's diet (see Chapter 2).

Ultimately, the greatest success comes from what works for the individual. There is no one diet that fits all. Kcalorie restriction is the key variable associated with weight reduction in the short term. This was reinforced with a study that found improvements in body weight, waist size, and triglyceride levels with the three basic diet types of high carbohydrate and high fiber, high protein, or high fat (McAuley and colleagues, 2005). One study found no difference in weight loss outcome with high protein (34%) and moderate carbohydrate (41%), whether there was high calcium intake (2400 mg daily) or moderate calcium intake (500 mg daily) (Bowen, Noakes, and Clifton, 2005).

Individual preferences therefore can and should be taken into account. The comprehensive treatment plan includes some basic components: a nutritionally adequate reduced-kcalorie eating plan; physical activity; and, as needed, behavior modification and cognitive behavioral therapy. Some simple and practical behavior modification strategies include factors such as slowing down the pace of eating or sitting down with a reasonable portion size versus large containers of food that make it too easy to eat past the point of fullness. Cognitive behavioral therapy is aimed at thought processes such as breaking the connection between using food for reward and comfort or contending with body image issues.

A nutritionally adequate eating plan meets the basic needs for protein and for energy from unsaturated fats and high-fiber carbohydrate sources to achieve a slow, steady weight loss with adequate variety of foods to meet vitamin and mineral needs. There are many ways to develop a daily menu or food plan that meets these basic nutritional needs.

A weight loss of only 5% to 10% of initial weight can improve the health complications found with the metabolic syndrome. For example, the Diabetes Prevention Program found a 7% reduction in initial weight, along with 150 minutes of physical activity per week, reduced the risk of developing type 2 diabetes by over 50%. Behavioral treatment consistently induces weight losses in this range (Jones, Wilson, and Wadden, 2007). Lifestyle modification includes three basic components: diet, physical activity, and behavior therapy. Behavior therapy in reference to weight control refers to a set of principles and techniques to can help a person develop new diet and exercise habits that can be sustained long term to promote health.

Whatever approach is chosen by an individual for weight loss, it needs to be safe and effective over the long term. A rapid weight loss that is not sustainable, or that causes damage to one's health, is not appropriate and should be discouraged by the health care professional. Health care professionals need to actively promote a realistic, sustainable, and appropriate weight loss goal to promote health and well-being.

Teaching Pearl

One challenge health care professionals face in their role of fostering a positive lifestyle is false perceptions regarding foods and snacks and their impact on weight and health. Reviewing specific food choices of an individual may reveal perceptions that are promoting weight gain. Adults who were asked to rate foods based on potential impact on weight were found to have misconceptions related to kcalorie content of foods. It was noted that some lower-calorie foods were perceived to promote greater weight gain than some other higher-calorie and higher-fat snacks (Oakes, 2005). A common belief is that bread, pasta and potatoes are fattening whereas fruit can be eaten freely. However, ½ cup of pasta or potatoes has only 20 kcal more than the majority of fruits per ½ cup volume. ■

Often it is felt that weight loss from changes in lifestyle is not very effective. For this reason the National Weight Control Registry was established in 1993 to examine the characteristics of those who are successful at weight loss. Criteria for membership is maintaining a 30-lb weight loss for over 1 year. There is variability in these characteristics of successful weight loss maintainers regarding physical activity levels, with about one fourth expending less than 1,000 kcal per week and about one third reporting over 3,000 kcal per week (Catenacci and colleagues, 2008). Another study of enrollees in the registry who had lost an average of about 70 lb with long-term maintenance of weight loss continued to follow a low-calorie diet with moderate fat intake, limited fast food, and high levels of physical activity (Phelan and colleagues, 2006). The majority of registry members with successful weight loss maintenance also reported watching 10 or fewer hours of TV per week, whereas only about 1 in 10 watched an average of over 3 hours daily. This contrasts with the national average of 28 hours of TV viewing per week (Raynor and colleagues, 2006).

Gender appears to play a role in successful weight loss. Obese men typically achieve significantly greater weight loss than overweight women. This is likely a result of the combination of larger body size, with inherent higher kcalorie needs, and the higher muscle mass. Muscle is active tissue, whereas adipose tissue requires less energy to sustain itself.

Typically, successful weight loss plans help incorporate high-fiber foods to promote satiety. Meal plans that follow the adage of dietitians that "all foods can fit" can help a person to avoid feelings of deprivation. An overly restrictive diet is generally setting a person up for weight loss failure in the long run. The body has some powerful mechanisms that will send a person foraging for food when the body perceives starvation.

Lifetime habits, not short-term diets, should be promoted. The only exceptions to this are if the individual's life is at risk because of sleep apnea or if surgery requires a rapid loss of body fat. Rapid weight loss generally includes muscle loss, a detriment particularly for women, who typically have low muscle mass to begin with. The same is also true for older adults, who generally are not well served by a goal of weight loss (see Chapter 13). An obese individual may actually have less muscle mass than his or her thinner counterpart, making it imperative that muscle mass be maintained while having the goal of loss of adipose tissue.

Physical activity can be a challenge for persons engaged in long workdays or those who have a variety of social engagements or family care issues. Any increase in physical activity is helpful. Developing a habit or routine of exercise can often best be established by setting small, achievable goals. Exercise can be as simple as walking in place in the confines of one's home. It is recommended that all Americans aim for at least 30 minutes of moderate-intensity exercise most days of the week. For the goal of weight loss or prevention of weight gain, at least 60 minutes of physical activity is advised with the MyPyramid guide.

Healthy People 2010 objectives include increasing the proportion of adults who engage regularly in moderate or vigorous activity to at least 50%. Current data indicate white adults and African American males are close to this goal at over 45%, but only a little over one third of African American women meet this goal, although the rate is increasing (Centers for Disease Control and Prevention, 2007).

PREDICTING WEIGHT LOSS

It takes a deficit of about 500 kcal/day to lose 1 lb of fat weekly, because 3500 kcal equates to approximately 1 lb of body fat. In other words, a reduction of 500 kcal daily predicts a weekly weight loss of 1 lb (3500 kcal). For safe and permanent weight loss, an individual should lose a maximum of 1 to 2 lb per week. Persons with a history of diet failures or weight cycling may be more accepting of a slow weight loss approach, having learned firsthand that rapid weight loss typically is not maintained in the long run.

Because of the way the body uses fuel from carbohydrate, fat, and protein, rapid weight loss will compel the body to use protein (muscle) instead of fat for energy. Rapid weight loss is therefore highly undesirable because it decreases muscle mass. Weight cycling can change the body's composition such that muscle percentage decreases with each dieting attempt and body fat percentage increases with each failed dieting attempt.

A simple estimate of kcalorie needs is a minimum of 10 kcal per pound of body weight for weight maintenance. Most adults need 12 kcal/lb, and active adults need 15 kcal/lb. Therefore a 250-lb individual should require at least 2500 kcal to maintain weight, and a meal plan of 2000 kcal would be expected to result in a 1-lb weight

Box 6-2 Nondieting Rules of Thumb

1. Eat regularly; don't get overly hungry, or common sense goes out the window.
2. Take half the amount you normally do, and chew twice as long for the same taste satisfaction.
3. Focus on high-fiber foods, and stop eating when the stomach is comfortably full.
4. When tempted by a food, ask yourself, "Do I really need this, or do I just want it?"
5. Wait 15 minutes if you're not sure you really need to eat.
6. Eat your fruit; don't drink it. Drink water for thirst.
7. To deal with the perceived need to "clean your plate," remember that excess food goes either to waste or to the waist.
8. When faced with an indulgence, ask yourself, "How will I feel tomorrow if I don't eat this food today?" Give yourself permission to eat if feelings of deprivation may arise.
9. When ready to give up on dieting efforts, remember Ann Landers' quote: "The difference between a successful person and an unsuccessful person is that the successful person never stops trying."
10. Include regular physical activity.

loss weekly. Another approach is to omit 500 unnecessary kcalories, such as those found with excess intake of sweetened beverages.

Theoretic needs, however, do not always match individual needs. Too much emphasis on kcalories can be counterproductive. Reducing the concentrated kcalorie sources of fat and sugar while increasing fiber intake and chewing thoroughly can allow internal hunger cues to guide a person's total food intake. This is part of the nondieting approach. See Box 6-2 for specific nondieting tips.

Fact & Fallacy

FALLACY Skipping meals is a good way to lose weight.

FACT Studies have shown that eating three to six meals a day is the best and most healthful approach. Skipping meals tends to suppress the metabolism (the rate at which kcalories are burned) and can lead to overeating later in the day. ■

MEDICATIONS AND SUPPLEMENTS FOR WEIGHT LOSS

Many individuals want a quick fix to promote weight loss. It should be remembered that there are no long-term data supporting the safety of any diet aid. Past experience indicates extreme caution should be taken. Prescription medications have proved to be dangerous and pulled from the market. Safety concerns led to the withdrawal of the fenfluramines in 1997 because they were linked with a form of heart disease and pulmonary hypertension, and phenylpropanolamine (norephedrine) was withdrawn in 2000 because of increased risk of stroke. The same holds true for herbal products such as ma huang (ephedra). The use of supplements should always be reviewed with a physician. Refer to Chapter 3 for quality concerns about the largely unregulated supplement industry.

Conjugated linoleic acid (CLA) is a popular weight loss supplement, but is controversial. On a positive note, supplementation among overweight adults was found to significantly reduce body fat over 6 months and prevent weight gain during the holiday season (Watras and colleagues, 2007). Lean body mass was found to increase with CLA by about 1½ lb at a level of supplementation of 6400 mg of CLA per day after 12 weeks of use. However, along with this there were significant decreases in the "good" HDL cholesterol, hemoglobin, and hematocrit, along with significant increases in indicators of inflammation (Steck and colleagues, 2007). Supplements of CLA increase its content in skeletal muscle along with ceramide and decrease insulin sensitivity (Thrush and colleagues, 2007).

Orlistat is a potent and specific inhibitor of intestinal lipases. The U.S. Food and Drug Administration approved the over-the-counter sale of orlistat (60 mg 3 times daily). Health care professionals should be aware of possible adverse effects, particularly gastrointestinal effects such as diarrhea. The fat malabsorption that occurs with orlistat may compromise health by reducing absorption of the fat-soluble vitamins (refer back to Chapters 3 and 4). The use of orlistat also has been associated with oily stools, abdominal pain, and fecal spotting due to incontinence. A few cases of serious liver adverse effects include cholelithiasis (gallstones, see Chapter 4) and liver problems. It also has been associated with rare cases of acute kidney injury, possibly due to the increased fat malabsorption resulting from the inhibition of fat-digesting enzymes. Orlistat interferes with the absorption of many drugs (such as warfarin, amiodarone, and thyroxine, as well as fat-soluble vitamins), affecting their bioavailability and effectiveness (Filippatos and colleagues, 2008).

Sibutramine hydrochloride (Meridia) is occasionally used as an appetite suppressant, but as with all medications, it is associated with a variety of potential side effects. Topiramate (Topamax) is a medication initially used for seizure management and more recently for migraine prophylaxis. It is associated with reduced appetite and weight loss but is not approved for this use. Bupropion (Wellbutrin) has shown modest weight loss when used for patients with depression.

WHAT ARE SOME POPULAR WEIGHT LOSS APPROACHES?

THE EXCHANGE LISTS FOR WEIGHT MANAGEMENT

The Exchange Lists is a tool used in reducing caloric intake. Originally developed by the American Diabetes Association and the American Dietetic Association, the system aims to control carbohydrate and caloric intake in the management of diabetes (see Appendix 3 on the Evolve website). It can also be used for weight management alone. Weight Watchers has used this system in the past. However, it is often too complicated and does not teach the recognition of internal cues of hunger and satiety. It can, however, still serve as an educational tool to teach nutritional content of foods. It is useful to develop a target meal plan based on percentage of macronutrients, such as the goal of 30% protein, 40% carbohydrate, 30% fat.

THE MYPYRAMID FOOD GUIDANCE SYSTEM

MyPyramid.gov provides individual guidance for amounts of food needed and provides a nutritional assessment tool. The minimum number of servings generally recommended provides about 1200 to 1500 kcal, especially if only lean meats and

Table 6-2 The MyPyramid Food Guidance System as a Healthy Weight Loss Plan

FOOD GROUP	SERVING SIZE	COMMENTS
Bread, cereal, rice, and pasta group (6-11 servings)*	1 slice of bread 1 oz of ready-to-eat cereal (check labels: 1 oz = ¼ to 2 c, depending on cereal) ½ c of cooked cereal, rice, or pasta ½ hamburger roll, bagel, English muffin 3-4 plain crackers (small)	Count each serving of starch as 80 to 100 kcal. Based on carbohydrate content and kcalories, count dry vegetables (potatoes) and sweet vegetables (sweet corn, sweet peas, and sweet winter squash) as a starch. Emphasis should be on whole grains.
Vegetable group (3-5 servings; 2½ c)*	1 c of raw leafy vegetables ½ c of other vegetables, cooked or chopped raw ¾ c of vegetable juice	One serving of vegetables is about 25 kcal. Vegetables that are low in carbohydrate and kcalories are high in water content and are not sweet.
Fruit group (2-4 servings; 2 c)*	1 medium apple, banana, orange, nectarine, peach ½ c of chopped, cooked, or canned fruit 1 c of fruit juice	One serving of fruit is about 60-100 kcal. Fruits that are dry (bananas) or are in portions greater than ½ c generally contain more kcalories.
Milk, yogurt, and cheese group (3 servings, low-fat or nonfat)*	1 c of milk or yogurt 1½ oz of natural cheese 2 oz of processed cheese	1 c of fat-free milk has about 80 kcal. 1% milk has 100 kcal, 2% milk has 125 kcal, and whole milk has 170 kcal. 2 oz of full-fat cheese contains 200 kcal.
Meat, poultry, fish, dry beans, eggs, and nuts group (2-3 servings; 5 oz)*	2-3 oz of cooked lean meat, poultry, or fish (1 oz of meat = ½ c of cooked dry beans, 1 egg, or 1 tbsp of peanut butter)	1 oz of most meat contains 75 kcal. Lean meat contains 50 kcal/oz, and high-fat meat contains 100 kcal/oz. 1 tbsp peanut butter contains 100 kcal and is counted as 1 oz of meat in the Exchange System. 1 oz = ¼ c; 3 oz is the size of a deck of cards.

*Recommended number of servings per day—refer to MyPyramid.com for individual guidance.

fat-free milk and no added fats or sugars are consumed (Table 6-2). The diet can safely be further reduced in kcalories if low-carbohydrate vegetables are consumed instead of fruits, because most vegetables have fewer than half the kcalories of fruit for similar nutritional value. This needs to be based on individual acceptance of nutrient-dense vegetables such as the dark-green leafy vegetables (all good sources of vitamins A and C). Too restrictive a diet may lead to nutritional deficiencies if followed long term or if food choices are not made wisely. A multivitamin and mineral supplement is recommended if kcalorie intake is less than 1200 daily.

The minimum amount of milk being advised by the 2005 Dietary Guidelines and the MyPyramid food guidance system is 3 cups, which provides about 1000 mg of calcium daily. The reports of milk promoting weight loss are based on little research. One study, however, found that a 1-week increase in dietary calcium intake to 1800 mg, with a normal protein intake, decreased the absorption of fat, thereby promoting energy loss by approximately 85 kcal. This observation may explain why a high-calcium diet has been observed to promote weight loss (Jacobsen and colleagues, 2005). Aside from possible weight loss benefits, calcium is still an essential mineral. Postmenopausal women on weight loss diets are advised to consume 1700 mg of calcium daily to minimize bone loss (Riedt and colleagues, 2005).

Table 6-3 shows how a normal 3000-kcal diet, which may be needed with an active adolescent teenager, can be modified to give one family member a 1200-kcal diet without preparing separate meals. Some items are omitted, some are served in smaller portions, and some are served in modified form—for example, fat-free milk instead of whole milk or coffee served black instead of with cream and sugar.

FOOD LABELS

Reading food labels can be a good way to help plan meal goals. A low-fat meal is defined as 15 to 20 g of fat or less. Snacks might be planned around 3 g of fat or less. Daily protein intake should be at least 60 g with a low caloric intake. Carbohydrate content of food is also included on labels.

The total carbohydrate value listed on food labels is the sum of the amounts of sugars, starch, and fiber. Net carbohydrates as currently listed on labels is the total grams of carbohydrate minus the fiber and the sugar alcohol content. This is slightly misleading, because sugar alcohols do contribute some kcalories. The American Dietetic Association advises counting half of the sugar alcohols as a carbohydrate source. From a kcalorie point of view, the American Dietetic Association further advises subtracting only one half of fiber content. This is due to bacterial breakdown of fiber in the gastrointestinal tract that results in fatty acid production, allowing for some energy production. Refer to Chapter 2 regarding the different forms of carbohydrate.

Weight loss can usually be achieved with a daily intake of 40 to 50 g of fat and 150 to 200 g of carbohydrate (after subtracting fiber). Labels can be used by those individuals who want to count their kcalories, or count fat, or count carbohydrates. Labels also indicate protein content. Depending on body weight, body composition, and activity levels, men generally will lose weight on a 2000-kcal diet (65 g of fat and 300 g of carbohydrate as per the food labels; for men with the metabolic syndrome, based on a 35% fat and 50% carbohydrate goal, these numbers are about 80 g of fat and 250 g of carbohydrate).

Fact & Fallacy

FALLACY If the food label states 0 g of fat, the food may be eaten freely.

FACT The low-fat message has been very successful—almost too successful in some cases. It is possible to have too low an intake of fat, and an absolute minimum of 20 to 30 g/day should be promoted for overall health and well-being. In the quest to achieve a low-fat diet, many have forgotten about carbohydrates and, specifically, sugar. Pointing out that 4 g of sugar equates to 1 tsp can be an eye-opener to many. About a handful (½ cup) of jelly beans or other pure-sugar candies, which contains about 100 g of sugar at 4 kcal/g, equates to about 400 kcal. ■

THE VERY LOW-FAT DIETS

Very low-fat diets are aiming their approach at the concentrated kcalories of fat. Fat has 9 kcal/g of weight, compared with 4 kcal/g for carbohydrate and protein. As an extreme example, ½ cup of pure fat has well over 1000 kcal. By comparison, even ½

Table 6-3 Modified 3000-kcal Diet

	1200 kcal	3000 kcal	
Breakfast			
Fresh orange	1 orange	Orange juice	½ c
Soft-cooked egg	1 egg	Soft-cooked egg	1 egg
Whole-wheat toast	1 slice	Bacon	2 medium strips
Butter or margarine	1 tsp	Whole-wheat toast	2 slices
Fat-free milk	1 c	Butter or margarine	2 tsp
Coffee (black), if desired	1 c	Whole milk	1 c
		Coffee	1 c
		Cream	1 tbsp
		Sugar	1 tbsp
Lunch			
Sandwich:		Sandwich:	
Whole-grain bread	2 slices	Enriched bread	3 slices
Boiled ham	1½ oz	Boiled ham	3 oz
Mayonnaise	1 tsp	Mayonnaise	2½ tsp
Mustard	free	Mustard	free
Lettuce	1 large leaf	Lettuce	2 large leaves
Celery	1 small stalk	Celery	1 small stalk
Radishes	4 radishes	Radishes	4 radishes
Dill pickle	½ large	Dill pickle	½ large
Fat-free milk	1 c	Whole milk	1 c
Tossed salad	1½ c	Tomato soup with milk	1 c
Salad dressing	1 tbsp	Apple	1 medium
Dinner			
Roast meat	2 oz	Roast meat	4 oz
Rice, converted	½ c	Rice, converted	⅔ c
Spinach	¾ c	Spinach, buttered	¾ c
Lemon	¼ medium	Lemon	¼ medium
Salad:		Salad:	
Peaches, canned	1 half peach	Peaches, canned	2 half peaches
Cottage cheese	2 tbsp	Cottage cheese	2 tbsp
Lettuce	1 large leaf	Lettuce	1 large leaf
Fat-free milk	1 c	Rolls, enriched	2 small
		Butter or margarine	1 tsp
		Plain cake, iced	1 piece, 3×3×2 in
Between-Meal Snack			
Apple	1 medium	Saltines	4
		Peanut butter	2 tbsp
		Whole milk	1 c

Modified from U.S. Department of Agriculture (USDA): *Food and your weight*, Home and garden bulletin No. 74, Washington, DC, USDA.

cup of sugar has only 400 kcal. Even better, ½ cup of most vegetables has only 25 kcal. Therefore, although sugar has fewer kcalories than fat, it is still a concentrated source of kcalories. So it is indeed possible to lose weight on a very low-fat diet, but because fat also helps with the feeling of satiety, such a diet often leaves dieters hungry and dissatisfied. This approach has also caused many individuals to be afraid of eating any fat. This is a health problem in that essential fatty acid deficiency can occur, resulting in hair loss and endocrine problems. Also, a very low-fat diet is inherently high in carbohydrates, which may lead to increased heart disease for a person with insulin resistance and hyperinsulinemia. The Ornish diet emphasizes very low fat but also promotes higher intake of fiber.

LOW IN FAT, HIGH IN FIBER

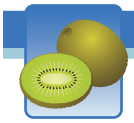
This type of meal plan has been referred to as the prudent diet. By emphasizing foods high in fiber, satiety is promoted, and low caloric value allows individuals to trust their natural hunger and satiety cues. This can be a commonsense and easy weight loss plan for many individuals. However, the very low-fat approach discourages use of the monounsaturated fats, which are helpful for individuals with the metabolic syndrome. The Weight Watchers program now uses a point system with the points based on fat and fiber content of foods. Foods high in fiber and low in fat are counted as having fewer points than foods low in fiber and high in fat. In the Women's Health Initiative Dietary Modification Trial a low-fat eating pattern in conjunction with increased intake of high-fiber foods was related to weight loss in postmenopausal women. There was more weight loss and maintenance of weight loss among women receiving group and individual counseling sessions as compared with women who only received diet-related education materials (Howard and colleagues, 2006).

MODERATE IN FAT, HIGH IN FIBER

A beneficial effect of consuming nuts, which are high in fiber and monounsaturated fats, has been noted on body weight, along with a 30% to 50% reduction in the risk of cardiovascular disease and improved cholesterol level. A moderate fat intake is about 35% of total kcalories, or about 60 g of fat for a 1500-kcal level.

Suppressed insulin release occurs with reduced carbohydrate intake or with meals that are more slowly digested. Peak plasma glucose and serum insulin concentrations were found to be greater after a high–glycemic index breakfast than after a low–glycemic index one. This has implications for metabolism. During exercise the estimated rate of fat oxidation was found to be greater in the group having the low–glycemic index meal (Stevenson and colleagues, 2006).

The antiinflammatory action of fish oil may be beneficial as part of a moderate fat intake. It was found that in young, overweight men the inclusion of any type of fish, lean or fatty, or fish oil as part of a low-kcalorie diet resulted in approximately 2 lb greater weight loss per month than did a similar low-kcalorie diet without fish or omega-3 supplement (Thorsdottir and colleagues, 2007).



Cultural Considerations

A significant number of people in the United States have "tried all the diets." Some of this may be a result of attempts to find an approach that works. However, some individuals enjoy the excitement of trying a new diet. This can be one reason for diet failure, because the excitement fades away with long-term adherence to a dietary regimen.

Thus such individuals purposely try all the latest diets. ■

THE LOW-GLYCEMIC DIETS

The low–glycemic index (GI) diets are similar to the Therapeutic Lifestyle Changes (TLC) diet (see Chapter 7). They differ, however, by putting undue emphasis on food rankings based on predicted rise in postprandial blood glucose levels. The problem with this approach is that it is overly simplistic. When the GI rankings were developed, it was by having research subjects ingest individual foods, one at a time. The issue is that most people don't sit down to eat just a potato. As may be recalled from Chapters 2 and 4, digestion time is slowed with protein and fats. Thus, if the potato is consumed as part of a meal with lean meat, unsaturated fats such as a salad dressing, and high-fiber vegetables, it is now a low-GI meal that includes the potato. Thus it is not about avoiding specific foods, but planning meals that are balanced with high-fiber sources, moderate amounts of carbohydrate, and inclusion of protein and fat sources to prolong the time of digestion and lessen the impact on blood glucose levels. A person with type 2 diabetes who is monitoring his or her blood glucose level can use the blood glucose monitor to help guide choices with meals (see Chapter 8).

One benefit of a low–glycemic index meal appears to be reduced kcalorie intake at the following meal (Flint and colleagues, 2006). From a weight loss perspective, lower peak plasma glucose and serum insulin concentrations with low–glycemic index meals can be beneficial to metabolism. The rate of fat oxidation during exercise has been found to be greater with a low–glycemic index meal (Stevenson and colleagues, 2006).

THE VERY LOW-CARBOHYDRATE DIETS

Very low-carbohydrate diets have sprung from the belief, substantiated by growing research, that insulin induces the gain of body fat. However, the consumer who follows this type of diet may share the extremist view that all carbohydrate foods are bad, which can lead to very poor diets. Because carbohydrate is primarily found in plant-based foods, these diets can set a person up for vitamin and mineral deficiencies. Some may argue that such a diet is sufficient as long as the person following it takes a vitamin and mineral supplement. However, it has been estimated that there are at least 100 phytochemicals (refer back to Chapter 3) yet to be discovered. Even arsenic is now considered essential for health, but it is much wiser to get it from plant-based foods than from a supplement because arsenic in excess is a known poison.

Premenopausal overweight and obese women assigned to follow the Atkins diet, which had the lowest carbohydrate intake, lost more weight at 12 months (about 10 lb) than women assigned to follow the Zone diet and had experienced comparable or more favorable metabolic effects than those assigned to the Zone or Ornish diets (Gardner and colleagues, 2007).

Teaching Pearl

It may be argued that our ancestors likely ate a lot of meat; however, it was not from commercially raised cattle sitting in a stall being force-fed all day. A 1-lb steak today has the equivalent of ½ cup of pure lard, whereas 1 lb of wild game contains about 1 to 2 tablespoons of fat. Unsaturated fats would have been the primary source of fat (e.g., from nuts and seeds for those living in forests or from fatty fish for those living near the sea). With an emphasis on unsaturated fats, insulin sensitivity is improved, allowing for better cellular use of glucose from carbohydrates, especially those high in fiber. ■

Fact & Fallacy

FALLACY Until his untimely death, Dr. Atkins continued to promote saturated fat as found in steak, sausage, bacon, and cheese, while promoting a very low-carbohydrate intake.

FACT Dr. Atkins was on national television the month before he died promoting a change to lean meats and use of unsaturated fats with increased intake of high-fiber foods. The book *Atkins Diabetes Revolution*, completed by his colleagues after his death, explains his change in thinking. ■

HIGH PROTEIN, MODERATE CARBOHYDRATE, LOW SATURATED FAT

There appear to be many benefits of a higher protein intake with low-kcalorie diets. Protein meals suppress levels of ghrelin and tend to reduce subsequent food intake (Bowen, Noakes, and Clifton , 2006). A high-protein (1-1.5:1 ratio of protein to carbohydrates) diet promotes weight loss while improving body composition better than a low-fat diet either alone or when combined with exercise (Meckling and Sherfey, 2007). An increase in dietary protein from 15% to 30% of kcalories was found to lower food intake equivalent to about 450 kcal daily. This anorexic effect of protein may be due to increased central nervous system leptin sensitivity (Weigle and colleagues, 2005). Overweight, menopausal women following a lacto-ovo vegetarian diet were found to have comparable weight loss outcomes at 17% protein intake as compared with a diet including meat at a 25% protein level for nonvegetarians (Mahon and colleagues, 2007).

However, adherence to a high-protein diet over a longer period of time may lead to problems, even with healthy kidney function. For persons with chronic kidney disease, which is often asymptomatic, high-protein diets have the potential to cause significant harm. Individuals wanting to follow a high-protein diet should first undergo a serum creatinine measurement (a laboratory value used to detect kidney problems—see Chapter 9) and urinary dipstick test for proteinuria (a measure of protein in the urine, another sign of kidney malfunction).

The Zone diet promotes a 30-20-10 approach to meals, meaning meals of 30 g carbohydrate, 20 g protein, and 10 g fat with snacks at half this quantity. This is an easy-to-remember approach that may be useful. This quantity meets the DRI for carbohydrate, is moderately high in protein, and moderately low in fat and tallies to 1300 kcal at 135 g carbohydrate (41%), 90 g protein (28%), and 45 g fat (31%). However, this amount of kcalories is likely to be too low for most men without causing excess hunger.

LIQUID DIETS

Liquid diets have been around for many years. Obviously if they promoted successful weight loss, we would not be in an epidemic of obesity. The chief problem with these diets is they are not sustainable. They promote the thinking that a person is either on a diet or off a diet. Such diets can be appropriate for someone whose life is in imminent danger and needs to lose weight quickly, but they should always be followed under physician supervision. Some individuals have actually gained weight with liquid diets. These products have a relatively high GI and can cause hyperinsulinemia in persons with insulin resistance. The prepackaged portion and convenience of consumption may be helpful. However, many prepackaged or smaller-portioned foods are also readily available.

PREPACKAGED FOODS DIETS

These programs can be useful for short-term weight loss. However, weight gain often occurs after the individual has grown weary of the foods or the program closes its doors. These types of commercial programs often seek other forms of revenue from their consumers, such as selling vitamins and minerals or other supplements touted to promote weight loss. These are often very expensive programs that do not have long-term success rates. Consumers can save a lot of money and develop long-term food habits simply by purchasing prepackaged foods from the local grocery store.

FOOD-RESTRICTIVE DIETS

There are many versions of food-restrictive diets. These are generally fad diets (diets that are popular at a certain time but that are not sustainable). A popular one has been the cabbage soup diet. Granted, there is absolutely nothing wrong with eating cabbage soup. However, there is a whole variety of vegetable-based soups that are low in kcalories. The thinking behind these restrictive diets is that overweight persons cannot control their food intake. The rationale of food-restricted diets is reduced intake. This is particularly true after eating cabbage day in and day out for weeks. Ultimately, though, intense cravings for other foods set in, and the person usually gains all the weight back plus more.

NONDIETING APPROACHES

A nondieting approach focuses on eating in response to physical hunger and satiety cues, rather than solely focused on knowledge of what to eat. Nondieting interventions can promote emotional health and healthy habits while allowing weight loss, as shown in one study in which almost half of the study participants had lost weight at the 4-month point (Bradshaw and colleagues, 2004) (Box 6-2). Data from the National Weight Control Registry have shown that individuals who reported a consistent diet versus those who were more strict at certain times were more likely to maintain their weight loss (Gorin and colleagues, 2004).

A nondieting approach is similar to behavior modification. The primary difference is a focus on internal hunger and satiety cues versus external cues to eat.

As reviewed previously, an emphasis on high-fiber foods with moderately high intake of lean protein sources and unsaturated fats promotes satiety. Add to this regular meal and snack times of about every 2 to 3 hours to prevent undue feelings of hunger, for the goal of six small meals. Furthermore, a slow pace of eating will promote the optimal feeling of satiety and reduce hunger levels. A decreased pace

of eating is a simple, effective, and positive means of managing weight. Men tend to lose weight easily simply by decreasing the pace of eating because increased satiety helps prevent excess intake; for children it affords a means that does not damage self-image through food restrictions.

BEHAVIOR MODIFICATION

There is increasing evidence of the value of behavior modification techniques. This includes promoting practical strategies to develop positive lifestyles in both dietary and exercise counseling (Hills and Byrne, 2006). Health care professionals can help a person develop effective behavioral goals by assessing his or her readiness to change, promoting realistic goal setting, and consistently working in a client-centered way to help motivate and encourage the individual's progress. Some other basic strategies that can be useful in promoting behavior changes for sustained weight loss include self-monitoring, behavioral contracting, stimulus control, cognitive restructuring, stress management, social support, physical activity, and relapse prevention.

The nurse or other health care professional can be of further help by assessing misconceptions about foods. In a study of adults involved in a behavioral weight loss program it was found that perceived healthy foods for weight loss were underestimated in kcalorie content, whereas perceived unhealthy foods that promoted weight gain were overestimated in kcalorie content. Higher baseline BMI was associated with greater inaccuracy in kcalorie estimation of foods (Carels, Harper, and Konrad, 2006).

Behavior modification involves assisting the overweight or obese individual in identifying the personal eating behaviors that have been promoting weight gain or preventing weight loss. Many may know how much food they should eat but have eating habits that are not conducive to change. Once these habits have been recognized, various techniques can be used to minimize their effects or remove them from the environment. For example, a person may have become conditioned to eat a high-fat snack on returning home after work. The change might be to a lower-calorie snack or a smaller portion. The goal might also be to learn to eat more slowly. For another person, it might be to drink beverages low in sugar. For another it might be to learn methods of stress management other than turning to food. Many older adults, who lived through the Great Depression, find it exceedingly difficult to leave food on their plates. Strategies to prepare more appropriate food portions or to order senior portions at restaurants might be helpful. By focusing on small, gradual behavioral changes, the individual learns to gain control of eating behaviors, with the goal of permanently changing negative habits.

Fact & Fallacy

FALLACY Eating carbohydrates only at night is a good weight loss plan.

FACT The only scientific evidence supporting this weight loss approach is that we are the most insulin resistant on arising. This is called the dawn phenomenon and generally results in increased production of insulin. Therefore including a smaller amount of carbohydrate foods at breakfast may be helpful for those with insulin resistance. There is no evidence, however, that this phenomenon is a concern for individuals without insulin resistance. Avoiding carbohydrate intake during the day may cause undue hunger and result in overeating at night. ■

WHAT IS BARIATRIC SURGERY AND WHAT IS ITS IMPACT?

The weight loss surgical techniques of **bariatric surgery** can be classified as restrictive (surgically making the stomach pouch smaller with removal of certain portions or placing a constrictive band around the stomach), malabsorptive (removing portions of the small intestine), or mixed procedures. The malabsorptive procedures have the greatest potential for causing malnutrition. Individuals with extreme obesity or class III obesity (formerly called morbid obesity) who have not had success with other weight loss efforts may be approved for surgical intervention. Persons with class II obesity with high mortality risk may also be considered for surgical intervention.

Surgery is meant to be the last-ditch effort to prevent mortality from conditions related to extreme obesity but is increasingly becoming part of mainstream medicine such as with diabetes management. The resolution or improvement of type 2 diabetes has been found to occur within the first week of bypass gastric surgery unrelated to weight loss (Wickremesekera and colleagues, 2005). The number of gastrointestinal surgeries performed annually for extreme obesity in the United States has increased from about 16,000 in the early 1990s to over 100,000 by 2003, and the numbers are expected to continue dramatically increasing.

Gastric banding is one form of bariatric surgery that is reversible. It has the lowest mortality rate and is effective in weight loss in the long run. In one study it was found to provide weight loss of 47% with an average BMI reduction of over 10 points, from about 45 to 35, by the third year (Spivak and colleagues, 2005). With the small intestine remaining intact, concerns of malnutrition are greatly diminished. The band can be removed, making this procedure the most advisable for adolescents and women of childbearing years. At New York University School of Medicine among obese adolescents weight loss using gastric banding was found to be as effective as malabsorptive gastric bypass procedures with 55% weight loss at both 1- and 2-year follow-up (Nadler and colleagues, 2008).

The primary form of malabsorptive bariatric surgery is called **Roux-en-Y gastric bypass** (a type of surgery that creates a Y-shaped reconnection between the stomach and lower portion of the small intestine aimed at decreasing the amount of absorptive surface in the upper part of the small intestine—see Figures 4-1 and 6-6*A*). This procedure reduces the stomach size through stapling off the lower portion and connecting the upper part of the stomach to the jejunum through a surgical procedure called **gastrojejunostomy** (see Chapter 15). Beneficial effects on appetite have been observed with bariatric surgery. This may be due to altered hormones. Resection of the gastric fundus seems to be the main cause of the postoperative reduction in ghrelin levels (Kotidis and colleagues, 2006).

However, there are multiple potential complications of bariatric surgery. Hyperinsulinemic hypoglycemia is a newly recognized rare but important complication after Roux-en-Y gastric bypass. Increased **incretin** (a hormone related to insulin production—see Chapter 8) levels may contribute to the increased insulin secretory response with bariatric surgery (Goldfine and colleagues, 2007).

The most severe malabsorptive procedure is called **distal gastric bypass biliopancreatic diversion (DBP),** often done in conjunction with a **duodenal switch (DS)—**see Figure 6-6*B*. In the DBP-DS procedure the upper part of the stomach is removed, thereby reducing risk of the dumping syndrome, because the pyloric

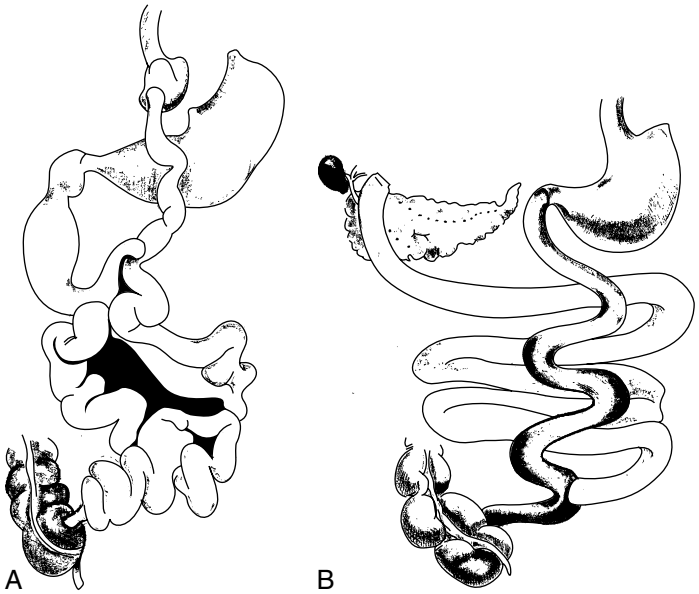


FIGURE 6-6 Gastric bypass procedures. **A,** Roux-en-Y procedure. **B,** Distal gastric bypass biliopancreatic diversion (DBP).

sphincter remains intact. However, the upper part of the duodenum is reconnected to the ileum, thereby bypassing the majority of the small intestine and severely limiting the absorptive surfaces. Whether the positive impact of about 80% weight loss of this procedure will outweigh the potential dire consequences of severe malnutrition and diarrhea has yet to be determined. Interestingly, postprandial hyperglycemia was observed in patients after total gastrectomy most prominently in groups with duodenal bypass surgery (Kalmár and colleagues, 2006). There has been an increase in **cholecystectomy** (removal of the gallbladder) operations with malabsorptive type of bariatric surgery, especially with rapid weight loss from the DBP-DS procedure. Unfortunately, the DBP-DS procedure is irreversible.

Bariatric surgery is not always as beneficial as portrayed for the goal of weight loss. In the condition of **Prader-Willi syndrome** (a developmental disability that is associated with lack of satiety—see Chapter 12) various bariatric procedures have been used with poor results in comparison with normal obese individuals (Scheimann and colleagues, 2008). In individuals with poor weight loss after gastric bypass, increased appetite has been associated with lower levels of appetite-suppressing hormones (le Roux and colleagues, 2007). Ghrelin plasma levels have been found to increase after a period of time, becoming significant as early as 3 months after surgery. This finding suggests that weight loss stimulates ghrelin secretion, even in the absence of part of the stomach (García-Unzueta and colleagues, 2005). It may be for this reason that oral intake of food increases in the long term after bariatric surgery. A review of the literature of Roux-en-Y and gastric banding surgeries of at least 3 years' duration found significant weight regain occurs over the long term. The improvement in health conditions associated with weight loss lessens in the long

term with the regain of weight. There is some evidence from a retrospective study that Roux-en-Y surgery is associated with only a modest decrease in long-term mortality (Shah, Simha, and Garg, 2006).

It is likely going to be some time before there is a reduction in the number of bariatric surgeries. For this reason health care professionals, and especially front-line nursing staff, need to know what to expect regarding nutritional needs and concerns to minimize health risks.

HOW ARE DIETARY INTAKE AND NUTRITIONAL NEEDS AFFECTED BY BARIATRIC SURGERY?

Diet directly after bariatric surgery is done in several steps. Initially clear liquids are advised for 2 to 3 days following surgery. A full liquid diet is then used for 2 to 4 weeks. Subsequently, soft or mechanically ground foods are added, including very soft protein-rich foods such as egg, low-fat cheese, and lean meats. A normal diet may be started within 8 weeks from surgery, but may be later as tolerated. High-protein foods are required with each meal in order to meet requirements. It is advised that a registered dietitian follow persons with bariatric surgery to alter meals as needed to cope with potential nausea/vomiting, constipation, diarrhea, dumping syndrome (a condition where food is "dumped" all at once into the small intestine—see Chapter 4), dehydration, food intolerances, overfeeding, or other complications. Because the stomach pouch is generally reduced to ¼-cup size, the size of one egg, and in some cases to a volume of 1 tbsp, called a micropouch, reduced food portions are critical. Other strategies include chewing foods slowly and thoroughly, and eating and drinking separately to avoid the dumping syndrome.

Malabsorption of nutrients can be adversely affected by any form of bariatric surgery because of problems with poor intake from nausea, vomiting, and diarrhea. Malnutrition is most likely to occur with removal of portions of the small intestinal tract. Minerals, water-soluble vitamins, and protein are all adversely affected by the Roux-en-Y procedure. Add to this the finding that most persons with extreme obesity have poor nutritional status before the surgery, and major nutritional concerns are likely.

The fat malabsorption that is found with the DBP-DS procedure has been shown to progressively increase the incidence and severity of deficiencies of vitamins A, D, and K, with about 65% of individuals experiencing these deficiencies by the fourth year after surgery. Low serum calcium levels were found in 48% of these patients during this time (Slater and colleagues, 2004). One consequence of the severely impaired absorption is the estimated three to six daily bowel movements that will continue throughout the person's life. The DBP procedure has been linked with protein-calorie malnutrition in up to 10% of individuals undergoing this procedure, with hospitalization often being required.

All persons undergoing bariatric surgery should be advised to take a multivitamin and mineral supplement within days after the procedure, and those with malabsorptive procedures need to take supplements and receive intramuscular B_{12} injections for life. The consequences of not doing so needs to be described in detail because the average person does not know the implications of malnutrition. It should also be stressed that nutrient needs following bariatric surgery have not been ade-

quately tested, and deficiencies may occur despite supplementation with multivitamin and minerals. It should further be explained that all necessary nutrients, as found in food, are not able to be provided in supplement form, in part due to unknown needs for a variety of trace minerals and the potential 100 phytochemicals yet to be discovered. It also needs to be stressed to persons undergoing any form of bariatric surgery to alert their health care provider of gastrointestinal problems such as vomiting and diarrhea that will interfere with the absorption of the supplements.

NUTRITIONAL DEFICIENCY CONDITIONS ASSOCIATED WITH OBESITY AND BARIATRIC SURGERY

It has been found that nutritional deficiencies occur far more frequently than previously realized with obesity itself, before bariatric surgery. This is likely due to altered metabolism and storage of fat-soluble vitamins in adipose tissue, causing serum levels to be reduced. Preoperative deficiencies of nutrients among persons who were undergoing bariatric surgery in New York of various ethnic backgrounds were noted on average, in descending order, for 25(OH)D with almost 70% prevalence, followed by iron and thiamin deficiencies. Whites and African Americans had over 70% prevalence of vitamin D deficiency, whereas Hispanics were just over 50%. Thiamin deficiency was most likely to occur with Hispanics at almost 50%, and the lowest rate was among whites at about 7% (Flancbaum and colleagues, 2006). For optimal health it is advised that nutritional deficiencies be corrected before bariatric surgery.

Complications associated with gastric banding are mostly due to decreased intake amounts of specific nutrients. Macronutrient deficiencies with malabsorptive bariatric surgery can include severe protein-calorie malnutrition and fat malabsorption and may require enteral or parenteral nutritional support (see Chapter 15). The most common known micronutrient deficiencies are of vitamins B_1; B_{12}; folate; the fat-soluble vitamins, especially vitamins A and D; and the minerals iron and calcium (Malinowski, 2006).

Anemia can be secondary to iron deficiency, folic acid deficiency, or vitamin B_{12} deficiency. Some complications have been reported, such as bone demineralization due to vitamin D deficiency, hair loss secondary to zinc deficiency, or **hemeralopia** (defective vision from bright light such as during the daytime) from vitamin A deficiency (Folope, Coëffier, and Déchelotte, 2007).

In another study in a U.S. university hospital setting, the Roux-en-Y gastric bypass procedure was related to an incidence of vitamin A (retinol) deficiency in 1 in 10 patients, over one third had vitamin C deficiency, about one fifth had vitamin B_1 deficiency, followed by deficiencies of B_6, B_2, and B_{12} at 1 and 2 years post surgery (Clements and colleagues, 2006). Abnormal levels of other minerals that have been noted include zinc at about 30% and selenium at 58% before surgery and 3% 1-year post surgery (Madan and colleagues, 2006).

Women who have bariatric surgery and develop chronic vomiting are at high risk of developing neurologic complications from thiamin deficiency estimated to occur in 5% to 10% of those who have bariatric surgery. Because there may be underreporting of vomiting, periodic assays of vitamin levels is advised, even if supplementation is prescribed (Morel and colleagues, 2008).

The triad of Wernicke encephalopathy symptoms of confusion due to degenerative changes of the brain, ataxia, and **nystagmus** (involuntary rapid and rhythmic movement of the eyeball) after bariatric surgery has been observed as soon as 2 weeks, but up to 18 months, postoperatively. Atypical neurologic features were common, including optic neuropathy, **papilledema** (edema of the optic disc), deafness, seizures, **asterixis** (a condition often associated with liver disease that causes a flapping movement due to sustained contraction of groups of muscles), weakness, and sensory and motor neuropathy (Singh and Kumar, 2007). In one case study a young woman with Class III obesity developed symptoms of Wernicke's encephalopathy after persistent vomiting for 2 weeks postoperatively. The initial symptoms began with headache, loss of balance, double vision, nystagmus, tingling and weakness in both upper and lower extremities, urinary incontinence, and memory loss to recent events. Results of all investigations were normal. However, a dramatic improvement in symptoms occurred in 24 hours after starting 100 mg thiamine infusion. It is recommended that thiamin supplementation be used once oral intake begins to help prevent deficiency (Al-Fahad and colleagues, 2006).

Rhabdomyolysis (a condition related to ruptured cells and resulting in muscle pain; often associated with use of statin medications—see Chapter 7) and Guillain-Barré syndrome have also been reported after bariatric surgery (Koffman and colleagues, 2006).

A delayed, but frequent, condition that occurs about one decade after bariatric surgery is **myelopathy** (a disabling pathologic change in the spinal cord). Except for vitamin B_{12} and copper deficiencies found with myelopathy, no specific nutritional deficiencies could be verified as the cause. Correction of the multiple nutritional deficiencies found generally did not provide expected results. The best result was achieved in one patient after surgical revision to reduce the bypassed jejunum (Juhasz-Pocsine et al., 2007).

Guidelines on vitamin and mineral supplementation are now being questioned because clearly the optimal dose has yet to be realized. Class III obese individuals undergoing the Roux-en-Y procedure were assessed for their vitamin A nutritional status before and after the procedure. Within 6 months approximately half of all persons with Roux-en-Y were found to have vitamin A deficiency despite receiving a supplementation of 5,000 International Units retinol acetate (Pereira and colleagues, 2008). This was further demonstrated in a study of the Roux-en-Y procedure among persons living in Maine who remained deficient in vitamin D despite 50,000 International Units weekly with a prevalence of 63% suboptimal status with 25(OH)D less than 80 nmol/L, and 8% were deficient with 25(OH)D less than 50 nmol/L (Nelson and colleagues, 2007). There is no consensus on how to maintain bone integrity in persons who have had bariatric surgery. Secondary hyperparathyroidism often occurs because of lack of dietary calcium, magnesium, or vitamin D along with issues of malabsorption (Schweitzer, 2007). The current standard for postsurgical supplementation with vitamin D and calcium is not adequate to suppress secondary hyperparathyroidism or to restore 25-hydroxy vitamin D status (Compher, Badellino, and Boullata, 2008).

Hair loss has been reported with bariatric surgery. This may be related to nutritional deficiencies. Biotin deficiency is characterized by hair loss and a scaly dermatitis distributed around the body orifices (Fujimoto and colleagues, 2005). Ferritin

levels have been found to be low with certain forms of hair loss among women (Kantor and colleagues, 2003). The active form of vitamin D (D_3) is needed to stimulate hair growth. Vitamin D_3 is produced in the kidneys from ingested vitamin D_2 or from the sun (Vegesna and colleagues, 2002). Reduced ability to change vitamin D into the active form may occur with bariatric surgery. Low levels of the essential amino acid L-lysine has been implicated in hair loss. Hair loss may occur from excessive intake of nutritional supplements, which are not recommended in the absence of a proven deficiency (Rushton, 2002).

It has been advised that a consensus is needed with regard to pregnancy issues and contraceptive therapy for women of childbearing years after the DBP. This form of bariatric surgery results in an improved fertility status from hormonal changes, placing a woman at increased risk of pregnancy, especially because oral contraceptives are less effective as a result of altered absorption and metabolism

Neural tube defects (see Chapter 11) such as found with folate deficiency are a potential threat to the infants of mothers who have had bariatric surgery. Deficiencies in iron, vitamin B_{12}, and calcium can result in other pregnancy complications such as poor fetal growth and failure to thrive. There are likely other nutrient deficiencies that occur, but they have not yet been identified. As more women of childbearing years undergo bariatric surgery, further adverse effects on pregnancy and fetal outcomes will likely become recognized.

WHAT IS THE ROLE OF PHYSICAL FITNESS IN HEALTHY WEIGHT MANAGEMENT?

The first and most obvious reason that exercise is important for weight management is that it burns kcalories. Humans are just fancy machines, and like machines they need fuel. Physical activity burns glucose as the primary fuel source. The duration and intensity of the activity, as well as the weight of the individual performing it, are all factors that affect just how many kcalories are expended through grams of carbohydrate used (see Table 8-3). A person who is an athlete is more efficient than a nonathlete at using body fat as a fuel, which partly explains a higher endurance level among well-conditioned athletes.

Activity is also important because it causes more kcalories to be expended even after the exercise is finished. Research shows that physical activity can increase the metabolic rate for as long as 24 hours after the activity ceases. This is especially true of aerobic exercise. This is important knowledge for a person with diabetes on medication. Hypoglycemia is more likely to occur with an increase in physical activity (see Chapter 8).

Regular involvement in exercise goes even further in the quest to prevent and manage obesity. It has to do with the functioning of body cells, in part through alteration of hormone levels. It has been noted that both moderate- and acute-intensity exercise causes hormonal changes that promote breakdown of adipose tissue (McMurray and Hackney, 2005).

Exercise also alters cellular composition. Mitochondria are the parts of body cells that act as furnaces to burn kcalories through the process of oxidation. Endurance training improves mitochondrial function and enhances insulin sensitivity of muscle

FIGURE 6-7 Individuals exercising in a simple dance routine to promote weight loss.

cells. Regular exercise, either alone or in combination with dietary modification, can have an important role in weight management. Exercise is a necessary component of daily living, but one that is often forgotten. Exercise helps do the following:

- Decrease body fat while helping to preserve and tone muscle tissue
- Manage mental stress
- Increase energy levels
- Provide a sense of control over health and lifestyle
- Control appetite
- Promote strong bones
- Help raise HDL-cholesterol levels
- Lower glucose levels to normal (diabetes medication can cause levels to go too low)
- Promote normal blood pressure

The amount of exercise for persons with health conditions depends on the health care provider's advice. Generally, walking and swimming are safe exercises for all persons. Those who are bedridden (see Figure 13-4 or are in wheelchairs can use upper-arm exercises to help maintain muscular strength and health. Individuals of all abilities generally enjoy some form of dancing as a means to increase physical activity (Figure 6-7).

AEROBIC VERSUS ANAEROBIC EXERCISE FOR WEIGHT MANAGEMENT

Aerobic exercise is any exercise that requires more air (just like the term sounds: "air-o-bic"). This type of activity tends to use the highest percentage of body fat for fuel, thus promoting the most beneficial weight loss. Aerobic exercise involves large muscle groups and builds cardiovascular endurance. Aerobic exercise includes cycling, jogging, walking briskly, soccer, basketball, cross-country skiing, rowing, and dancing. When such activity is performed continuously for at least 30 minutes three to five times per week, there is considerable benefit for weight management and cardiovascular health. Achieving goals through athletic events has the additional reward of an increased sense of well-being (Figure 6-8). Those persons not able to

FIGURE 6-8 Team spirit soars after winning a regional varsity soccer game.

be involved with endurance levels of activity can still benefit with even 5 minutes here or there, which is better than no exercise and can encourage a person to slowly increase physical activity.

Anaerobic exercise means exercise "without air." Weight training is an example of anaerobic exercise; it will produce an increase in lean body mass, which will indirectly help weight management because more energy is required to maintain muscle than adipose tissue. In the short term, muscle development can be associated with weight gain, but this is a healthy gain and is often accompanied by a loss of inches related to body fat. (A pound of muscle takes up less space than a pound of fat because it is denser; weight loss may not occur, even though inches decrease.)

Teaching Pearl

A good analogy for the effect of aerobic exercise is that of a fire in a fireplace that is going out. You can say, "When you blow on the fire, giving it more air, it burns faster. Although we do not have fire in our cells, we still use air (oxygen) to burn kcalories. Aerobic exercise causes us to take in more oxygen, so we burn kcalories faster." ■

EXERCISE-ASSOCIATED PROBLEMS

It is wise to seek medical clearance before embarking on an exercise program. This is particularly true for persons with diabetes who have complications. Damage to nerves from uncontrolled diabetes (see Chapter 8) can prevent the heart rate from increasing during exercise. This is a problem with even moderately intense workouts because the body cannot increase the flow of blood and oxygen to the working body cells.

WHAT IS THE ROLE OF THE NURSE OR OTHER HEALTH CARE PROFESSIONAL IN PROMOTING HEALTHY WEIGHT AND PHYSICAL ACTIVITY?

Nurses and other health professionals can help in the process of identifying individuals at high risk for developing obesity. Children's growth records should be reviewed to rule out a trend of excessive gain in BMI percentile. Strategies to stabilize weight gain among children require positive messages to avoid causing a negative self-image. Clinical studies suggest that children and adolescents with major depressive disorder may be at increased risk for gaining excess weight. Referral to a mental health professional may be warranted to rule out issues of depression or bipolar disorder (alternating periods of mania or hyperactivity with periods of depression or severe inactivity), in order for the individual to receive the most appropriate treatment.

The nurse or other health care professional can assist persons of all ages in identifying appropriate weight for health and effective means to achieve changes in body composition. The health care professional can assess if an individual is following a fad diet and whether there is a risk of nutrient imbalances. An easy and effective assessment strategy is to review types and amounts of beverages consumed. Any health professional can advise a person to reduce intake of sugar-based beverages as needed. Assessing intake of fiber-based foods and encouraging their intake is generally appropriate. Focus on soluble fiber sources is always a safe piece of advice. The Dietary Guidelines for Americans, the MyPyramid Food Guidance System, and food labels are excellent tools that any health professional can use effectively in teaching individuals to make good food choices for maintaining physical fitness and wellness.

All health professionals need to keep an open mind and understand that we do not yet have all the answers to the puzzle of the obesity epidemic. Consequently, we need to assess individual nutritional intake and hunger levels and plan accordingly rather than simply handing out preprinted diet sheets. Reviewing the knowledge base of effective and healthy weight loss or obesity prevention is appropriate. Listening to an individual's account of prior weight loss attempts and current practices can go a long way toward establishing a trusting relationship.

Referral to a registered dietitian is in order when a person expresses frustration at the inability to lose weight. The dietitian can often identify the problem and help develop effective strategies. Outpatient dietitians or those in private practice are often the ones who specialize in long-term weight loss support and consulting. For individuals with insulin resistance, referral to a registered dietitian who is also a certified diabetes educator or well versed in diabetes management and the metabolic syndrome may be most helpful.

Nurses and all health care professionals working with the obese population should be able to discuss the pros and cons of bariatric surgery. The potential long-term adverse complications should be stressed, along with the need to maintain regular physical examinations, blood work, and intake of vitamins and minerals through supplements. Regular visits also are needed for B_{12} injections among those who have malabsorptive bariatric surgery. Signs and symptoms of nutritional deficiencies should be reviewed to alert the person with bariatric surgery of the potential serious consequences, such as permanent nerve damage.

Chapter Challenge Questions and Classroom Activities

1. Determine your BMI (see Appendix 9 on the Evolve website).
2. One scoop (½ cup) of ice cream contains 15 g of carbohydrates, 4 g of protein, and 10 g of fat. How many kcalories does the ice cream contain? How many days would it take for a 1-lb weight loss to occur with this reduction in kcalories?
3. How might you advise a family to plan meals to meet the needs of all its members—overweight adults and growing children? Should you suggest separate meals? Why or why not?
4. Plan a 1200- to 1500-kcal diet pattern appropriate for weight loss using the Exchange Lists.
5. How many grams of carbohydrates equate to 500 to 600 kcal? How many grams of fat?
6. How does exercise help with weight management?
7. Compare the macronutrient content of a commercial weight loss drink with a can of soft drink and a half-pint carton of milk. Describe the differences and similarities. Discuss the pros and cons of the drinks. Compare the caloric value of the drink with that of a meal consisting of a turkey sandwich, ½ cup of carrot sticks, and 1 cup of low-fat (1%) milk; refer to Appendix 6 on the Evolve website as needed.

Case Study

Shannon was now having regular menstrual cycles since she had normalized her weight. Her doctor had been right after all, that if she just kept her weight steady, she would "grow into" her weight. She still craved sweets, but it had become easier to avoid them, especially because the rest of the family were watching their carbs. Her mother battled her own weight, her father had high triglyceride levels, and her younger sister now had type 1 diabetes. Shannon found it important that she not let herself get overly hungry and that she include protein with each meal. Having small snacks of fruit or other carbs such as yogurt or whole grains further seemed to keep her "sweet tooth" in line. She knocked on her friend's door and reminded herself, "want versus need" because she knew there were always cookies there.

Critical Thinking Applications

1. What weight-related condition is related to irregular menstrual cycles?
2. How would you explain BMI?
3. How might the family health history affect Shannon's health needs?
4. How did asking "want versus need" help with weight management?
5. How would you advise an overweight teenager to eat to promote optimal bone growth without contributing to excess weight gain?
6. How might protein help reduce Shannon's appetite?
7. If Shannon had considered bariatric weight loss surgery, what adverse effects might she have dealt with?

REFERENCES

Al-Fahad T, Ismael A, Soliman MO, Khoursheed M: Very early onset of Wernicke's encephalopathy after gastric bypass, *Obes Surg* 16(5):671-672, 2006.

Barnes AS, Goodrick GK, Pavlik V, Markesino J, Laws DY, Taylor WC: Weight loss maintenance in African-American women: focus group results and questionnaire development, *J Gen Intern Med* 22(7):915-922, 2007.

Berkey CS, Rockett HR, Willett WC, Colditz GA: Milk, dairy fat, dietary calcium, and weight gain: a longitudinal study of adolescents, *Arch Pediatr Adolesc Med* 159(6):543-550, 2005.

Blixen CE, Singh A, Xu M, Thacker H, Mascha E: What women want: understanding obesity and preferences for primary care weight reduction interventions among

African-American and Caucasian women, *J Natl Med Assoc* 98(7):1160-1170, 2006.

Bowen J, Noakes M, Clifton PM: Effect of calcium and dairy foods in high protein, energy-restricted diets on weight loss and metabolic parameters in overweight adults, *Int J Obes Relat Metab Disord* 29(8):957-965, 2005.

Bowen J, Noakes M, Clifton PM: Appetite regulatory hormone responses to various dietary proteins differ by body mass index status despite similar reductions in ad libitum energy intake, *J Clin Endocrinol Metab* 91(8):2913-2919, 2006.

Bowen J, Noakes M, Trenerry C, Clifton PM: Energy intake, ghrelin, and cholecystokinin after different carbohydrate and protein preloads in overweight men, *J Clin Endocrinol Metab* 91(4):1477-1483, 2006.

Bradshaw A, Katzer L, Horwath CC, Gray A, O'Brien S, Joyce J, Jabs J: A randomised trial of three non-dieting programs for overweight women, *Asia Pac J Clin Nutr* 13(Suppl):S43, 2004.

Brandacher G, Hoeller E, Fuchs D, Weiss HG: Chronic immune activation underlies morbid obesity: is IDO a key player? *Curr Drug Metab* 8(3):289-295, 2007.

Campo S, Mastin T: Placing the burden on the individual: overweight and obesity in African American and mainstream women's magazines, *Health Commun* 22(3):229-240, 2007.

Carels RA, Harper J, Konrad K: Qualitative perceptions and caloric estimations of healthy and unhealthy foods by behavioral weight loss participants, *Appetite* 46(2):199-206, 2006.

Catenacci VA, Ogden LG, Stuht J, Phelan S, Wing RR, Hill JO, Wyatt HR: Physical activity patterns in the National Weight Control Registry, *Obesity* 16(1):153-161, 2008.

Centers for Disease Control and Prevention: Prevalence of regular physical activity among adults—United States, 2001 and 2005, *MMWR Morb Mortal Wkly Rep* 56(46):1209-1212, 2007.

Clements RH, Katasani VG, Palepu R, Leeth RR, Leath TD, Roy BP, Vickers SM: Incidence of vitamin deficiency after laparoscopic Roux-en-Y gastric bypass in a university hospital setting, *Am Surg* 72(12):1196-1202, 2006.

Coleman KJ, Tiller CL, Sanchez J, Heath EM, Sy O, Milliken G, Dzewaltowski DA: Prevention of the epidemic increase in child risk of overweight in low-income schools: the El Paso coordinated approach to child health, *Arch Pediatr Adolesc Med* 159(3):217-224, 2005.

Compher CW, Badellino KO, Boullata JI: Vitamin D and the bariatric surgical patient: a review, *Obes Surg* 18(2): 220-224, 2008.

DellaValle DM, Roe LS, Rolls BJ: Does the consumption of caloric and non-caloric beverages with a meal affect energy intake? *Appetite* 44(2):187-193, 2005.

Diniz YS, Faine LA, Galhardi CM, Rodrigues HG, Ebaid GX, Burneiko RC, Cicogna AC, Novelli EL: Monosodium glutamate in standard and high-fiber diets: metabolic syndrome and oxidative stress in rats, *Nutrition* 21(6):749-755, 2005.

Dubois L, Farmer A, Girard M, Peterson K: Regular sugar-sweetened beverage consumption between meals increases risk of overweight among preschool-aged children, *J Am Diet Assoc* 107(6):924-934, 2007.

Duvigneaud N, Wijndaele K, Matton L, Philippaerts R, Lefevre J, Thomis M, Delecluse C, Duquet W: Dietary factors associated with obesity indicators and level of sports participation in Flemish adults: a cross-sectional study, *Nutr J* 6:26, 2007.

Filippatos TD, Derdemezis CS, Gazi IF, Nakou ES, Mikhailidis DP, Elisaf MS: Orlistat-associated adverse effects and drug interactions: a critical review, *Drug Saf* 31(1):53-65, 2008.

Flancbaum L, Belsley S, Drake V, Colarusso T, Tayler E: Preoperative nutritional status of patients undergoing Roux-en-Y gastric bypass for morbid obesity, *J Gastrointest Surg* 10(7):1033-1037, 2006.

Flegal KM, Graubard BI, Williamson DF, Gail MH: Cause-specific excess deaths associated with underweight, overweight, and obesity, *JAMA* 298(17):2028-2037, 2007.

Fleming-Moran M, Thiagarajah K: Behavioral interventions and the role of television in the growing epidemic of adolescent obesity—data from the 2001 youth risk behavioral survey, *Methods Inf Med* 44(2):303-309, 2005.

Flint A, Gregersen NT, Gluud LL, Møller BK, Raben A, Tetens I, Verdich C, Astrup A: Associations between postprandial insulin and blood glucose responses, appetite sensations and energy intake in normal weight and overweight individuals: a meta-analysis of test meal studies, *Br J Nutr* 98(1):17-25, 2007.

Flint A, Møller BK, Raben A, Sloth B, Pedersen D, Tetens I, Holst JJ, Astrup A: Glycemic and insulinemic responses as determinants of appetite in humans, *Am J Clin Nutr* 84(6):1365-1373, 2006.

Folope V, Coëffier M, Déchelotte P: [Nutritional deficiencies associated with bariatric surgery], *Gastroenterol Clin Biol* 31(4):369-377, 2007.

Fox MK, Devaney B, Reidy K, Razafindrakoto C, Ziegler P: Relationship between portion size and energy intake among infants and toddlers: evidence of self-regulation, *J Am Diet Assoc* 106(1 Suppl 1):S77-S83, 2006.

Fujimoto W, Inaoki M, Fukui T, Inoue Y, Kuhara T: Biotin deficiency in an infant fed with amino acid formula, *J Dermatol* 32(4):256-261, 2005.

Funk S, Miller MM, Mishell DR Jr, Archer DF, Poindexter A, Schmidt J, Zampaglione E, for the Implanon U.S. Study Group: Safety and efficacy of Implanon, a single-rod implantable contraceptive containing etonogestrel, *Contraception* 71(5):319-326, 2005.

Garaulet M, Hernandez-Morante JJ, Lujan J, Tebar FJ, Zamora S: Relationship between fat cell size and number and fatty acid composition in adipose tissue from different fat depots in overweight/obese humans, *Int J Obes* 30(6):899-905, 2006.

García-Unzueta MT, Fernández-Santiago R, Domínguez-Díez A, Vazquez-Salví L, Fernández-Escalante JC, Amado JA: Fasting plasma ghrelin levels increase progressively

after biliopancreatic diversion: one-year follow-up, *Obes Surg* 15(2):187-190, 2005.

Gardner CD, Kiazand A, Alhassan S, Kim S, Stafford RS, Balise RR, Kraemer HC, King AC: Comparison of the Atkins, Zone, Ornish, and LEARN diets for change in weight and related risk factors among overweight premenopausal women: the A TO Z Weight Loss Study: a randomized trial, *JAMA* 297(9):969-977, 2007.

Goldfine AB, Mun EC, Devine E, Bernier R, Baz-Hecht M, Jones DB, Schneider BE, Holst JJ, Patti ME: Patients with neuroglycopenia after gastric bypass surgery have exaggerated incretin and insulin secretory responses to a mixed meal, *J Clin Endocrinol Metab* 92(12):4678-4685, 2007.

Gonzalez-Sanchez JL, Zabena CA, Martinez-Larrad MT, Fernandez-Perez C, Perez-Barba M, Laakso M, Serrano-Rios M: An SNP in the adiponectin gene is associated with decreased serum adiponectin levels and risk for impaired glucose tolerance, *Obes Res* 13(5):807-812, 2005.

Gorin AA, Phelan S, Wing RR, Hill JO: Promoting long-term weight control: does dieting consistency matter? *Int J Obes Relat Metab Disord* 28(2):278-281, 2004.

Hamdy O, Porramatikul S, Al-Ozairi E: Metabolic obesity: the paradox between visceral and subcutaneous fat, *Curr Diabetes Rev* 2(4):367-373, 2006.

Hills AP, Byrne NM: State of the science: a focus on physical activity, *Asia Pac J Clin Nutr* 15(Suppl):40-48, 2006.

Howard BV, Manson JE, Stefanick ML, Beresford SA, Frank G, Jones B, Rodabough RJ, Snetselaar L, Thomson C, Tinker L, Vitolins M, Prentice R: Low-fat dietary pattern and weight change over 7 years: the Women's Health Initiative Dietary Modification Trial, *JAMA* 295(1):39-49, 2006.

Jacobsen R, Lorenzen JK, Toubro S, Krog-Mikkelsen I, Astrup A: Effect of short-term high dietary calcium intake on 24-h energy expenditure, fat oxidation, and fecal fat excretion, *Int J Obes Relat Metab Disord* 29(3):292-301, 2005.

James WP: The epidemiology of obesity: the size of the problem, *J Intern Med* 263(4):336-352, 2008.

Jones LR, Wilson CI, Wadden TA: Lifestyle modification in the treatment of obesity: an educational challenge and opportunity, *Clin Pharmacol Ther* 81(5):776-779, 2007.

Juhasz-Pocsine K, Rudnicki SA, Archer RL, Harik SI: Neurologic complications of gastric bypass surgery for morbid obesity, *Neurology* 68(21):1843-1850, 2007.

Kalmár K, Németh J, Kelemen D, Agoston E, Horváth OP: Postprandial gastrointestinal hormone production is different, depending on the type of reconstruction following total gastrectomy, *Ann Surg* 243(4):465-471, 2006.

Kantor J, Kessler LJ, Brooks DG, Cotsarelis G: Decreased serum ferritin is associated with alopecia in women, *J Invest Dermatol* 121(5):985-988, 2003.

Karbowska J, Kochan Z: Effect of DHEA on endocrine functions of adipose tissue, the involvement of PPAR gamma, *Biochem Pharmacol* 70(2):249-257, 2005.

Kien CL, Bunn JY: Gender alters the effects of palmitate and oleate on fat oxidation and energy expenditure, *Obesity* 16(1):29-33, 2008.

Kien CL, Bunn JY, Ugrasbul F: Increasing dietary palmitic acid decreases fat oxidation and daily energy expenditure, *Am J Clin Nutr* 82(2):320-326, 2005.

Koffman BM, Greenfield LJ, Ali II, Pirzada NA: Neurologic complications after surgery for obesity, *Muscle Nerve* 33(2):166-176, 2006.

Kopp HP, Krzyzanowska K, Mohlig M, Spranger J, Pfeiffer AF, Schernthaner G: Effects of marked weight loss on plasma levels of adiponectin, markers of chronic subclinical inflammation and insulin resistance in morbidly obese women, *Int J Obes Relat Metab Disord* 29(7):766-771, 2005.

Kotidis EV, Koliakos G, Papavramidis TS, Papavramidis ST: The effect of biliopancreatic diversion with pylorus-preserving sleeve gastrectomy and duodenal switch on fasting serum ghrelin, leptin and adiponectin levels: is there a hormonal contribution to the weight-reducing effect of this procedure? *Obes Surg* 16(5):554-559, 2006.

Kushner RF, Jackson Blatner D: Risk assessment of the overweight and obese patient, *J Am Diet Assoc* 105(5 Suppl 1): S53-S62, 2005.

Kwon K, Jung SH, Choi C, Park SH: Reciprocal association between visceral obesity and adiponectin in healthy premenopausal women, *Int J Cardiol* 101(3):385-390, 2005.

le Roux CW, Welbourn R, Werling M, Osborne A, Kokkinos A, Laurenius A, Lönroth H, Fändriks L, Ghatei MA, Bloom SR, Olbers T: Gut hormones as mediators of appetite and weight loss after Roux-en-Y gastric bypass, *Ann Surg* 246(5):780-785, 2007.

Levitsky DA, Obarzanek E, Mrdjenovic G, Strupp BJ: Imprecise control of energy intake: absence of a reduction in food intake following overfeeding in young adults, *Physiol Behav* 84(5):669-675, 2005.

Lustig RH: Childhood obesity: behavioral aberration or biochemical drive? Reinterpreting the First Law of Thermodynamics, *Nat Clin Pract Endocrinol Metab* 2(8):447-458 2006a.

Lustig RH: The "skinny" on childhood obesity: how our western environment starves kids' brains, *Pediatr Ann* 35(12):898-902, 2006b.

Madan AK, Orth WS, Tichansky DS, Ternovits CA: Vitamin and trace mineral levels after laparoscopic gastric bypass, *Obes Surg* 16(5):603-606, 2006.

Mahon AK, Flynn MG, Stewart LK, McFarlin BK, Iglay HB, Mattes RD, Lyle RM, Considine RV, Campbell WW: Protein intake during energy restriction: effects on body composition and markers of metabolic and cardiovascular health in postmenopausal women. *J Am Coll Nutr* 26(2):182-189, 2007.

Malinowski SS: Nutritional and metabolic complications of bariatric surgery, *Am J Med Sci* 331(4):219-225, 2006.

McAuley KA, Hopkins CM, Smith KJ, McLay RT, Williams SM, Taylor RW, Mann JI: Comparison of high-fat and high-protein diets with a high-carbohydrate diet in insulin-resistant obese women, *Diabetologia* 48(1):8-16, 2005.

McMurray RG, Hackney AC: Interactions of metabolic hormones, adipose tissue and exercise, *Sports Med* 35(5): 393-412, 2005.

Meckling KA, Sherfey R: A randomized trial of a hypocaloric high-protein diet, with and without exercise, on weight loss, fitness, and markers of the Metabolic Syndrome in overweight and obese women, *Appl Physiol Nutr Metab* 32(4):743-752, 2007.

Monroe MB, Seals DR, Shapiro LF, Bell C, Johnson D, Parker Jones P: Direct evidence for tonic sympathetic support of resting metabolic rate in healthy adult humans, *Am J Physiol Endocrinol Metab* 280(5):E740-E744, 2001.

Morel L, Fontana E, Michel JM, Ruffieux A, Ottiger M, Regamey C: [A new treatment: bariatric surgery; a new complication: Wernicke-Korsakoff encephalopathy], *Presse Med* 37(1 Pt 1):49-53, 2008.

Mrdjenovic G, Levitsky DA: Nutritional and energetic consequences of sweetened drink consumption in 6- to 13-year-old children, *J Pediatr* 142(6):604-610, 2003.

Mrdjenovic G, Levitsky DA: Children eat what they are served: the imprecise regulation of energy intake, *Appetite* 44(3):273-282, 2005

Murakami K, Sasaki S, Takahashi Y, Uenishi K, Yamasaki M, Hayabuchi H, Goda T, Oka J, Baba K, Ohki K, Kohri T, Muramatsu K, Furuki M: Hardness (difficulty of chewing) of the habitual diet in relation to body mass index and waist circumference in free-living Japanese women aged 18-22 y, *Am J Clin Nutr* 86(1):206-213, 2007.

Nadler EP, Youn HA, Ren CJ, Fielding GA: An update on 73 US obese pediatric patients treated with laparoscopic adjustable gastric banding: comorbidity resolution and compliance data, *J Pediatr Surg* 43(1):141-146, 2008.

Nelson ML, Bolduc LM, Toder ME, Clough DM, Sullivan SS: Correction of preoperative vitamin D deficiency after Roux-en-Y gastric bypass surgery, *Surg Obes Relat Dis* 3(4):434-437, 2007.

Oakes ME: Stereotypical thinking about foods and perceived capacity to promote weight gain. *Appetite* 44(3):317-324, 2005.

Pereira S, Saboya C, Chaves G, Ramalho A: Class III Obesity and its relationship with the nutritional status of vitamin A in pre- and postoperative gastric bypass, *Obes Surg* April 8, 2008 [Epub ahead of print].

Phelan S, Wyatt HR, Hill JO, Wing RR: Are the eating and exercise habits of successful weight losers changing? *Obesity* 14(4):710-716, 2006.

Pilz S, Horejsi R, Moller R, Almer G, Scharnagl H, Stojakovic T, Dimitrova R, Weihrauch G, Borkenstein M, Maerz W, Schauenstein K, Mangge H: Early atherosclerosis in obese juveniles is associated with low serum levels of adiponectin, *J Clin Endocrinol Metab* 90(8):4792-4796, 2005.

Raynor DA, Phelan S, Hill JO, Wing RR: Television viewing and long-term weight maintenance: results from the National Weight Control Registry, *Obesity* 14(10):1816-1824, 2006.

Riedt CS, Cifuentes M, Stahl T, Chowdhury HA, Schlussel Y, Shapses SA: Overweight postmenopausal women lose bone with moderate weight reduction and 1 g/day calcium intake, *J Bone Miner Res* 20(3):455-463, 2005.

Rushton DH: Nutritional factors and hair loss, *Clin Exp Dermatol* 27(5):396-404, 2002.

Sbrocco T, Carter MM, Lewis EL, Vaughn NA, Kalupa KL, King S, Suchday S, Osborn RL, Cintrón JA: Church-based obesity treatment for African-American women improves adherence, *Ethn Dis* 15(2):246-255, 2005.

Scheimann AO, Butler MG, Gourash L, Cuffari C, Klish W: Critical analysis of bariatric procedures in Prader-Willi syndrome, *J Pediatr Gastroenterol Nutr* 46(1):80-83, 2008.

Schinner S, Scherbaum WA, Bornstein SR, Barthel A: Molecular mechanisms of insulin resistance, *Diabet Med* 22(6):674-682, 2005.

Schliess F, Häussinger D: Call volume and insulin signaling, *Int Rev Cytol* 225:187-228, 2003.

Schoeller DA, Buchholz AC: Energetics of obesity and weight control: does diet composition matter? *J Am Diet Assoc* 105(5 Suppl 1):S24-S28, 2005.

Scholl TO, Chen X: Insulin and the "thrifty" woman: the influence of insulin during pregnancy on gestational weight gain and postpartum weight retention, *Matern Child Health J* 6(4):255-261, 2002.

Schwartz J, Byrd-Bredbenner C: Portion distortion: typical portion sizes selected by young adults, *J Am Diet Assoc* 106(9):1412-1418, 2006.

Schweitzer DH: Mineral metabolism and bone disease after bariatric surgery and ways to optimize bone health, *Obes Surg* 17(11):1510-1516, 2007.

Sebert SP, Lecannu G, Kozlowski F, Siliart B, Bard JM, Krempf M, Champ MM: Childhood obesity and insulin resistance in a Yucatan mini-piglet model: putative roles of IGF-1 and muscle PPARs in adipose tissue activity and development, *Int J Obes Relat Metab Disord* 29(3):324-333, 2005.

Setse R, Grogan R, Cooper LA, Strobino D, Powe NR, Nicholson W: Weight loss programs for urban-based, postpartum African-American women: perceived barriers and preferred components, *Matern Child Health J* 12(1):119-127, 2008.

Shah M, Simha V, Garg A: Review: long-term impact of bariatric surgery on body weight, comorbidities, and nutritional status, *J Clin Endocrinol Metab* 91(11):4223-4231, 2006.

Shahar DR, Abel R, Elhayany A, Vardi H, Fraser D: Does dairy calcium intake enhance weight loss among overweight diabetic patients? *Diabetes Care* 30(3):485-489, 2007.

Shea SA, Hilton MF, Orlova C, Ayers RT, Mantzoros CS: Independent circadian and sleep/wake regulation of adipokines and glucose in humans, *J Clin Endocrinol Metab* 90(5):2537-2544, 2005.

Singh S, Kumar A:Wernicke encephalopathy after obesity surgery: a systematic review, *Neurology* 68(11):807-811, 2007.

Slater GH, Ren CJ, Siegel N, Williams T, Barr D, Wolfe B, Dolan K, Fielding GA: Serum fat-soluble vitamin deficiency and abnormal calcium metabolism after malabsorptive bariatric surgery, *J Gastrointest Surg* 8(1):48-55, 2004.

Smith C, Richards R: Dietary intake, overweight status, and perceptions of food insecurity among homeless Minnesotan youth, *Am J Hum Biol* 20(5):550-563, 2008.

Spivak H, Hewitt MF, Onn A, Half EE: Weight loss and improvement of obesity-related illness in 500 U.S. patients following laparoscopic adjustable gastric banding procedure, *Am J Surg* 189(1):27-32, 2005.

Steck SE, Chalecki AM, Miller P, Conway J, Austin GL, Hardin JW, Albright CD, Thuillier P: Conjugated linoleic acid supplementation for twelve weeks increases lean body mass in obese humans, *J Nutr* 137(5):1188-1193, 2007.

Stevenson EJ, Williams C, Mash LE, Phillips B, Nute ML: Influence of high-carbohydrate mixed meals with different glycemic indexes on substrate utilization during subsequent exercise in women, *Am J Clin Nutr* 84(2):354-360, 2006.

Stookey JD, Constant F, Gardner CD, Popkin BM: Replacing sweetened caloric beverages with drinking water is associated with lower energy intake, *Obesity* 15(12):3013-3022, 2007.

Thorsdottir I, Tomasson H, Gunnarsdottir I, Gisladottir E, Kiely M, Parra MD, Bandarra NM, Schaafsma G, Martinéz JA: Randomized trial of weight-loss-diets for young adults varying in fish and fish oil content, *Int J Obes* 31(10):1560-1566, 2007.

Thrush AB, Chabowski A, Heigenhauser GJ, McBride BW, Or-Rashid M, Dyck DJ: Conjugated linoleic acid increases skeletal muscle ceramide content and decreases insulin sensitivity in overweight, non-diabetic humans, *Appl Physiol Nutr Metab* 32(3):372-382, 2007.

Tsuboyama-Kasaoka N, Shozawa C, Sano K, Kamei Y, Kasaoka S, Hosokawa Y, Ezaki O: Taurine (2-aminoethanesulfonic acid) deficiency creates a vicious circle promoting obesity, *Endocrinology* 147(7):3276-3284, 2006.

Vegesna V, O'Kelly J, Uskokovic M, Said J, Lemp N, Saitoh T, Ikezoe T, Binderup L, Koeffler HP: Vitamin D_3 analogs stimulate hair growth in nude mice, *Endocrinology* 143(11):4389-4396, 2002.

Vorona RD, Winn MP, Babineau TW, Eng BP, Feldman HR, Ware JC: Overweight and obese patients in a primary care population report less sleep than patients with a normal body mass index, *Arch Intern Med* 165(1):25-30, 2005.

Wake DJ, Strand M, Rask E, Westerbacka J, Livingstone DE, Soderberg S, Andrew R, Yki-Jarvinen H, Olsson T, Walker BR: Intra-adipose sex steroid metabolism and body fat distribution in idiopathic human obesity, *Clin Endocrinol* 66(3):440-446, 2007.

Wang YC, Colditz GA, Kuntz KM: Forecasting the obesity epidemic in the aging U.S. population, *Obesity* 15(11):2855-2865, 2007.

Watras AC, Buchholz AC, Close RN, Zhang Z, Schoeller DA: The role of conjugated linoleic acid in reducing body fat and preventing holiday weight gain. *Int J Obes* 31(3):481-487, 2007.

Weigle DS, Breen PA, Matthys CC, Callahan HS, Meeuws KE, Burden VR, Purnell JQ: A high-protein diet induces sustained reductions in appetite, ad libitum caloric intake, and body weight despite compensatory changes in diurnal plasma leptin and ghrelin concentrations, *Am J Clin Nutr* 82(1):41-48, 2005.

Wickremesekera K, Miller G, Naotunne TD, Knowles G, Stubbs RS: Loss of insulin resistance after Roux-en-Y gastric bypass surgery: a time course study, *Obes Surg* 15(4):474-481, 2005.

Wyatt HR, Jortberg BT, Babbel C, Garner S, Dong F, Grunwald GK, Hill JO: Weight loss in a community initiative that promotes decreased energy intake and increased physical activity and dairy consumption: Calcium weighs-in, *J Phys Act Health* 5(1):28-44, 2008.

chapter

7

Cardiovascular Disease

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Chapter Topics

Types and Risk Factors of Cardiovascular Disease
Impact of Diet on the Prevention and Treatment of Lipid Disorders
Hypertension, Its Role in Cardiovascular Disease and Management
Role of Exercise in Prevention of Cardiovascular Disease
Impact of Medications on Lipid Lowering and Other Cardiovascular Concerns
The Role of the Nurse and Other Health Care Professionals in the Prevention and Management of Cardiovascular Disease

Objectives

After completing this chapter, you should be able to:

- Identify risk factors related to the development of cardiovascular disease.
- Discuss medical nutrition therapy goals for cardiovascular disease and hypertension.
- Discuss appropriate foods to prevent or manage cardiovascular disease.
- Discuss the role of the nurse or other health care professional in the prevention and management of cardiovascular disease.

Terms to Identify

Adult Treatment Panel III (ATP III)
Aerobic exercise
Arteriosclerosis
Atherosclerosis
Cardiovascular disease (CVD)
Cerebrovascular accident (CVA)
Chylomicrons
Congestive heart failure (CHF)
Coronary artery disease (CAD)
Coronary heart disease (CHD)
Diastolic blood pressure
Dietary Approaches to Stop Hypertension (DASH)
Edema
Endothelial dysfunction
Heart failure
High-density–lipoprotein cholesterol (HDL-C)
HMG-CoA reductase
Hypercholesterolemia
Hyperlipidemia
Hypertension
Hypertriglyceridemia
Hypocholesterolemia
Lipids
Low-density–lipoprotein cholesterol (LDL-C)
Morbidity
Mortality
Myocardial infarction (MI)
Myopathy
National Cholesterol Education Program (NCEP)
Nitric oxide
Peripheral arterial disease (PAD)
Plant stanol

Plant sterols
Postprandial dysmetabolism
Rhabdomyolysis
Systolic blood pressure
Therapeutic Lifestyle Changes (TLC) diet
Thrombosis
Transient ischemic attack (TIA)
Triglycerides
Vasoconstriction
Very-low-density lipoprotein (VLDL)

INTRODUCTION

In the twentieth century United States, deaths from vascular disease reached a peak incidence in the 1950s, but little was known about the underlying causes of this epidemic of disease. During the Korean War, which was taking place at that time, it was first appreciated how many young men had signs of heart disease, previously thought to be an older person's disease. Since then a tremendous amount of research has taken place to understand how to prevent it. When the connection was made that high blood cholesterol level was associated with heart disease, the simple message to avoid high-cholesterol foods, such as eggs and liver, began. Although it had been noted in the 1960s that saturated fat was statistically related to elevated serum cholesterol levels, many believed it did not make common sense and it was discounted. As evidence has continued to develop that saturated fat is the primary factor in blood cholesterol levels, and not cholesterol in the diet, eggs are once again being recommended as part of a healthy diet.

Cardiovascular disease (CVD), often interchangeably described as **coronary artery disease (CAD)** or **coronary heart disease (CHD)**, the latter being the more-inclusive term, remains the leading cause of death for Americans and around the world for both men and women. There are many lifestyle factors contributing to this. There are also many causal factors for CHD unrelated to diet and lifestyle, such as bacterial infections and genetic anomalies. **Atherosclerosis** (the condition of plaque buildup in the circulatory system—see Figure 7-1) is a complex disease that involves chronic inflammation.

There has been progress in preventing the **mortality** (death) and **morbidity** (effects of disease) of heart disease. The proportion of Americans with high cholesterol levels has continued to drop, in part because of better screening and intervention. Evidence suggests that individuals can significantly reduce their risk for heart disease through physical activity and a good diet.

Individual guidance should complement the general guidelines to allow for specific needs; for example, guidelines can be adjusted to suit frail, elderly persons or terminally ill patients who may need to rely on high-fat foods for adequate kilocalorie (kcalorie or kcal) intake. For everyone, attempts to lower the risk for CVD should not take precedence over sound nutritional intake. Meat, milk, and cheese still play an important role in one's diet; however, moderation and an emphasis on low–saturated-fat and lower-sodium alternatives can result in a healthy balance.

The role of stress continues to receive attention with regard to its effects on CVD. Our fast-paced lifestyle may be contributing to CVD. One study found that relaxation practice enhanced recovery from a heart attack and helped prevent a recurrence (van Dixhoorn and White, 2005).

WHAT ARE THE TYPES AND RISK FACTORS OF CARDIOVASCULAR DISEASE?

CVD relates to the heart and the entire vascular system. Therefore **hypertension** (high blood pressure), **cerebrovascular accident (CVA)**, or, more commonly, stroke, and **arteriosclerosis** (hardening of the arteries) are all examples of CVD. A **transient ischemic attack (TIA)** is referred to as a ministroke. **Thrombosis** is the formation of clots. Clots can be stationary when attached to the walls of blood vessels but can later dislodge and plug a smaller blood vessel. The majority of individuals with diabetes mellitus die from a thrombosis. This is, in part, caused by the enhanced activation of platelets and clotting factors seen in diabetes. Fibrinogen levels, which are related to increased clotting, have been associated with mortality after incidence of heart attack and may serve as a marker for increased risk for recurrence (Coppola and colleagues, 2005).

In diseases of the heart, one or several parts of the heart, such as the heart muscle or the valves, may be damaged. **Congestive heart failure (CHF),** now also referred to as simply **heart failure,** relates to the inability of the heart to function in its pumping role.

ATHEROSCLEROSIS

Atherosclerosis is a complex disease of the arteries; it is a form of arteriosclerosis. The passageways through the arteries become roughened and clogged with fatty deposits such that blood cannot flow freely, like clogged sink pipes (Figure 7-1). This is the form of heart disease described as ischemic. Atherosclerosis is thought to be a cause of coronary thrombosis, **myocardial infarction (MI)** (heart attack, or coronary), and CVA. **Peripheral arterial disease (PAD)** is a form of atherosclerosis and is associated with significant cardiovascular morbidity and mortality. PAD is defined as an ankle-brachial blood pressure index of less than 0.9 in either leg. As shown from the NHANES 1999 to 2004 data, PAD prevalence increases with age and is found in about 1 in 4 persons 80 years of age and older. Non-Hispanic black men and women and Mexican American women have a higher prevalence of PAD than non-Hispanic white men and women, with other risk factors being current or previous: smoking, diabetes mellitus, low kidney function, high-sensitivity C-reactive protein level greater than 3.0 mg/L, and uncontrolled hypertension, treated or not (Ostchega and colleagues, 2007).

LIPOPROTEINS

High-density–lipoprotein cholesterol (HDL-C), low-density–lipoprotein cholesterol (LDL-C), and **very-low-density lipoprotein (VLDL)** are all forms of cholesterol found in the blood. **Lipids** is the term used to describe all forms of fat found in the blood. **Chylomicrons** are another form of lipoprotein. VLDL is the main carrier of **triglycerides** (a type of blood fat) synthesized in the body. **Hypercholesterolemia** refers to elevated total cholesterol level but is usually a result of high serum LDL-C. **Hyperlipidemia** is the term generally used to describe a combination of high levels of LDL-C and triglycerides. Dyslipidemia, as discussed in Chapter 5, refers to low levels of HDL-C but usually coexists with elevated triglycerides.

What very few people know is that the total cholesterol number is based on a mathematical calculation. Total cholesterol is the sum of HDL-C plus LDL-C plus

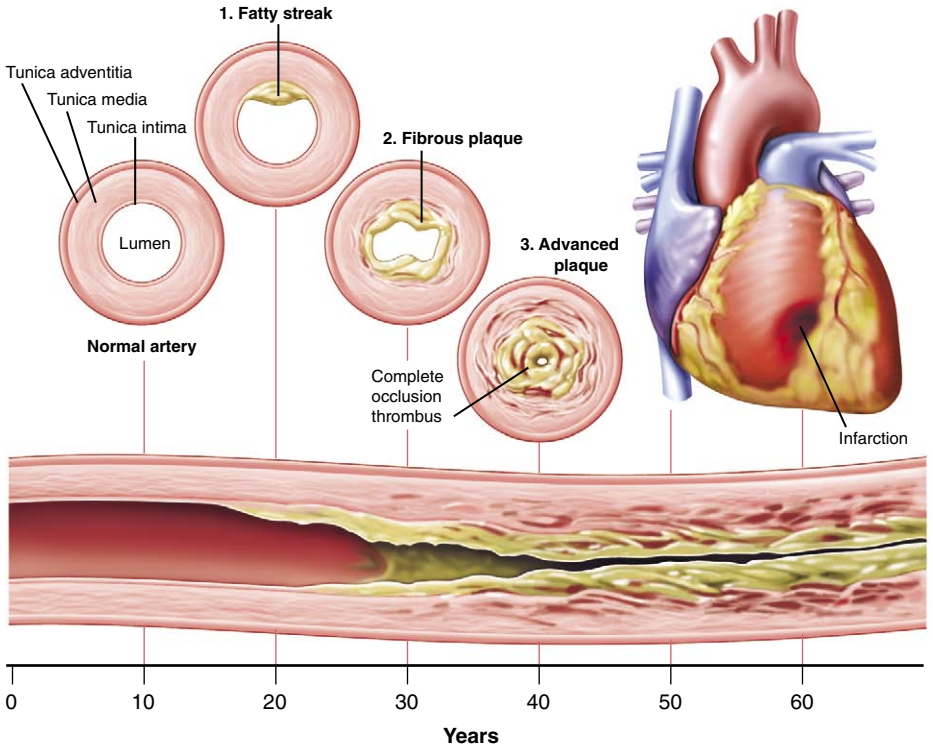


FIGURE 7-1 Natural progression of atherosclerosis. (From Harkreader H: *Fundamentals of nursing: caring and clinical judgment*, ed 3, St. Louis, 2007, Saunders.)

one fifth of triglycerides. The laboratory measurements are of total cholesterol, HDL-C, and triglycerides, with the difference being the calculated LDL-C level (if triglycerides are over 400 mg/dL, the calculation of LDL-C is not possible; in this case a direct laboratory measurement of LDL-C level may be performed). Therefore when a person needs to lower the total cholesterol level, he or she is really lowering the LDL-C and/or triglyceride levels. Changes made are aimed at protecting or raising the HDL-C level.

HDL-C, which has more protein than does LDL-C or VLDL, allows more cholesterol to be taken from the body's cells, resulting in greater transport and removal of cholesterol through the liver. HDL-C is often called "good cholesterol." In fact, research has shown that individuals with more HDL-C have less heart disease. However, one's level of HDL-C is highly genetic, and it can be a challenge to increase it to optimal levels.

LDL-C is often referred to as "bad cholesterol." It is well recognized that a high level of LDL-C induces atherosclerosis and is a strong risk factor for heart disease. The majority of cholesterol medications are aimed at lowering LDL-C. Diet can have a strong influence, but it can take at least 3 months for an impact to be seen. Unfortunately, not everyone responds to changes in the diet. However, because there are no adverse health outcomes with medical nutrition therapy (MNT), this is advised as the primary strategy before use of medications (Table 7-1).

Table 7-1 Medical Nutrition Therapy for Lipoprotein Management

LIPID GOALS	SATURATED FAT	UNSATURATED FATS (ALL)	SOLUBLE FIBER	WEIGHT (AS NEEDED)	GLYCEMIC LOAD/ GLYCEMIC INDEX	OMEGA-3 FATS	MONOUNSATURATED FATS	POLYUNSATURATED FATS	EXERCISE	ALCOHOL
Lower LDL-C	↓	↑	↑	↓	↓ May be of benefit if hyperinsulinemia present				↑ To promote weight loss as needed	
Lower triglycerides (TG)	↓	↑ If TG >300 mg/dL, restrict to 50 g fat per day	↑	↓	↓	↑			↑	↓ If in excess intake
Raise HDL-C	↓		↑	↓ Rapid weight loss may lower HDL-C	↓	↑	↑	↓	↑	↑ In moderate amount if person already includes

HDL-C, High-density–lipoprotein cholesterol; *LDL-C,* low-density–lipoprotein cholesterol.

Teaching Pearl

Because HDL-C helps to keep blood vessels clean, the analogy of "H" for "housecleaner" is generally well received by individuals initially learning about cholesterol. LDL-C can be remembered as "L" for "lousy." Before providing this analogy, asking the person whether you should start with the basics is helpful. Those who indicate in the affirmative are typically appreciative of this analogy. ■

It was as recently as the early 1990s that elevated triglyceride levels started being recognized as a contributor to CVD, although controversy still exists as to its role in CVD. In recent years the American Heart Association (AHA) lowered the definition of high fasting triglyceride level from 200 to 150 mg/dL. This was a result of the realization that the higher the fasting triglyceride level, the greater the rise of postprandial triglycerides. It has been shown among women that triglyceride levels, in either fasting or fed states, correlated with known cardiac risk factors and indicators of insulin resistance. However, elevated triglyceride levels measured 2 to 4 hours postprandially had the strongest association with cardiovascular events (Bansal and colleagues, 2007). Arterial stiffness has been noted in women with elevated triglyceride levels and CVD (Le and colleagues, 2005).

Nutritional habits have a significant impact on triglyceride levels and are described below. In a person whose only elevated lipid is triglycerides, the condition is referred to as **hypertriglyceridemia.** There are some medications that address triglycerides and are described at the end of the chapter.

Teaching Pearl

Levels of triglycerides can reach over 8000 mg/dL. When this occurs, blood drawn in a laboratory setting will separate out into red blood and the white "guck" (see Figure 5-2). Thus the ability of red blood cells to carry oxygen throughout the body is impaired with very high triglyceride levels. ■

GOALS FOR BLOOD CHOLESTEROL LEVELS

Total cholesterol level should be less than 200 mg/dL. The **National Cholesterol Education Program (NCEP)** indicates the goal for LDL-C is less than 130 mg/dL for moderately high-risk persons (two or more risk factors and a 10-year risk for CHD of 10% to 20%—see Figure 7-2). The NCEP III guidelines state that in very high-risk patients a LDL-C level of less than 70 mg/dL is a reasonable goal, regardless of age (Aronow, 2006).

Triglyceride levels are advised to be less than 150 mg/dL, and HDL greater than 40 mg/dL for men and 50 mg/dL for women, with the goal being greater than 60 mg/dL to best help prevent CVD. However, triglyceride levels greater than 100 mg/dL have been linked with high C-reactive protein (CRP) levels, suggesting that fasting triglyceride levels under 100 mg/dL may further reduce CVD risk (Ahmad and colleagues, 2005).

Third Report of the Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III)

Risk score results:	
Age:	25
Gender:	male
Total Cholesterol:	290 mg/dL
HDL Cholesterol:	25 mg/dL
Smoker:	Yes
Systolic Blood Pressure:	180 mm/Hg
On medication for HBP:	Yes
Risk Score*	Greater than 30%
Risk score results:	
Age:	55
Gender:	female
Total Cholesterol:	270 mg/dL
HDL Cholesterol:	49 mg/dL
Smoker:	No
Systolic Blood Pressure:	120 mm/Hg
On medication for HBP:	No
Risk Score*	2%

* The risk score shown was derived on the basis of an equation. Other NCEP materials, such as ATP III print products, use a point-based system to calculate a risk score that approximates the equation-based one.

FIGURE 7-2 Framingham risk score. (Sample from www.nhlbi.nih.gov)

On the other hand, low levels of total cholesterol less than 160 mg/dL, referred to as **hypocholesterolemia,** can be an indicator of poor health. Lipid metabolism is known to be altered in many acute diseases. There are many potential causes of decreased serum cholesterol levels. Malabsorption is one factor, and this is likely the factor behind hypocholesterolemia with the active phase of Crohn's disease. There may also be altered synthesis of cholesterol (Hrabovský and colleagues, 2007). In solid tumors and those of the blood, hypocholesterolemia may be due to increased use of cholesterol by cancer cells (Yavasoglu and colleagues, 2008).

Hypocholesterolemia has been implicated in genetically based violent behavior (Edgar and colleagues, 2007). Low levels of cholesterol have been found to help predict mortality in critically ill surgical patients. Promotion of higher levels of cholesterol is advised for the management of critical illness (Bonville and colleagues, 2004).

The guidelines of the NCEP now recommend that adults 20 years of age and older have their total cholesterol and HDL-C levels measured. If the total cholesterol is 200 mg/dL or more, or the HDL is less than 40 mg/dL, a complete lipoprotein profile is advised (including the LDL-C and triglyceride levels). In assessing risk for CHD it has been noted that total cholesterol level, blood pressure, and body mass index (BMI) showed average levels significantly higher during the winter months (Ulmer and colleagues, 2004). This is likely due, in part, to decreased production of vitamin D from a cholesterol-based hormone with reduced sunlight.

Goals for MNT and use of medications vary depending on the differing levels of these lipids and risk factors. There is debate on goals and treatment for the elder

population, in part due to limited research verifying the benefit of cholesterol-lowering medications. Polypharmacy, with excess prescription of medications, continues to be a potential problem especially for the elder population (see Chapter 13). Before the use of lipid-lowering medications, referral to a registered dietitian is advised by the AHA, unless the individual is at very high risk for an MI or CVA.

RISK FACTORS FOR CORONARY HEART DISEASE

The 2004 guidelines to control CVD as developed by the **Adult Treatment Panel III (ATP III)** is an updated version of recommendations made initially in 2001 by the NCEP of the National Heart, Lung, and Blood Institute. The goals were aimed at lowering cholesterol levels. Changes in the updated 2004 ATP III report are primarily aimed at guidelines for medication use. The ATP IV guidelines are expected in 2010. Although LDL has received the most attention in regard to medical and nutritional management, there are other risk factors that can be controlled for greatest reduction in CVD risk. The following are considered risk factors for CVD:

- Elevated LDL-C (especially with small LDL particle size)
- Cigarette smoking
- Hypertension: blood pressure of greater than or equal to 140/90 mm Hg or on antihypertensive medication
- Low HDL-C (less than 40 mg/dL for men; less than 50 mg/dL for women)
- Family history of premature CHD
- CVD in male first-degree relative younger than 55 years
- CVD in female first-degree relative younger than 65 years
- Age (men 45 years of age or older; women 55 years or older)
- Diabetes
- Multiple metabolic risk factors (insulin resistance or metabolic syndrome)

The AHA guidelines indicate that HDL-C greater than 60 mg/dL counts as a negative risk factor; its presence removes one risk factor from the total count from the list. This is because HDL particles have the capacity to promote cholesterol transport out of the body and antagonize pathways of inflammation, thrombosis, and oxidation.

Oxidation of LDL-C

Oxidation of LDL-C is thought to play a key role in the development of atherosclerosis. When the body cells use oxygen in the metabolism of energy, it is not a clean process. Free radicals are formed through oxidation. The free radicals cause damage at the cellular level. This reinforces the importance of a good diet that includes foods rich in antioxidants.

Monounsaturated fats, such as found with nut intake (see Figure 2-4), have been associated with reduced CHD risk. In addition to cholesterol-lowering properties, almonds have been shown to lower oxidized LDL concentrations. Antioxidant activity provides an additional possible mechanism, in addition to lowering cholesterol, that may account for the reduction in CHD risk with nut consumption (Jenkins and colleagues, 2008).

Obesity is one of the risk factors for atherosclerosis and is related to LDL oxidation. It was found that with moderate kcalorie restriction, along with regular physical activity, in obese adolescents there was reduced lipid oxidation and improved body weight and composition (Lazzer and colleagues, 2005).

Metabolic or Insulin Resistance Syndrome and Its Relation to Cardiovascular Disease

As described in Chapter 5, the metabolic or insulin resistance syndrome is a diagnosis made by health correlations. The primary correlations are central obesity, hypertension, dyslipidemia, and type 2 diabetes, all of which are all risk factors for CHD. Having several of these health conditions is believed to further increase risk for CHD, and intensified risk management to lower risk is advised. Some of the causes of CHD as found with the metabolic syndrome include the following:

- Prothrombotic factors
- Proinflammatory factors
- Impaired fasting glucose

The inflammatory marker CRP, as discussed in Chapter 5, is a risk factor for CVD. An approach in primary prevention is to measure CRP only among those at intermediate risk as defined by the Framingham risk score (see Figure 7-2). In secondary prevention, the potential utility of CRP is less certain (Corrado and Novo, 2007). Elevated CRP levels have been found with advanced atherosclerosis in adolescents and young adults (Zieske and colleagues, 2005). Adult Asian Indians have significantly higher CRP levels than do persons with European heritage (Misra, 2004). This may explain the higher risk for CVD in Asian Indians even when there is a normal HDL-C level. High levels of CRP and blood glucose are found in conjunction and jointly contribute to cardiovascular risk in men with type 2 diabetes (Bahceci and colleagues, 2005). Inflammation associated with periodontal disease is associated with development of early atherosclerotic carotid lesions (Soder and colleagues, 2005).

Fact & Fallacy

FALLACY My grandfather lived to be 100 and ate eggs and bacon daily; therefore I do not have to worry about heart disease.

FACT Individuals who subscribe to the preceding idea need to be reminded that heredity also comes from the grandmother's side of the family, as well as from both parents. Careful questioning often reveals some form of CHD risk in the family's history, even if it is not heart disease specifically. A person might also be exposed to other risk factors that did not affect previous generations of his or her family, such as cigarette smoking, obesity, diabetes, or low levels of physical activity. ■

A high level of homocysteine, a sulfur-containing amino acid, is often considered an important risk factor for CVD, including stroke. Hyperhomocysteinemia has been implicated in plaque formation found in atherosclerosis and is associated with

hypertension (Curgunlu and colleagues, 2005). Elevated levels of homocysteine and **nitric oxide** (a substance related to epithelial function) were found in persons who required coronary artery bypass surgery and among their children (Pac and colleagues, 2005). However, more recent data suggest that homocysteine is a marker, and not the cause, of CVD (Wierzbicki, 2007).

Although diabetes is a risk factor for CHD, a high-normal level of blood glucose is also a risk factor. Fasting glucose levels are associated with many cardiovascular risk factors, and a glucose level less than 75 mg/dL is associated with the lowest prevalence (Gupta and colleagues, 2007). Based on data from 1-hour plasma glucose challenge, it appears that maintaining normal glucose levels early in life may reduce later health care problems in older age (Liu and colleagues, 2005).

Treatment of dyslipidemia, as found with the metabolic syndrome, has been effective in reducing CVD (Ginsberg, Zhang, and Hernandez-Ono, 2005). Not surprisingly, low levels of HDL found in adolescents are predictive of dyslipidemia in adulthood (Magnussen and colleagues, 2008).

Vitamin D deficiency is being linked with the metabolic syndrome. Low 25(OH) D levels have been associated with the cardiovascular disease risk factors of hypertension, obesity, diabetes mellitus, and the metabolic syndrome, as well as cardiovascular disease events including stroke and congestive heart failure (Michos and Melamed, 2008).

A postprandial state characterized by abnormally increased levels of glucose and lipids **(postprandial dysmetabolism)** is an independent predictor of future cardiovascular events, even in nondiabetic subjects. Suppressing the postprandial spikes in glucose and lipids improves inflammation and endothelial function and appears to help prevent atherosclerosis (O'Keefe and Bell, 2007).

Hypertensive patients with high plasma insulin levels or metabolic syndrome have a greater occurrence of left ventricular hypertrophy, which appears related to hyperinsulinemia (Sharma and colleagues, 2007). This is attributed to altered metabolism.

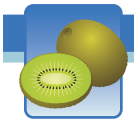
Gender Differences in Risk Factors for Cardiovascular Disease

Low iron states in premenopausal women appear to be protective against CHD (Ozdemir and colleagues, 2007). The Increased CHD after menopause, when risk approaches that observed in men of similar age, may be due to higher levels of iron. However, this phenomenon is more likely in women with central obesity, or apple shape, and other factors of the metabolic syndrome. It has been observed that carrying excess body fat in the thighs (pear shape) rather than in the abdominal region helps protect against cardiovascular disease and diabetes in obese postmenopausal women (Aasen, Fagertun, and Halse, 2008; Faloia and colleagues, 2009). Women who have menstrual irregularities often have indicators of insulin resistance, and it may be hormonal changes that increase risk of CVD among women. Increased menstrual cycle length between menstruation greater than 30 days has been implicated in increased risk of CVD with a trend toward higher LDL-C level and dyslipidemia (Rubba and colleagues, 2008). Women who are insulin sensitive have lower triglyceride and higher HDL-C levels. The triglyceride to HDL-C ratio is a predictor for glucose disposal rates (Karelis and colleagues, 2007).

The metabolic syndrome may occur in 40% of postmenopausal women. Menopause promotes the development of central obesity among women. Hormonal replacement therapy has been found to worsen insulin resistance among women with the metabolic syndrome, although in general it is thought to increase insulin sensitivity (Lobo, 2008).

There are a variety of issues related to age, gender, and ethnicity. Some recent findings related to individuals who have the metabolic syndrome or those in the known high-risk population groups are summarized as follows:

- Females are at greater risk for early carotid atherosclerosis (Iglseder and colleagues, 2005).
- Among Asian Indians, risk factors for CVD were found even with an HDL-C greater than 40 mg/dL (Superko and colleagues, 2005).
- In Asian males the individual components of hyperlipidemia and hypertension were equivalent or better predictors of CVD than being diagnosed with the metabolic syndrome (Sone and colleagues, 2005).
- Middle-age and older adults are at risk for arteriosclerosis with arteries losing their flexibility (S Li and colleagues, 2005).
- Men with hypertension remain at a high risk for stroke, heart attack, and mortality from CHD, even with medically controlled blood pressure (Almgren et al., 2005).



Cultural Considerations

In a group of manufacturing employees in Kentucky, more than three out of four had BMI greater than 25, higher than national estimates. Consistent with national data, males had risk factors found with the metabolic syndrome, including hypertension and dyslipidemia. The females had an increased prevalence of larger waist measurements. Dietary practices did not meet recommended guidelines for health (Brehm and colleagues, 2007). ■

Genetic Reasons

Persons with a relatively rare form of familial hypercholesterolemia cannot remove LDL-C from their systems. These individuals have dangerously high LDL-C levels that are resistant to MNT and medications. It has been noted that these individuals benefit from physical removal of blood LDL through medical procedures (Sachais and colleagues, 2005). Such individuals need to avoid even moderate intake of cholesterol such as found in egg yolks, shellfish, and organ meats. Genetic risk of metabolic syndrome also is associated with dyslipidemia.

RISK FACTORS AND PREVENTION STRATEGIES FOR STROKES

There are a variety of risk factors for stroke, including hypertension, diabetes, obesity, and lack of physical activity. Research related to stroke risk and the metabolic syndrome indicates that individuals with CVD, especially women, are at high risk for ischemic stroke or TIA (Koren-Morag, Goldbourt, and Tanne, 2005).

Trans fatty acids increase risk of stroke. Protection from stroke occurs with omega-3 fatty acids and other unsaturated fats, including oleic, linolenic, and

arachidonic fatty acids (see Chapter 2 for food sources—Table 2-5). The unsaturated fats appear protective in women but appear to increase risk of ischemic stroke in men (Monteiro and Vaz Almeid, 2007). Another benefit of omega-3 fats as found in fish oil includes increasing the size of LDL particles, making them more fluffy and less likely to adhere to the lining of vascular walls.

A high glycemic load along with a higher intake of fatty meats has been found to increase stroke risk. A diet low in fruits, vegetables, fish, and whole grains is associated with increased risk of stroke (Fung and colleagues, 2004). High glycemic load is related to high postprandial insulin production and, along with reduced antioxidant vitamins with low intake of high-fiber plant-based foods, likely has an enhanced risk of atherosclerosis.

Following stroke or TIA there is increased risk of future incidents. Riboflavin deficiency has been found to be common after stroke. Supplementation of vitamin B_2 may be beneficial after CVA due to reduced oxidative damage and consequent cerebral edema (Gariballa and Ullegaddi, 2007).

WHAT IS THE IMPACT OF DIET ON THE PREVENTION AND TREATMENT OF LIPID DISORDERS?

WEIGHT MANAGEMENT

In obese, insulin-resistant persons, a calorie-restricted diet resulting in 10% to 15% weight loss and that is moderately lower in carbohydrate (40%) and higher in unsaturated fat has been found to be as effective as the traditional low-fat diet (60% carbohydrate) in producing weight loss. This approach also is more effective in lowering triglyceride and insulin levels and increasing HDL-C levels and the size of LDL particles (McLaughlin and colleagues, 2006).

Approximately a 20-lb weight loss has been shown to lower fasting and postprandial triglyceride levels along with improving endothelial function and lowering inflammation. This was compared with the intake of 1 g/day of fish oil supplement alone, which reduced only postprandial triglyceride levels (Plat and colleagues, 2007). The triglyceride response to a high-carbohydrate meal has been found to increase immediately after a meal and 6 hours later. Weight reduction helps to lower the second postprandial triglyceride rise (Dallongeville and colleagues, 2007).

Medical nutrition therapy (MNT) with a focus on the Dietary Approaches to Stop Hypertension (DASH) diet (see later section), as provided by a registered dietitian in a physician's office, has been shown to promote an average of 5% weight loss in under a 2-year period. Over 80% of these individuals maintained the weight loss over a 30-month period. With the weight loss, lipids improved with an average drop of about 9% in LDL-C level, 35% in triglyceride level, and increase of HDL-C level of almost 10%. Blood pressure further improved (Welty and colleagues, 2007). In a study of individuals with Class I obesity there was a 3% weight loss over a 3-month period with lifestyle modification (exercise of at least 60 minutes three times a week) and a 1500-kcal diet with about 50% carbohydrate and 25% fat. There was significant improvement in anthropometric and cardiovascular risk factors (De Luis and colleagues, 2008).

In one study, preschoolers were assessed for CVD risk initially and at follow-up 4 years later. Increasing BMI, waist circumference, and intake of sucrose at follow-up

was found to lower HDL-C level and increase triglyceride levels. It was found that as intake of monounsaturated fat and dietary fiber increased there was a resulting reduction in total cholesterol level among the children (Williams and Strobino, 2008).

CHOLESTEROL INTAKE

There still remains controversy regarding cholesterol intake for heart health. Research shows conflicting outcomes. Data from free-living populations show that egg intake generally does not cause higher cholesterol levels. The most recent AHA guidelines no longer specifically advise limiting egg intake (Kritchevsky, 2004). However, the ATP III guidelines still advocate reduced cholesterol intake with a goal of less than 200 mg of cholesterol daily. This essentially limits egg, shellfish, and organ-meat intake. The yolk of a medium-sized egg is estimated to contain about 225 mg of cholesterol. Three ounces of beef liver contains over 400 mg of cholesterol. Canada does not have a specific guideline on cholesterol intake because of the evidence suggesting a closer link between saturated and trans fatty acid intake and increased endogenous production of cholesterol. For most healthy individuals, synthesis of cholesterol by the liver adjusts to the level of dietary cholesterol intake.

One study found that with a restricted carbohydrate intake an additional 640 mg of cholesterol from eggs had an antiinflammatory effect with increased HDL-C. This finding may be due to the cholesterol itself or possibly due to the antioxidant lutein content of egg yolk, which helps lower an inflammatory response (Ratliff and colleagues, 2008).

As with much of nutrition, individualized guidance should be advocated. Choline, for example, with the highest dietary sources being liver and eggs, has been shown to reduce homocysteine levels (Olthof and colleagues, 2005). Individuals who want to include whole eggs and liver in the diet because of taste preference and/or positive health associations should have their serum cholesterol levels assessed to ensure tolerance.

Research outcomes of two studies further indicate the need for individualization. The first study found that in men, consumption of two or more eggs daily was not related to total cholesterol level as compared with a lower intake of eggs; for women, there was an association. Women who limit their intake to one to two eggs weekly had significantly lower cholesterol levels than those with daily consumption (Nakamura and colleagues, 2004). Among persons with insulin resistance, a high-cholesterol diet did not promote an increase in inflammation as indicated by CRP levels or non–HDL-C levels, but it did have an adverse effect among insulin-sensitive individuals (Tannock and colleagues, 2005). Generally, if LDL-C is at the very high risk level of over 200 mg/dL, cholesterol intake should be limited to under 200 mg daily average. If LDL is at a more moderately low risk level (Table 7-2), cholesterol intake can be more moderate as per food label guidelines at 300 mg daily.

DIETARY FATS

There is strong evidence that the type of fat rather than the total amount of fat is most important in preventing CVD. Low-fat diets have been advocated because this is one simple strategy to lower intake of saturated and trans fats. However, this can be confusing to the consumer who may assume that carbohydrates may be included freely in the diet with a low-fat diet, which would have an adverse effect on

Table 7-2 ATP III Guidelines for Therapeutic Lifestyle Changes (TLC) Diet

NUTRIENT COMPOSITION OF TLC DIET

NUTRIENT	RECOMMENDED INTAKE
Saturated fat	Less than 7% of total calories
Polyunsaturated fat	Up to 10% of total calories
Monounsaturated fat	Up to 20% of total calories
Total fat	25%-35% of total calories
Carbohydrate	50%-60% of total calories
Fiber	20-30 g/day
Protein	Approximately 15% of total calories
Cholesterol	Less than 200 mg/day
Total calories (energy)	Balance energy intake and expenditure to maintain desirable body weight and prevent weight gain

NEW FEATURES OF ATP III

More Intensive Lifestyle Intervention (TLC)

Therapeutic diet lowers saturated fat and cholesterol intakes to levels of previous Step II

Adds dietary options to enhance LDL reduction

- Plant stanols and sterols (2 g/day)
- Viscous (soluble) fiber (10-25 g/day)

Increased emphasis on weight management and physical activity

From National Heart, Lung, and Blood Institute: *Adult Treatment Panel guidelines for therapeutic lifestyle changes (TLC) diet*, Washington, DC, 2001, National Institutes of Health.
ATP III, Adult Treatment Panel III, *LDL*, low-density lipoprotein.

individuals with the metabolic syndrome. It also has been found that a very low-fat diet with 10% fat increased fasting triglyceride level and the total cholesterol to HDL-C ratio, whereas a moderate fat intake of 35% lowered triglyceride level and the total cholesterol to HDL-C ratio. This adverse impact of a very low-fat diet was found even in healthy, endurance-trained runners (Larson-Meyer and colleagues, 2008).

As reviewed in Chapter 2, there are many forms of fatty acids. Some are beneficial to cholesterol levels and heart disease and others have adverse effects. In moderation, all may be included. Research continues on the impact of specific fatty acids. Although saturated fat is generally advised to be reduced in the prevention and management of CVD, a low intake of certain fats in butter has been found to be detrimental. This includes lauric acid from dairy products, with low intake being associated with acute MI. It is advised that recommendations on fatty acid intake should aim for both an upper and lower limit (Lopes and colleagues, 2007).

SATURATED AND TRANS FATTY ACIDS

Saturated fat has long been known to raise cholesterol levels, specifically LDL-C levels. Because risk of heart disease begins in childhood, the American Academy of Pediatrics advises low-fat or fat-free milk for children older than 2 years of age.

Although saturated fat intake should be lowered to reduce risk of CVD, food sources are not always as clear. Among the 12 major milk fatty acids, only 3 (lauric, myristic, and palmitic—see Table 2-5) have been associated with raising total serum

cholesterol levels. However, their individual effects are variable regarding impact on LDL-C and HDL-C (German and Dillard, 2006). Moderate supply of myristic acid (see Table 2-5) at less than 2% of total kcalories with the recommended intake of alpha-linolenic acid from canola oil at about 1% of total kcalories contributes to improved cholesterol removal from tissues into HDL-C, dependent on enzyme activity (Vaysse-Boué and colleagues, 2007).

Although red meat is thought of as being high in saturated fat, it was found that lean red meat, trimmed of visible fat, did not increase cholesterol levels or risk of thrombosis (D Li and colleagues, 2005). A fast-food meal of a burger and fries was found to have more myristic (C14:0), palmitic (C16:0), stearic (C18:0), and trans fatty acids (C18:1) than an organic beef meal. LDL-C decreased more with the organic beef meal, which had lesser amounts of saturated and trans fatty acids, than in the fast-food beef meal (Bray and colleagues, 2007).

It is now recognized that trans fatty acids act as saturated fats do in the body and have been linked with inflammation in women (Mozaffarian and colleagues, 2004). As reviewed in Chapter 2, hydrogenated fats are referred to as trans fatty acids. In the last 10 years or so, the adverse health effect of hydrogenated fats has been recognized. One explanation for the increased CVD associated with trans fatty acids is that they decrease HDL-C level (Dyerberg and colleagues, 2004). In January 2006, listing of the estimated amount of trans fatty acids on the Nutrition Facts section of food labels became mandatory; the listing can be found under saturated fats.

As the percentage of kcalories from trans fatty acids increases, there is a linear impact on increasing LDL-C levels in relation to reducing HDL-C levels. There appears to be no safe level of intake of trans fatty acids, and they have double the adverse impact of saturated fats (Ascherio, 2006).

UNSATURATED FATS

The unsaturated fats in general are helpful for reducing LDL-C levels. In the 1970s only polyunsaturated fats (see Figure 2-4), as primarily found in seed and vegetable oils, were promoted as a means to normalize hypercholesterolemia. Although this was effective, the unintended effect was that HDL-C levels also were reduced with a high intake of polyunsaturated fats. Excess intake of the polyunsaturated type of fat found in seed oils, linoleic acid (see Table 2-5), has been shown to oxidize LDL-C and increase risk of clot formation (Khor, 2004). Further research has found monounsaturated fats lower LDL-C levels but are protective to the HDL-C levels, the desired effect.

The form of polyunsaturated fats known as the omega-3 fatty acids do have beneficial effects and generally are advised. Diets rich in eicosapentaenoic acid (EPA), an omega-3 fatty acid, are associated with decreased arterial stiffness; adding EPA to a high-fat meal results in acute changes in vascular tone, independent of changes in oxidative stress (Hall and colleagues, 2008). For vegans or others who do not consume fatty fish, it is advised to increase intake of alpha-linolenic acid and decrease linoleic acid to promote the endogenous production of these longer chain n-3 polyunsaturated fatty acids (Griffin, 2008).

Omega-3 fats are known to reduce blood levels of triglycerides and therefore are recommended in the control of CVD. These fats also reduce the inflammation process of the body and tend to reduce the clotting time of the blood. A study looking at

changes in triglyceride levels with fish consumption found that triglycerides fell almost 30% with intake of fish and almost 40% with both fish consumption and weight loss. Furthermore, one form of HDL-C, HDL2, increased by about 25% (Mori and colleagues, 1999). Fish intake has been found to help prevent worsening of atherosclerosis in women (Erkkila and colleagues, 2004).

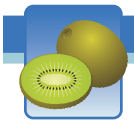
The cardioprotective effect of omega-3 fatty acids is so great that the AHA is now recommending that everyone consume fatty fish at least twice weekly. This equates to 6 oz of salmon or other fatty fish such as lake trout or one can of sardines or herring weekly. If an individual will not eat fish, it is now advised that omega-3 fatty acid supplements be taken. An alternative to which some individuals do not object is to take cod-liver oil. One teaspoon of cod-liver oil is the equivalent of eating about 2 oz of fatty fish and contains approximately 500 mg of EPA and docosahexaenoic acid (DHA)—two forms of omega-3 fats as found in fish oil supplements. One-half teaspoon of cod liver oil daily will meet the guideline set forth by the AHA to eat fatty fish twice weekly. Supplement use should be reviewed with the person's physician to avoid excess intake because of the anticlotting aspect of omega-3 fatty acids.

Fish oils influence HDL-C metabolism chiefly by decreasing its breakdown, resulting in higher HDL-C levels. Addition of atorvastatin (a cholesterol-lowering medication) to treatment with fish oils had no additional effect on HDL-C compared with fish oils alone (Chan and colleagues, 2006).

On the negative side, increased consumption of fish rich in omega-3 polyunsaturated fatty acids (omega-3 PUFAs) is also related to increased incidence of sudden death and arrhythmias in patients with acute myocardial ischemia. This may be due to altered cardiac electrophysiology and may be proarrhythmic or antiarrhythmic, depending on the mechanism of arrhythmia. Advice to increase intake of omega-3 PUFA supplements or fatty fish should be tailored to individual patients with respect to the arrhythmogenic mechanisms associated with the underlying pathologic process (Den Ruijter and colleagues, 2007).

Teaching Pearl

Old American Heart Association cookbooks from the 1970s and 1980s specifically advised to add 1 tbsp of polyunsaturated fats to meals, such as corn oil, safflower oil, or sunflower oil. This was due to the recognition that these oils lowered LDL-C levels. At that time monounsaturated fats were felt to have a neutral effect on cholesterol levels and were not known to lower LDL-C levels. ■

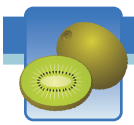


Cultural Considerations

Older adults, especially, often enjoy eating sardines and herring, having grown up eating them as a staple food. Many also had cod-liver oil as children, and some even liked it. Many of the younger generation have not had this exposure to fish, which may increase their risk for CVD later in life. Given the benefits of omega-3 fatty acids, we should start to help our children, if not ourselves, to learn to like fish such as salmon, sardines, or herring (see Chapter 12 for tips on helping children learn to eat new foods). Concerns about mercury intake for pregnant women and children are addressed in Chapters 11 and 14. ■

Counseling Points to Control Dietary Intake of Saturated Fat and Cholesterol

1. Advise those who have shown the need for lower cholesterol intake to eat no more than one egg yolk per day or no more than four egg yolks per week.
2. Advise those who have shown the need for lower cholesterol intake to moderate the use of shrimp and limit organ meats.
3. Advise use of fish, skinless chicken and turkey, and veal in most of the meat meals for the week; use moderate-sized portions (3 oz of meat equals the size of a deck of cards) of beef, lamb, pork, and ham less frequently. Substitute low-fat protein foods such as legumes for meat regularly (e.g., red beans and rice or baked bean sandwiches). Legumes are also very high in soluble fiber.
4. Advise lean cuts of meat, trim visible fat, and discard the fat that cooks out of the meat. Removing the skin from a piece of chicken eliminates about 1 tsp of fat.
5. Advise avoiding deep-fat frying, or recommend using oil that is low in saturated fats (peanut and canola oil are monounsaturated fats appropriate for frying)
6. Advise restricting the use of fatty luncheon and variety meats such as sausage and salami.
7. Instead of butter and cooking fats that are solid or completely hydrogenated, emphasize liquid vegetable oils, such as olive oil, and soft or liquid margarines. Cooking with other liquids such as wine, water, broth, or fruit juice will help reduce the fat content of meals. Using a combination of butter and olive oil works well for flavor while lowering saturated fat intake.
8. Advise instead of whole milk and cheeses made from whole milk and cream, using skim or low-fat (1%) milk and low-fat or part-skim milk cheeses.
9. Advise using more plant foods in place of animal foods. For example, fill up on legumes and vegetables rather than meat. Think of meat as a side dish rather than as the main dish. Suggest the plate method with one half of the plate vegetables.
10. Advise when shopping to look for food labels showing less than 15 g of fat for a meal and less than 3 g of fat for a snack. The level of saturated fat should be less than one third of the total amount of fat per day. An acceptable level of sodium per meal is 800 mg; snack foods should have less than 200 mg of sodium per serving, with a daily goal of less than 2400 mg of sodium per the food label guidelines.



Cultural Considerations

Many Americans grew up with a "meat-and-potato" diet. This can be a difficult pattern to alter for the goal of reduced intake of saturated fat. Suggestions are to include more nonstarchy vegetables to fill up on, so that the meat portion can be reduced. Some individuals may do better by eating more slowly to achieve the goal of earlier satiety and resultant decrease in meat portion. Use of turkey hot dogs may be acceptable, or stews and chili con carne may be used to limit meat portions. ■

CARBOHYDRATES

Recommendations for percentages of macronutrients should be individualized. For a person with the metabolic syndrome, a lower amount of carbohydrate is generally advised with a higher fat intake, although the quality of fat is still important.

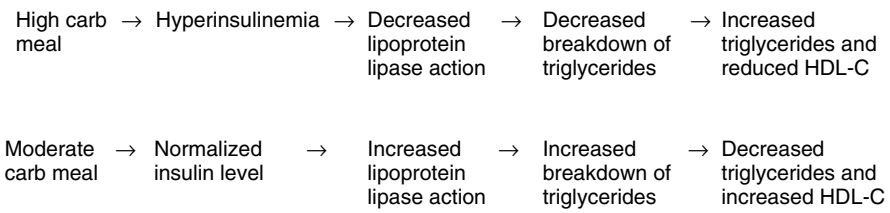


FIGURE 7-3 Role of carbohydrate in triglyceride production in the metabolic syndrome. *HDL-C*, High-density–lipoprotein cholesterol.

Glycemic Index and Glycemic Load

As glycemic index (GI) and glycemic load (GL) increase, HDL-C levels are reduced. All types of fiber contribute to low–glycemic index meals. Therefore fiber helps to promote normal blood glucose and insulin levels. A low–glycemic index diet was found to reduce LDL-C 10% in a 10-week period (Sloth and colleagues, 2004). Foods high in fiber further help reduce CVD, because these foods are high in trace minerals and antioxidants. High glycemic index is associated directly with increased triglyceride levels (Mosdøl and colleagues, 2007). This is due to a high–glycemic load meal promoting hyperinsulinemia, leading to impaired function of lipoprotein lipase (an enzyme), resulting in high triglyceride levels (Figure 7-3). In middle-age, sedentary, overweight to mildly obese, dyslipidemic individuals, consuming a diet with a low GL is associated with better cardiorespiratory fitness (Huffman and colleagues, 2007).

Carbohydrate-restricted diets promote weight loss, reduce plasma triglyceride levels, and increase HDL-C levels but may increase LDL-C levels in some people (Wood and colleagues, 2007). A 30- to 50-g carbohydrate meal that is high in fiber and contains protein and unsaturated fats has a low glycemic index. For example, one half of a turkey sandwich on whole-grain bread with a tossed salad topped with chickpeas and oil and vinegar dressing has a low glycemic load.

Teaching Pearl

Thinking "solid carbohydrates and liquid oils" is a general strategy to promote low–glycemic load meals. ■

Soluble Fiber

There is now strong evidence that dietary fiber plays a role in preventing and controlling CVD. The water-soluble fibers—pectins from fruits, gums from legumes, and the water-soluble fiber in oat grain (see Box 2-1)—appear to be effective in reducing serum cholesterol levels. The benefits of soluble fiber are so impressive that daily consumption has been advised, whether it comes from oat bran, brown rice, barley, legumes, or other vegetable and fruits sources. In one study it was found that consumption of one serving of beans daily is associated with almost a 40% lower risk of MI (Kabagambe and colleagues, 2005).

Soluble fiber is believed to lower LDL-C because of its absorptive role: it absorbs bile salts, which are essential for proper digestion. Because the liver requires cholesterol to produce more bile salts, levels of serum cholesterol are reduced.

High-fiber foods, along with a low–saturated-fat diet, were found to double the effect of low saturated fat on lowering the total cholesterol and LDL-C levels (Gardner and colleagues, 2005). The recommendation of the National Academy of Science for fiber intake is 25 and 38 g/day for young women and men, respectively, based on an intake of 14 g of fiber per 1000 kcal.

PROTEINS

Long-term consumption of a low-calorie, low-protein vegan diet or regular endurance exercise training is associated with low cardiovascular risk. Moreover, data suggest that specific components of a low-calorie, low-protein vegan diet provide additional beneficial effects on blood pressure (Fontana and colleagues, 2007).

In a study of Japanese persons, three diet patterns were assessed: vegetable, meat, and a Western diet. In men, the meat pattern was associated with higher total, HDL, and LDL cholesterol levels. The Western pattern was associated with higher total and LDL cholesterol levels. In women, the vegetable pattern was associated with lower systolic and diastolic blood pressure and pulse pressure, and higher HDL cholesterol level. The meat pattern was associated with higher total and HDL cholesterol levels. The Western pattern was associated with higher total, HDL, and LDL cholesterol levels (Sadakane and colleagues, 2008).

The diet patterns tested in the Optimal Macronutrient Intake Trial to Prevent Heart Disease (OmniHeart) found the basic guidelines to lower cholesterol and hypertension are all appropriate, whether the DASH diet or the 2005 Dietary Guidelines for Americans. These patterns include the following:

- 2300 mg sodium
- 2000 kcal (approximately)
- Low saturated fat (6% saturated fat)
- High monounsaturated fat (up to 20% of kcalories)
- Low cholesterol (up to 200 mg daily)
- Moderate carbohydrate (48% to 58%)
- Moderate protein (15% to 25%)
- Moderate fat (27% to 37% fat; see Chapter 2 and Table 7-3 for calculations) (Swain and colleagues, 2008)

ROLE OF DIET IN REDUCING CARDIOVASCULAR DISEASE IN THE METABOLIC SYNDROME

The optimal level of fat intake becomes more challenging in the management of the metabolic syndrome. Data on U.S. adults obtained from the Third National Health and Nutrition Examination Survey (NHANES III) showed that as fruit and grain intake increased, as with a low-fat diet, total cholesterol and LDL-C levels went down, but dyslipidemia was worsened with lower HDL-C level (Tande, Hotchkiss, and Cotugna, 2004).

The Third Report of the National Cholesterol Education Program's Adult Treatment Panel (ATP III) in 2001 was updated in 2004. The original ATP III report focused on the risk factors of a high–saturated-fat diet, obesity, and a sedentary lifestyle and

Table 7-3 TLC Recommended Total Fat for Various kcal Levels

KILOCALORIE LEVEL	TOTAL RECOMMENDED FAT (35%)
1200	45 g
1500	60 g
1800	70 g
2100	80 g
2400	95 g
2700	105 g
3000	115 g

TLC, Therapeutic Lifestyle Changes.
To calculate percentage of fat of total kilocalories (kcalories):
1. Multiply total kcalories by percentage of fat (0.35 used above), which yields the number of kcalories to be contributed by fat.
2. Divide the number of kcalories of fat by 9 to determine the total grams of fat (above numbers rounded up or down).

To calculate the percentage of total kcalories of a given amount of fat:
1. Multiply grams of fat by 9 to equal kcalories contributed by fat.
2. Divide kcalories from fat by total kcalories to determine the percentage.

Use the Exchange Lists system (see Appendix 3 on the Evolve website) for an easy method to calculate fat content from a given menu. Foods not listed in the Exchange Lists will generally be listed in a food composition table from which fat content can be determined (see Appendix 6 on the Evolve website).

recommended a **Therapeutic Lifestyle Changes (TLC) diet** (Box 7-1 and Table 7-2), a change from the previous use of the Step I and Step II diets, which focused only on saturated fat and cholesterol intake. The TLC diet is specifically aimed at managing the risk factors of the metabolic syndrome to lower CVD.

The TLC diet is aimed at keeping saturated fat and trans fatty acid intake low with an increase in soluble fiber and **plant stanol** and sterol esters (found in some margarines). The plant stanol esters can be thought of as medication, and a minimum of 6 to 8 weeks of use is needed to verify individual impact. The TLC diet further promotes a higher intake of fat to 35% with emphasis on the monounsaturated fats. It has been found that regular intake of nuts can result in a 10% lowering of LDL-C within a few weeks and has not been shown to induce weight gain (Strahan, 2004). Figure 7-4 shows how to implement the TLC diet for an individual with the metabolic syndrome. Persons with high triglyceride level and low HDL-C level should be aggressively treated with TLC (Szapary and Rader, 2004).

The traditional Mediterranean diet is very similar to the TLC diet. Monounsaturated fatty acids, such as found with the traditional Mediterranean diet, appear to reduce mortality from CVD and should be included as part of a moderate-fat diet to lower triglyceride levels (Carson, 2003). There is a direct and positive effect of a Mediterranean diet (foods with omega-3 and monounsaturated fats and high fiber content) and moderate alcohol intake in lowering risk of thrombosis (Michalsen and Dobos, 2005). In a person with CVD, greater adherence to the traditional Mediterranean diet was found to significantly reduce mortality (Trichopoulou, Bamia, and Trichopoulos, 2005).

The ATP III guidelines now recommend 25% to 35% of kcalories as fat, with up to 20% in the monounsaturated form (see Table 7-2), with the higher amount of fat for treatment of the metabolic syndrome. Table 7-3 shows the equivalent amount of fat based on 35% of various kcalorie levels and how to calculate this percentage.

Box 7-1 Sample Menu ■ For a TLC Diet (Approximately 2000 kcal)

Breakfast
Grapefruit half
½ c oatmeal
1 slice whole-wheat toast
1 tbsp natural peanut butter
1 tsp brown sugar or jelly
4 oz skim milk
Coffee

Lunch
Turkey sandwich:
3 oz turkey (no skin)
2 slices whole-grain bread
Tomato slices
½ c coleslaw made with 1 tbsp mayonnaise dressing
Small apple
Iced tea with lemon

Afternoon Snack
8 oz low-fat yogurt
¼ c almonds

Supper/Dinner
3 oz pork tenderloin
½ c brown rice
½ c spinach sautéed in 2 tsp olive oil and garlic
½ c carrots with lemon juice
1 c tossed salad with 1 tbsp olive oil and vinegar dressing topped with ¼ c chickpeas
8 oz skim milk

Evening Snack
3 c low-fat popcorn

MEDICAL NUTRITION THERAPY FOR C-REACTIVE PROTEIN

The CRP level, an indicator of inflammation, is receiving increased attention as a predictor of a variety of health problems, including CVD. Levels of high-sensitivity CRP greater than 3 mg/L have been shown to correspond to higher risk for cardiovascular events. A brief description of MNT for lowering CRP levels is as follows:

- Improve glycemic control—see Chapter 8 (Ridker, 2004).
- Aim for a high-fiber and low–saturated-fat diet (Richter and colleagues, 2004).
- Include folate foods—dark green, leafy vegetables, legumes, whole grains, and fortified white-flour products (Bertran and colleagues, 2005).
- Increase intake of foods rich in the amino acid arginine, such as nuts and fish (Wells, Mainous, and Everett, 2005).
- For those who already drink alcohol, include moderate amounts along with fish oil and vitamin E sources (Liepa and Basu, 2003).

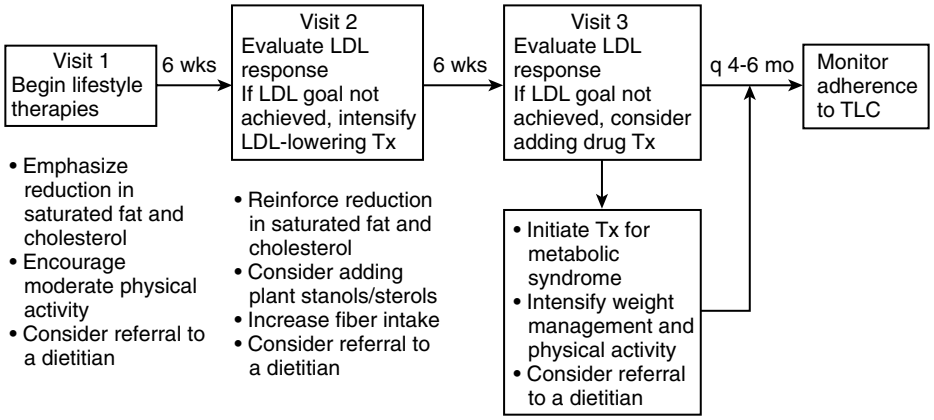


FIGURE 7-4 A model of steps in the Therapeutic Lifestyle Changes (TLC) diet. *LDL,* Low-density lipoprotein; *Tx,* treatment. (From National Heart, Lung, and Blood Institute, 2001.)

VITAMINS, MINERALS, AND PHYTOCHEMICALS

Endothelial dysfunction is one of the earliest signs of heart disease and is present in persons with hypertension, dyslipidemia, diabetes, or hyperhomocysteinemia and in those who smoke. Magnesium appears to have a positive effect on endothelial function (Cuevas and Germain, 2004). Magnesium has antiarrhythmic effects, and its depletion has been associated with CHF. Supplementation is advised when magnesium deficiency is suspected (Ohtsuka and Yamaguchi, 2005). A diet high in magnesium includes whole grains, legumes, dark green leafy vegetables, milk, and fish.

Teaching Pearl

The rhyme "beans, greens, and sardines" is a strategy to remember food sources high in magnesium. Because humor can be helpful in a counseling session, if the person likes salmon but not sardines, you can add, "… or salmon; it just doesn't rhyme." ■

Magnesium has now been found to act as a hydroxymethyl glutaryl coenzyme A reductase (HMG-CoA reductase) inhibitor (see section on statin medications below). Furthermore, magnesium serves an additional function that statins do not, in the conversion of omega-3 linoleic acid and omega-6 linolenic acid into prostaglandins (hormones) that are needed for cardiovascular health (Rosanoff and Seelig, 2004). Advising that foods containing high amounts of magnesium be eaten is beneficial for a variety of reasons (refer to Chapter 3 for a list of foods). If a person chooses to take a magnesium supplement, it should be no more than 100% to 200% of the Dietary Reference Intake (DRI) because of the potential for toxicity.

It was found that coronary artery bypass graft (CABG) surgery in men led to a decrease in magnesium level and an increase in epinephrine and norepinephrine levels. Supplementation of magnesium before surgery was found to reduce complications related to surgery (Pasternak and colleagues, 2006).

Severe chronic thiamin deficiency can cause a type of heart failure called wet beriberi. This form of heart failure clearly benefits from thiamin supplementation. Heart failure patients should routinely be advised to ingest a thiamin-containing multivitamin. Those who are taking diuretics or have increased urinary excretion, such as with uncontrolled diabetes, are especially at risk for developing thiamin deficiency—see Table 3-2 for foods high in thiamin (Sica, 2007).

Found with heart failure is reduced energy production by the heart muscle. Persons suffering from CHF exhibit impaired myocardial energy production, calcium overload of certain muscular tissue, and increased oxidative stress. Nutritional factors known to be important for myocardial energy production, calcium balance, and reduced oxidative stress include vitamins B_1, B_2, and B_6, L-carnitine, coenzyme Q_{10}, creatine, and taurine, which are reduced in persons with heart failure. Restoring depleted levels may result in improvement in myocardial structure and function as well as exercise capacity (Allard, Jeejeebhoy, and Sole, 2006).

Fortification of the U.S. food supply with folic acid in 1998, as mandated by the U.S. Food and Drug Administration, was associated with a further decline in mortality from vascular disease. This is presumably because of increased blood folate and decreased blood homocysteine in the population (McCully, 2007).

Evidence suggests women can lower inflammation and CRP levels by certain vitamins and trace elements from supplements such as vitamin E, the B vitamins, and selenium. Others such as vitamin C, carotenoids, and zinc have not been found effective in lowering CRP. Specific amounts of vitamins and minerals and combinations are yet to be determined for optimal reduction in CRP levels (Scheurig and colleagues, 2008). A lacto-ovo vegetarian diet is linked with lower CRP levels, which is believed to be due to long-term intake of fruits and vegetables. These foods are important sources of dietary salicylates as well as other antiinflammatory compounds (Krajcovicova-Kudlackova and Blazicek, 2005).

Dietary intake of vitamins C and E reduces CHD risk, but supplement use of vitamin C has no significant association with CHD risk (Ye and Song, 2008). Vitamin E supplements (in the fat-soluble form alpha-tocopherol) appear to actually increase mortality. This may be due to adverse interactions with certain medications and increased blood pressure in high-risk populations (Clarke, Burnett, and Croft, 2008). A natural dietary source rich in vitamin E is nuts. The American Heart Association advises a handful of nuts daily to promote cardiovascular health. Evidence suggests a 35% reduction in risk of CHD with adequate intake of nuts. This is due, in part, to reduction in the LDL-C level. It also appears other natural compounds in nuts provide cardioprotective benefits, including fiber, phytochemicals, and minerals such as potassium and magnesium (Kris-Etherton and colleages, 2008).

The phytochemicals found in dark chocolate are believed to promote coronary vasodilation with improved circulation and blood pressure, improve coronary vascular function, and decrease platelet adhesion within hours after consumption. There also is reduced oxidative stress (Flammer and colleages, 2007; Taubert and colleages, 2007). Nondairy dark chocolate is the preferred source, which is identified by the list of ingredients not including butter or milk fat. Nonflavonoid white chocolate has no such effect (Shiina and colleages, 2009).

In persons at high risk of cardiovascular events, a greater dietary soy isoflavone intake is associated with better vascular endothelial function and lower carotid

atherosclerotic burden (Chan and colleages, 2007). **Plant sterols** are bioactive compounds, found in all vegetable foods, that inhibit cholesterol absorption. Little is known about the effect of habitual natural dietary intake of plant sterols. Two epidemiologic studies have shown a significant lowering of serum cholesterol from naturally occurring plant sterols (Klingberg and colleages, 2008). However, caution should be exercised with excess intake of plant sterols because serum vitamin E levels were reduced in a study among those who used sterol products. This suggests that long-term effects of plant sterols on serum fat-soluble vitamin concentrations should be further explored, especially in relation to very low-fat diets (Tuomilehto and colleages, 2008).

Although deficiency of nutrients can lead to CHD, excess is implicated as well. This is true with a high iron level, as indicated by elevated ferritin, which has been associated with inflammation. As ferritin levels increase, HDL-C levels decline (Kraml and colleages, 2004). A relationship has been noted between serum ferritin levels and carotid atherosclerosis (Wolff and colleages, 2004). Research on iron levels may explain the increase in CVD among women after menopause. Vitamin and mineral supplements designed for men and older adults are formulated to be lower in iron because of the low risk for anemia in these populations.

ALCOHOL

Alcohol in moderation is associated with reduced cardiovascular disease. This is attributed to reduced insulin resistance and increased HDL-C levels. With reduced insulin resistance there is a lowered tendency for inflammation and reduced risk of clot formation. Excess alcohol intake is a known risk factor for cardiovascular disease.

CAFFEINE

Chronic coffee intake has been found to promote aortic stiffness. This effect was noted even after controlling for cigarette smoking (Vlachopoulos and colleages, 2005). Some individuals have noted increased blood pressure after consumption of caffeine.

WHAT IS HYPERTENSION, ITS PREVENTION, AND TREATMENT TO HELP PREVENT CARDIOVASULAR DISEASE?

Hypertension is an elevation of the blood pressure to greater than normal levels. Hypertension damages blood vessels and the lining of arteries. This damage impedes adequate circulation and enhances the buildup of plaque. Hypertension is a common and powerful contributor to all forms of CVD, including stroke, peripheral vascular disease, and heart failure, and also leads to renal disease (see Chapter 9).

Optimal readings are under 120/80 mm Hg (the top number is the **systolic blood pressure,** and the bottom number is the **diastolic blood pressure**). Systolic blood pressure refers to the amount of pressure it takes from the blood pressure cuff to stop blood flow. The diastolic blood pressure relates to the ability of the blood vessels to relax allowing blood flow to resume. This level of blood pressure control is of particular importance for individuals at high risk for CVD. The classification for degrees of hypertension are as follows:

- Stage 1: blood pressure greater than or equal to 140/90
- Stage 2: blood pressure greater than or equal to 160/100
- Stage 3: blood pressure greater than or equal to 180/110

Evaluating blood pressure response during exercise rather than at rest might better detect blood pressure problems. Among persons with CAD, those with hypercholesterolemia had significantly higher diastolic blood pressure during exercise than those without hypercholesterolemia (Kubozono greater than or equal to, 2005). Most pediatric nephrologists treat hypertensive children with blood pressure at greater than the 90th percentile (see Appendix 10 on the Evolve website), but the question remains whether children with renal disease or diabetes should have lower blood pressure guidelines, as do adults with concurrent health problems (Woroniecki and Flynn, 2005).

CAUSES OF HYPERTENSION

It is increasingly recognized that the endothelial lining affects blood pressure. Nitric oxide is one of the major regulators of vascular tone produced in the endothelial layer. Altered nitric oxide metabolism leads to increased **vasoconstriction** (constriction of blood vessels), promoting high blood pressure. Nitric oxide alterations have been linked with CHD.

Hypertension is associated with the metabolic syndrome. One population at high risk for the metabolic syndrome, African Americans, also has the highest prevalence of hypertension in the world. It is thought that low birth weights among this population contribute to adult hypertension. Efforts to improve intrauterine growth as well as lessen weight gain in adolescence might substantially reduce excess high blood pressure or hypertension in this ethnic group (Cruickshank and colleages, 2005).

There is now recognition that magnesium deficiency is a primary cause of hypertension and other aspects of the metabolic syndrome through altered calcium metabolism and increased inflammation. Magnesium promotes vasodilation, acts as a calcium channel blocker, and has been used to protect organs during an MI (Shimosawa and Fujita, 2005). It appears that magnesium inhibits norepinephrine release, which allows a decrease in blood pressure (Shimosawa and colleages, 2004). Magnesium supplementation greater than 15 mmol (greater than 350 mg) per day can normalize high blood pressure without medication (Rosanoff, 2005). However, excess intake of magnesium can occur. Individuals should not exceed 200% of the DRI for any mineral (see the back of the book). Current research is further indicating that low intake of calcium, potassium, and magnesium is associated primarily with elevated systolic blood pressure, whereas high sodium intake is found primarily with elevated diastolic blood pressure (Townsend and colleages, 2005).

DIETARY TREATMENT STRATEGIES TO CONTROL HYPERTENSION

Weight Management

Because obesity is a predisposing factor in hypertension, a low-kcalorie diet is often prescribed to reduce weight. A study noted that with the same 10-lb weight loss, a diet high in low-fat dairy products, vegetables, and fruit resulted in a greater decrease in blood pressure than did a low-fat diet. This dietary approach may provide additional benefits in those who are overweight with hypertension (Nowson and colleages, 2005).

Macronutrient Contributions

Changing the proportions of dietary fat by decreasing saturated fatty acids and increasing monounsaturated fats decreased diastolic blood pressure. Interestingly, the beneficial effect on blood pressure induced by fat quality was negated by the consumption of a high total fat intake greater than 37%. The addition of n-3 fatty acids to the diet had no significant effect on blood pressure (Rasmussen and colleages, 2006).

In a study of rats it was the addition of salt to a high-fructose diet that resulted in increased cardiac wall thickness and increased rates of mortality not observed in other dietary groups consisting of high complex carbohydrates, low carbohydrates, or moderate intake of fructose and high intake of fat (Sharma and colleages, 2007).

The DASH Diet

The **Dietary Approaches to Stop Hypertension (DASH)** eating plan (see Appendix 11 on the Evolve website) promotes increased amounts of potassium through high intake of fruit, vegetables, fish, and nuts, use of low-fat dairy products, and reduced levels of total and saturated fat, along with lowered sodium intake. A range of 1200 to 2300 mg of sodium was found to be acceptable for persons with or at risk for hypertension following the DASH diet (Karanja and colleages, 2007). Simultaneous increases in magnesium intake through leafy greens, legumes, and whole grains could have an additional beneficial effect. Dietary phosphorus, calcium, and magnesium are related to lower levels of blood pressure (Elliott and colleages, 2008). The relationship between magnesium intake and blood pressure appears strongest for magnesium obtained from food rather than from supplements (Champagne, 2008).

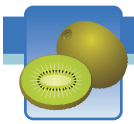
The higher intake of fruits and vegetables advocated with the DASH diet has been linked with long-term control of blood pressure. Over a 5-year period this pattern of eating consumption helped prevent the rise of systolic blood pressure (Dauchet and colleages, 2007). Adherence to the DASH-style diet was found to be associated with a lower risk of CHD and stroke among middle-age women over a 24-year period from 1980 to 2004 (Fung and colleages, 2008).

It appears that calcium combined with daily intake of 800 International Units of vitamin D best lowers systolic blood pressure in elderly women (Mosekilde, 2005). This may be due to improved absorption of dietary calcium. Interestingly, mood and depression also are improved with a low-sodium, high-potassium diet (Torres, Nowson, and Worsley, 2008).

Further adjustments in protein, fluid, and sodium intake are made if there is concurrent kidney disease. Sodium restriction has been found to improve the effectiveness of diuretic therapy. However, a severe restriction of sodium intake has been associated with insulin resistance and obesity in rats. The resulting impairment of the insulin signaling in muscle and liver tissues, but not in adipose tissue, may lead to increased adiposity and insulin resistance (Prada and colleages, 2005).

Individuals who take potassium-depleting diuretics are advised to increase their potassium intake to replenish what is lost in the increased urine volume. Bananas and orange juice are frequently recommended for their potassium content, but many foods are high in potassium. Most fresh vegetables (especially dark green, leafy ones), most fruits, legumes, milk, and fresh meats are good sources of potassium (see Box 15-2 and add only a small amount of sodium to the diet. Physicians should be consulted before a potassium substitute for salt is used; individuals on angioten-

sin-converting enzyme (ACE) inhibitors or with impaired renal function should not use salt substitutes containing potassium.



Cultural Considerations

A community-based study of low-income African American women who altered the DASH diet to include soul foods, "DASH of Soul," was conducted during a 10-month period. Methods included 10 filmed cooking labs to modify traditional soul food to reduce food kcalories, total fat, saturated fat, sugar, and sodium. It was concluded that the potential is good for the study population to make Modified Soul–DASH a lifestyle choice (Rankins, Wortham, and Brown, 2007). ■

Licorice

Large intake of licorice is well known to lead to hypertension. Hypokalemia and hypertension from licorice are due to altered cortisol-related hormonal levels (Sontia and colleagues, 2008). Aside from licorice, there are other sources, including licorice tea. To avoid adverse health impact a maximum intake of 10 to 30 g of licorice and no more than half a cup of licorice tea a day is advised (Boganen, van Hee, and Grundmeijer, 2007). Herbal products may contain licorice. A case study involving a 93-year-old hypertensive woman found her to have severe hypokalemia (as low as 1.3 mEq/L); she developed paralysis of all extremities and had indications of **rhabdomyolysis** (a condition of cell rupture that can cause severe kidney failure). The symptoms were attributed to her use of licorice-containing herbal medicines for the previous 7 years; discontinuation and other treatments allowed resolution of all symptoms in 2 weeks (Yasue and colleagues, 2007). Traditional Chinese medicine may contain 2.0 g of licorice in the approved daily dose. In one case study this dose was found to be related to development of severe hypokalemic rhabdomyolysis diagnosed after the woman developed diarrhea and vomiting, but she had been suffering from general fatigue and hypertension during the 2 years of taking the supplement (Toyohara and colleagues, 2008).

Teaching Pearl

The 6-month PREMIER trial showed comprehensive behavioral intervention programs improve lifestyle behaviors with reduced weight, fat intake, and sodium intake and resulted in lower blood pressure. Better outcomes were found than with advice-only approaches. Over 18 months, persons with prehypertension and stage 1 hypertension were able to sustain multiple lifestyle modifications that improved control of blood pressure (Elmer and colleagues, 2006). Similar findings were found with adolescents with prehypertension or hypertension, who had improved outcomes with a behavioral intervention emphasizing the DASH diet (Couch and colleagues, 2008). ■

PURPOSES OF AND INDICATIONS FOR SODIUM-CONTROLLED DIETS

There are several reasons for restricting sodium intake (see Chapter 3 to review information on this mineral). The indications for restricting sodium intake include the following:

- Hypertension (to relieve elevated or high blood pressure)
- CHF, or simply heart failure (a condition in which the heart cannot pump blood adequately)
- **Edema** (a condition of fluid buildup, which can be treated by helping the body to eliminate sodium and fluids)
- Renal disorders with edema
- Adrenocorticotropic hormone and cortisone therapy
- Cirrhosis of the liver with ascites (a disease often caused by alcoholism but also derived from other causes)
- The Dietary Guidelines for Americans of 2300 mg of sodium per day (2400 mg of sodium listed on food labels remains appropriate)

WHAT IS A SODIUM-RESTRICTED DIET?

A sodium-restricted diet is a normal adequate diet with modified sodium content, from a very low amount of 1000 mg to 3000 mg. Generally 2000 mg of sodium is the lowest level of restriction currently advised (Table 7-4).

An average diet prepared in the kitchen with some commercially prepared foods, foods salted during cooking, and some salt added at the table provides about 3000 to 7000 mg of sodium daily. (These numbers should not be confused with salt intake—40% of salt consists of sodium. One teaspoon of salt contains about 2000 mg of sodium.)

A no-added-salt diet by definition means 3000 to 4000 mg of sodium. Low-sodium diets should be described by the level of sodium restriction, the most usual being the 3000- to 4000-mg sodium diet (mild restriction) and the 2000-mg sodium diet (moderate), with the 500- to 1000-mg sodium diet (very strict) rarely used. See Chapter 3 for more information on sodium.

Although the initial elimination of salt from the diet is very difficult for a person used to its taste, the taste for salt can be unlearned fairly rapidly. Use of spices, herbs, lemon juice, or vinegar can help enhance the taste appeal of food while the preference for salt is changing.

WHAT IS THE ROLE OF EXERCISE IN THE MANAGEMENT OF CARDIOVASCULAR DISEASE?

Exercise is a well-known component of weight control. Because obesity is associated with other risk factors found in the development of CVD, exercise should be an integral aspect in both the prevention and the treatment of CVD. Physical activity, including moderate-intensity exercise such as walking, is associated with substantial reduction in risk of stroke. The guideline of 30 minutes of brisk walking on most days of the week has been found to significantly decrease blood pressure, reduce stroke risk, and reduce 10-year risk for CHD among middle-age adults (Tully and colleages, 2005). It has been noted that the more physical activities, the greater the health and financial advantages, with reduced need for medication related to diabetes, a risk factor for CHD (Di Loreto and colleages, 2005).

Aerobic exercise (any exercise that makes a person take in more air, such as a brisk walk) decreases blood pressure by reducing vascular resistance through beneficial effects on the nervous and hormonal systems. Resistance training also appears able to reduce blood pressure (Fagard, 2006).

Table 7-4 Sodium-Restricted Diets

FOODS	2-4 g SODIUM	2 g SODIUM
Milk	3 c milk or yogurt, no processed cheese; natural cheese (1 oz) can replace 1 c milk; free use of low-sodium cheese	2 c milk or yogurt; up to 1 oz natural cheese can be substituted for 1 c milk; free use of low-sodium cheese
Meat and meat substitutes	Limited use of processed meats; free use of fresh meat	No processed meat; use salt-free canned tuna; limited use of regular peanut butter; free use of low-sodium peanut butter
Breads and cereals	Avoid breads and crackers with salt topping; regular bread may be used in normal amounts; free use of low-sodium bread and cereal products; avoid canned soups and vegetables and cereals with added salt	Up to 6 slices regular bread or 1 serving regular processed cereal may be used; free use of low-sodium grains and cereals
Vegetables and fruits	All fresh, frozen, and dried; all canned fruit but limited use of canned vegetables; free use of low-sodium canned vegetables; no salted products such as potato chips or fries	Use only low-sodium canned vegetables; moderate amounts of naturally high-sodium vegetables (beets, carrots, celery, spinach); free use of all others
Condiments		
Sweets		
Brown sugar	Free use	Free use
Table sugar	Free use	Free use
Honey	Free use	Free use
Jams and jellies	Free use	Free use
Maple syrup	Free use	Free use
Molasses	Free use	Free use
Sauces		
Catsup	Limited use	Use low-sodium variety freely
Mayonnaise	Limited use	Use low-sodium variety
Mustard	Limited use	Use low-sodium variety
Soy sauce	Limited use	Use low-sodium variety
Worcestershire sauce	Limited use	Not allowed
Butter and margarine	Limited use	Use low-sodium variety
Other		
Cooking oil	Free use	Free use
Vinegar	Free use	Free use
Spices		
Natural	Free use	Free use
Salt-based spices	Limited use	Not allowed
Lemon	Free use	Free use
Horseradish	Free use	Limited use
Salt	Very limited use (few sprinkles)	Use salt substitute (physician approval)

In addition, regular aerobic exercise is associated with increased levels of HDL-C and decreased levels of LDL-C, and it has been recommended that persons with low HDL-C levels be encouraged to exercise. This level of exercise is generally considered to be at least 30 minutes of exercise that significantly raises the heart rate at least three to four times weekly. However, particularly for someone with long-standing diabetes, consultation with a physician or health care provider before engaging in exercise is advised.

WHAT IS THE ROLE OF DRUG THERAPY IN THE MANAGEMENT OF CARDIOVASCULAR DISEASE?

Medications to reduce CVD have a broad range of mechanisms. The lipid-lowering medications, such as the statins and fenofibrate, lower lipid levels. Aspirin is used to control inflammation and help prevent clot formation. A variety of medications aimed at controlling hypertension indirectly help prevent CVD, and there are many medications used to treat CVD once it has developed. This review is primarily aimed at lipid-lowering medications.

Statin medications work to interfere with the body's natural cholesterol formation. Cholesterol is produced in the liver through a series of metabolic reactions. Statin medications are aimed at preventing the final step in this process, thereby lowering LDL-C levels. The final enzyme required to produce LDL-C is HMG-CoA reductase. Statins are referred to as HMG-CoA reductase inhibitors, because they inhibit this enzyme, causing reduced production of LDL-C by the liver. Statins also interfere with the liver's production of Co-Q_{10} enzyme.

Various statin medications lower LDL-C and CRP levels, some more than others (Schaefer and colleages, 2005). Other lipid medications have been implicated in lowering inflammation as indicated by reduced CRP levels. These include niacin, fibrates, gemfibrozil, and aspirin.

All medications have the potential for serious side effects. Those associated with statins include the painful muscle conditions **myopathy** (any disease of the muscles) and rhabdomyolysis along with polyneuropathy. These conditions all resemble the pathologic process of selenium deficiency, especially myopathy (Moosmann and Behl, 2004). A meta-analysis of studies found breast cancer increases with long-term use of statins, and hemorrhagic stroke has been implicated. Evidence of effectiveness also was found to be reduced in women and in persons over the age of 65 years as compared with studies of men (Preobrazhenskiĭ and colleages, 2007).

Statins and fenofibrate (a medication that decreases absorption of fat and lowers levels of triglycerides and LDL-C) have been found to alter levels of essential fatty acids with an increase of arachidonic acid and decrease of linolenic acid. Fenofibrate further reduced DHA. Increasing the omega-3 fatty acid sources while lowering the intake of omega-6 fatty acids may improve the outcome of these lipid-lowering medications (de Lorgeril and colleages, 2005). Fenofibrate reduced inflammation markers, increased adiponectin levels, and improved insulin sensitivity in persons with the metabolic syndrome (Koh and colleages, 2005).

Questions of benefit versus risk of lipid-lowering medications need to be considered. In the case of statins and the elderly, the benefit may not outweigh the risk of adverse side effects. Because research notes that the elderly may not have extension of life by lowering serum cholesterol levels, the risk-to-benefit ratio becomes greater.

Table 7-5 National Heart, Lung, and Blood Institute Adult Treatment Panel III (ATP III) Guidelines for LDL-Cholesterol Goal and Levels for Therapeutic Lifestyle Changes (TLC) and Drug Therapy in Different Risk Categories

RISK CATEGORY	LDL-C GOAL	LDL-C LEVEL AT WHICH TO INITIATE TLC	LDL-C LEVEL AT WHICH TO CONSIDER DRUG THERAPY
CHD or CHD risk equivalent (10-year risk >20%)	<100 mg/dL	≥100 mg/dL	≥130 mg/dL (optional 100-129)
2+ Risk factors (10-year risk ≤ 20%)	<130 mg/dL	≥130 mg/dL	10-year risk 10% to 20%: ≥130 mg/dL
0-1 Risk factors	<160 mg/dL	≥160 mg/dL	10-year risk <10% ≥160 mg/dL ≥190 mg/dL(optional 160-199)

CHD, Coronary heart disease; *LDL*, low-density lipoprotein, *LDL-C*, low-density–lipoprotein cholesterol.

Such adverse concerns of statin medications with the elderly include increased risk of cancer, neurodegenerative disease, and heart failure (Golomb, 2005). There is inadequate research to fully support recommendations of statin use for the elderly population. This is particularly true for those persons with dyslipidemia over the age of 85, in whom little research has been undertaken (Deedwania and Volkova, 2005).

A form of niacin or vitamin B_3, nicotinic acid, helps normalize all lipids, including HDL-C, LDL-C, and triglycerides (Berra, 2004). The amount of niacin used to control lipids is in a pharmacologic dose and should be used under medical supervision. The immediate-release form of niacin contains the therapeutic form of free nicotinic acid and is the least expensive form, while being the safest and most effective. The slow-release form of niacin was found to be safe and effective at doses of 1000 to 3000 mg, with more women than men achieving significant decreases in lipids (Goldberg, 2004). Niacin inhibits production of triglyceride. It serves as an antioxidant and has antiinflammatory actions. Combining niacin with statins, which also have antiinflammatory action, is advised (Meyers, Kamanna, and Kashyap, 2004).

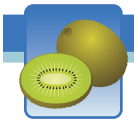
Aspirin is used to help prevent heart attacks and stroke by reducing clot formation. Aspirin also has antiinflammatory action. However, not everyone benefits from aspirin therapy. Aspirin resistance occurs in about one third of individuals treated with this form of therapy. Ischemic heart disease, cigarette smoking, and treatment with statin medications have all been associated with increased aspirin resistance (Coma-Canella, Velasco, and Castano, 2005).

Other factors leading to elevated lipid levels and hypertension should be explored. One example is with hypothyroidism. Addition of the thyroid hormone levothyroxine lowered lipid levels found with subclinical hypothyroidism; in particular, improved triglyceride levels were noted (Milionis and colleages, 2005). Stopping oral contraceptives is an effective antihypertensive intervention (Lubianca and colleages, 2005).

Determining risk for CHD can help guide an individual in the decision to use lipid-lowering medications (Table 7-5). An online 10-year risk factor analysis for CHD is available through the National Heart, Lung, and Blood Institute. The risk analysis is based on age, gender, and cholesterol and blood pressure values. The website address is www.nhlbi.nih.gov/guidelines/cholesterol/index.htm.

Pharmaceuticals can certainly be detrimental. With adolescents experimenting with prescription medications in the home, and athletes using a variety of substances

for the goal of improving performance, adverse impacts on CHD need to be considered. It was found that atrial fibrillation in one young adult was due to ingestion of creatine monohydrate. Other anecdotal reports also have linked creatine to the development of arrhythmia. (Kammer, 2005). Clenbuterol is a common veterinary medication that is approved for use in countries outside the United States as a bronchodilator for humans. Athletes are known to abuse this medication because of its anabolic and lipolytic effects. Health care professionals should be aware of this potential abuse because side effects have been observed among athletes, including atrial fibrillation and severe electrolyte imbalances (Daubert and colleagues, 2007).



Cultural Considerations

Genetics alter the use of pharmaceuticals. It was found that the ACE inhibitors used in controlling renal vascular response and blood pressure, captopril and candesartan, were more effective in whites than in African Americans (Forman and colleagues, 2007). In another study, Native American men and women age 40 years or older with type 2 diabetes with no prior CVD events were aggressively treated with medications. This resulted in reduced LDL-C levels (70 mg/dL) and systolic blood pressure (less than 115 mm Hg) with the lower targets helping in the regression of carotid thickness and greater decrease in left ventricular mass in individuals with type 2 diabetes. However, there were more adverse and serious adverse events related to blood pressure medications in the aggressively treated group (Howard and colleagues, 2008). ■

WHAT IS THE ROLE OF THE NURSE OR OTHER HEALTH CARE PROFESSIONAL IN THE PREVENTION AND CONTROL OF CARDIOVASCUAR DISEASE?

Nurses and other health care professionals are important team members in the fight against CVD. A large body of evidence reinforces the belief that nutritional changes can lower the risk of CVD. Yet many individuals either are not aware of how to make appropriate dietary changes to help prevent CVD or believe that the cost of change is greater than the results accrued. The nurse has the opportunity through direct patient contact to assess the reasons that various individuals may not be following the general CVD reduction guidelines.

A health care professional can assess whether lack of knowledge is the reason for poor dietary compliance by saying, "You probably have heard about cholesterol and saturated fat in television commercials, but are you aware of which foods contain high amounts?" Sometimes a negative attitude or belief may be the reason for not making dietary changes. To assess this, a good question would be, "How do you feel about all the discussion concerning cholesterol?"

It is for safety concerns with any medication that MNT is advised as a primary defense line against CVD. Providing an individual with a preprinted diet sheet provided by a pharmaceutical company is not adequate. Referral to a registered dietitian is advised before the use of lipid-lowering medications for individualized MNT. For individuals who cannot adequately lower their lipid levels through diet and exercise, the benefit of the medications is felt to outweigh the risks.

Educating populations at risk for CVD is essential. However, whether from inadequate compliance with treatment protocol or differences in individual responses to MNT and medication outcomes, risk factors for CVD remain. It was found that in

persons with hypertension, LDL-C levels were generally not at target, even in those undergoing current methods of treatment (Pedrinelli, Esposti, and Dell'Omo, 2005).

Through positive reinforcement of steps taken, no matter how small, and referral to appropriate services, nurses and other health care professionals can play a key role in reducing this society's primary health risk.

Chapter Challenge Questions & Classroom Activities

1. Interview family members regarding personal family history of CVD and hypertension. Use the National Heart, Lung and Blood Institute Website (see p. 285) to determine your personal risk factors for heart disease.
2. List traditional ethnic foods from your family's meals (those your grandparents ate or those that are currently consumed); which foods do you like to eat that are low in saturated fat and high in soluble fiber?
3. Collect samples of vegetable oils, including at least one that is predominantly a saturated fat, one that is a monounsaturated fat, and one that is a polyunsaturated fat, and refrigerate all of them. Compare textures to determine the degree of solidity. Which ones are cardioprotective?
4. Taste-test low-sodium food products. Compare these foods with different seasonings, such as spices, herbs, lemon, and jelly.
5. List 20 everyday foods, then read food labels of these foods to determine saturated fat and sodium content.
6. Evaluate your family's saturated fat intake according to food labels. Does your family eat foods that contain trans fatty acids? What are some alternatives?
7. What could you recommend for a lunch for someone who is employed at a construction work site and has dyslipidemia and hypertension? What could you recommend for a dessert for such a person?
8. Calculate the Food Exchanges using Box 2-3 and referring to Appendix 3 on the Evolve website for a TLC diet based on 1800 kcal based on the Exchange Lists.
9. Assess your dietary needs on the National Heart, Lung, and Blood Institute website (www.nhlbi.nih.gov/chd).

Case Study

Royce was taking his daughter out for a walk. Katie had recovered well from her stroke, but continued to have problems with balance and didn't like to walk alone. Katie put on her jacket with a pocket because she liked to carry something to eat in case her blood sugar level dropped. She seemed to have inherited that tendency from her mother. Even though Katie didn't have diabetes, it did run in her mother's side of the family.

Critical Thinking Applications

1. What are risk factors for having a stroke?
2. What can Katie carry to prevent low blood sugar level, but with low impact on triglyceride level and blood pressure?
3. How might Katie get exercise in which she didn't have to worry about balance?
4. What are some considerations for Katie to lower her risk of diabetes?
5. What cholesterol levels would be advised for Katie?

REFERENCES

Aasen G, Fagertun H, Halse J: Regional fat mass by DXA: high leg fat mass attenuates the relative risk of insulin resistance and dyslipidaemia in obese but not in overweight postmenopausal women. *Scand J Clin Lab Invest* 68(3):204-211, 2008.

Ahmad I, Zhan M, Miller M: High prevalence of C-reactive protein elevation with normal triglycerides (100-149 mg/dL): are triglyceride levels below 100 mg/dL more optimal in coronary heart disease risk assessment? *Am J Med Sci* 329(4):173-177, 2005.

Allard ML, Jeejeebhoy KN, Sole MJ: The management of conditioned nutritional requirements in heart failure, *Heart Fail Rev* 11(1):75-82, 2006.

Almgren T, Persson B, Wilhelmsen L, Rosengren A, Andersson OK: Stroke and coronary heart disease in treated hypertension—a prospective cohort study over three decades, *J Intern Med* 257(6):496-502, 2005.

Aronow WS: Management of hyperlipidemia with statins in the older patient, *Clin Interv Aging* 1(4):433-438, 2006.

Ascherio A: Trans fatty acids and blood lipids, *Atheroscler Suppl* 7(2):25-27, 2006.

Bahceci M, Tuzcu A, Ogun C, Canoruc N, Iltimur K, Aslan C: Is serum C-reactive protein concentration correlated with HbA1c and insulin resistance in type 2 diabetic men with or without coronary heart disease? *J Endocrinol Invest* 28(2):145-150, 2005.

Bansal S, Buring JE, Rifai N, Mora S, Sacks FM, Ridker PM: Fasting compared with nonfasting triglycerides and risk of cardiovascular events in women, *JAMA* 298(3):309-316, 2007.

Berra K: Clinical update on the use of niacin for the treatment of dyslipidemia, *J Am Acad Nurse Pract* 16(12):526-534, 2004.

Bertran N, Camps J, Fernandez-Ballart J, Arija V, Ferre N, Tous M, Simo D, Murphy MM, Vilella E, Joven J: Diet and lifestyle are associated with serum C-reactive protein concentrations in a population-based study, *J Lab Clin Med* 145(1):41-46, 2005.

Boganen H, van Hee K, Grundmeijer HG: Hypertension due to liquorice and liquorice tea consumption, *Ned Tijdschr Geneeskd* 151(51):2825-2828, 2007.

Bonville DA, Parker TS, Levine DM, Gordon BR, Hydo LJ, Eachempati SR, Barie PS: The relationships of hypocholesterolemia to cytokine concentrations and mortality in critically ill patients with systemic inflammatory response syndrome, *Surg Infect (Larchmt)* 5(1):39-49, 2004.

Bray GA, Most M, Rood J, Redmann S, Smith SR: Hormonal responses to a fast-food meal compared with nutritionally comparable meals of different composition, *Ann Nutr Metab* 51(2):163-171, 2007.

Brehm B, Gates D, Singler M, Poeppelman A, Succop P, D'Alessio D: Prevalence of obesity and cardiovascular risk factors among manufacturing company employees in Kentucky, *AAOHN J* 55(10):397-406, 2007.

Carson JA: Nutrition therapy for dyslipidemia, *Curr Diab Rep* 3(5):397-403, 2003.

Champagne CM: Magnesium in hypertension, cardiovascular disease, metabolic syndrome, and other conditions: a review, *Nutr Clin Pract* 23(2):142-151, 2008.

Chan DC, Watts GF, Nguyen MN, Barrett PH: Factorial study of the effect of n-3 fatty acid supplementation and atorvastatin on the kinetics of HDL apolipoproteins A-I and A-II in men with abdominal obesity, *Am J Clin Nutr* 84(1):37-43, 2006.

Chan YH, Lau KK, Yiu KH, Li SW, Chan HT, Tam S, Shu XO, Lau CP, Tse HF: Isoflavone intake in persons at high risk of cardiovascular events: implications for vascular endothelial function and the carotid atherosclerotic burden, *Am J Clin Nutr* 86(4):938-945, 2007.

Clarke MW, Burnett JR, Croft KD: Vitamin E in human health and disease, *Crit Rev Clin Lab Sci* 45(5):417-450, 2008.

Coma-Canella I, Velasco A, Castano S: Prevalence of aspirin resistance measured by PFA-100, *Int J Cardiol* 101(1):71-76, 2005.

Coppola G, Rizzo M, Abrignani MG, Corrado E, Di Girolamo A, Braschi A, Braschi G, Novo S: Fibrinogen as a predictor of mortality after acute myocardial infarction: a forty-two-month follow-up study, *Ital Heart J* 6(4):315-322, 2005.

Corrado E, Novo S: High sensitivity of C-reactive protein in primary prevention, *G Ital Cardiol (Rome)* 8(6):327-334, 2007.

Couch SC, Saelens BE, Levin L, Dart K, Falciglia G, Daniels SR: The efficacy of a clinic-based behavioral nutrition intervention emphasizing a DASH-type diet for adolescents with elevated blood pressure, *J Pediatr* 152(4):494-501, 2008.

Cruickshank JK, Mzayek F, Liu L, Kieltyka L, Sherwin R, Webber LS, Srinavasan SR, Berenson GS: Origins of the "black/white" difference in blood pressure: roles of birth weight, postnatal growth, early blood pressure, and adolescent body size—the Bogalusa Heart Study, *Circulation* 111(15):1932-1937, 2005.

Cuevas AM, Germain AM: Diet and endothelial function, *Biol Res* 37(2):225-230, 2004.

Curgunlu A, Karter Y, Uzun H, Aydin S, Erturk N, Vehid S, Simsek G, Kutlu A, Ozturk E, Erdine S: Hyperhomocysteinemia, *Int Heart J* (2):245-254, 2005.

Dallongeville J, Gruson E, Dallinga-Thie G, Pigeyre M, Gomila S, Romon M: Effect of weight loss on the postprandial response to high-fat and high-carbohydrate meals in obese women, *Eur J Clin Nutr* 61(6):711-718, 2007.

Daubert GP, Mabasa VH, Leung VW, Aaron C: Acute clenbuterol overdose resulting in supraventricular tachycardia and atrial fibrillation, *J Med Toxicol* 3(2):56-60, 2007.

Dauchet L, Kesse-Guyot E, Czernichow S, Bertrais S, Estaquio C, Péneau S, Vergnaud AC, Chat-Yung S, Castetbon K, Deschamps V, Brindel P, Hercberg S: Dietary patterns and blood pressure change over 5-y follow-up in the

SU.VI.MAX cohort, *Am J Clin Nutr* 85(6):1650-1656, 2007.

Deedwania P, Volkova N: Dyslipidemia and lipid-lowering therapy in the elderly, *Expert Rev Cardiovasc Ther* 3(3):453-463, 2005.

de Lorgeril M, Salen P, Guiraud A, Zeghichi S, Boucher F, de Leiris J: Lipid-lowering drugs and essential omega-6 and omega-3 fatty acids in patients with coronary heart disease, *Nutr Metab Cardiovasc Dis* 15(1):36-41, 2005.

De Luis DA, Aller R, Izaola O, Gonzalez Sagrado M, Conde R, Perez Castrillon JL: Effects of lifestyle modification on adipocytokine levels in obese patients, *Eur Rev Med Pharmacol Sci* 12(1):33-39, 2008.

Den Ruijter HM, Berecki G, Opthof T, Verkerk AO, Zock PL, Coronel R: Pro- and antiarrhythmic properties of a diet rich in fish oil, *Cardiovasc Res* 73(2):316-325, 2007.

Di Loreto C, Fanelli C, Lucidi P, Murdolo G, De Cicco A, Parlanti N, Ranchelli A, Fatone C, Taglioni C, Santeusanio F, De Feo P: Make your diabetic patients walk: long-term impact of different amounts of physical activity on type 2 diabetes, *Diabetes Care* 28(6):1295-1302, 2005.

Dyerberg J, Eskesen DC, Andersen PW, Astrup A, Buemann B, Christensen JH, Clausen P, Rasmussen BF, Schmidt EB, Tholstrup T, Toft E, Toubro S, Stender S: Effects of trans- and n-3 unsaturated fatty acids on cardiovascular risk markers in healthy males: an 8 week dietary intervention study, *Eur J Clin Nutr* 58(7):1062-1070, 2004.

Edgar PF, Hooper AJ, Poa NR, Burnett JR: Violent behavior associated with hypocholesterolemia due to a novel APOB gene mutation, *Mol Psychiatry* 12(3):258-263; 221, 2007.

Elliott P, Kesteloot H, Appel LJ, Dyer AR, Ueshima H, Chan Q, Brown IJ, Zhao L, Stamler J; INTERMAP Cooperative Research Group, Dietary phosphorus and blood pressure: international study of macro- and micro-nutrients and blood pressure, *Hypertension* 51(3):669-675, 2008.

Elmer PJ, Obarzanek E, Vollmer WM, Simons-Morton D, Stevens VJ, Young DR, Lin PH, Champagne C, Harsha DW, Svetkey LP, Ard J, Brantley PJ, Proschan MA, Erlinger TP, Appel LJ; PREMIER Collaborative Research Group, Effects of comprehensive lifestyle modification on diet, weight, physical fitness, and blood pressure control: 18-month results of a randomized trial, *Ann Intern Med* 144(7):485-495, 2006.

Erkkila AT, Lichtenstein AH, Mozaffarian D, Herrington DM: Fish intake is associated with a reduced progression of coronary artery atherosclerosis in postmenopausal women with coronary artery disease, *Am J Clin Nutr* 80(3):626-632, 2004.

Fagard RH: Exercise is good for your blood pressure: effects of endurance training and resistance training, *Clin Exp Pharmacol Physiol* 33(9):853-856, 2006.

Faloia E, Tirabassi G, Canibus P, Boscaro M: Protective effect of leg fat against cardiovascular risk factors in obese premenopausal women, *Nutr Metab Cardiovasc Dis* 19(1):39-44, 2009.

Flammer AJ, Hermann F, Sudano I, Spieker L, Hermann M, Cooper KA, Serafini M, Lüscher TF, Ruschitzka F, Noll G, Corti R: Dark chocolate improves coronary vasomotion and reduces platelet reactivity, *Circulation* 116(21):2376-2782, 2007.

Fontana L, Meyer TE, Klein S, Holloszy JO: Long-term low-calorie low-protein vegan diet and endurance exercise are associated with low cardiometabolic risk, *Rejuvenation Res* 10(2):225-234, 2007.

Forman JP, Price DA, Stevanovic R, Fisher ND: Racial differences in renal vascular response to angiotensin blockade with captopril or candesartan, *J Hypertens* 25(4):877-882, 2007.

Fung TT, Chiuve SE, McCullough ML, Rexrode KM, Logroscino G, Hu FB: Adherence to a DASH-style diet and risk of coronary heart disease and stroke in women, *Arch Intern Med* 168(7):713-720, 2008.

Fung TT, Stampfer MJ, Manson JE, Rexrode KM, Willett WC, Hu FB: Prospective study of major dietary patterns and stroke risk in women, *Stroke* 35(9):2014-2019, 2004.

Gardner CD, Coulston A, Chatterjee L, Rigby A, Spiller G, Farquhar JW: The effect of a plant-based diet on plasma lipids in hypercholesterolemic adults: a randomized trial, *Ann Intern Med* 142(9):725-733, 2005.

Gariballa S, Ullegaddi R: Riboflavin status in acute ischaemic stroke, *Eur J Clin Nutr* 61(10):1237-1240, 2007.

German JB, Dillard CJ: Composition, structure and absorption of milk lipids: a source of energy, fat-soluble nutrients and bioactive molecules, *Crit Rev Food Sci Nutr* 46(1):57-92, 2006.

Ginsberg HN, Zhang YL, Hernandez-Ono A: Regulation of plasma triglycerides in insulin resistance and diabetes, *Arch Med Res* 36(3):232-240, 2005.

Goldberg AC: A meta-analysis of randomized controlled studies on the effects of extended-release niacin in women, *Am J Cardiol* 94(1):121-124, 2004.

Golomb BA: Implications of statin adverse effects in the elderly, *Expert Opin Drug Saf* 4(3):389-397, 2005.

Griffin BA: How relevant is the ratio of dietary n-6 to n-3 polyunsaturated fatty acids to cardiovascular disease risk? Evidence from the OPTILIP study, *Curr Opin Lipidol* 19(1):57-62, 2008.

Gupta R, Sarna M, Thanvi J, Sharma V, Gupta VP: Fasting glucose and cardiovascular risk factors in an urban population, *J Assoc Physicians India* 55:705-709, 2007.

Hall WL, Sanders KA, Sanders TA, Chowienczyk PJ: A high-fat meal enriched with eicosapentaenoic acid reduces postprandial arterial stiffness measured by digital volume pulse analysis in healthy men, *J Nutr* 138(2):287-291, 2008.

Howard BV, Roman MJ, Devereux RB, Fleg JL, Galloway JM, Henderson JA, Howard WJ, Lee ET, Mete M, Poolaw B, Ratner RE, Russell M, Silverman A, Stylianou M, Umans JG, Wang W, Weir MR, Weissman NJ, Wilson C, Yeh F, Zhu J: Effect of lower targets for blood pressure and LDL cholesterol on atherosclerosis in diabetes: the SANDS randomized trial, *JAMA* 299(14):1678-1689, 2008.

Hrabovský V, Zadák Z, Bláha V, Hyspler R, Karlík T: Changes in lipid metabolism in patients in the active phase of Crohn's disease, *Vnitr Lek* 53(10):1035-1039, 2007.

Huffman KM, Orenduff MC, Samsa GP, Houmard JA, Kraus WE, Bales CW: Dietary carbohydrate intake and high-sensitivity C-reactive protein in at-risk women and men, *Am Heart J* 154(5):962-968, 2007.

Iglseder B, Cip P, Malaimare L, Ladurner G, Paulweber B: The metabolic syndrome is a stronger risk factor for early carotid atherosclerosis in women than in men, *Stroke* 36(6):1212-1217, 2005.

Jenkins DJ, Kendall CW, Marchie A, Josse AR, Nguyen TH, Faulkner DA, Lapsley KG, Blumberg J: Almonds reduce biomarkers of lipid peroxidation in older hyperlipidemic subjects, *J Nutr* 138(5):908-913, 2008.

Kabagambe EK, Baylin A, Ruiz-Narvarez E, Siles X, Campos H: Decreased consumption of dried mature beans is positively associated with urbanization and nonfatal acute myocardial infarction, *J Nutr* 135(7):1770-1775, 2005.

Kammer RT: Lone atrial fibrillation associated with creatine monohydrate supplementation, *Pharmacotherapy* 25(5):762-764, 2005.

Karanja N, Lancaster KJ, Vollmer WM, Lin PH, Most MM, Ard JD, Swain JF, Sacks FM, Obarzanek E: Acceptability of sodium-reduced research diets, including the Dietary Approaches To Stop Hypertension diet, among adults with prehypertension and stage 1 hypertension, *J Am Diet Assoc* 107(9):1530-1538, 2007.

Karelis AD, Pasternyk SM, Messier L, St-Pierre DH, Lavoie JM, Garrel D, Rabasa-Lhoret R: Relationship between insulin sensitivity and the triglyceride-HDL-C ratio in overweight and obese postmenopausal women: a MONET study, *Appl Physiol Nutr Metab* 32(6):1089-1096, 2007.

Khor GL: Dietary fat quality: a nutritional epidemiologist's view, *Asia Pac J Clin Nutr* 13(suppl):S22, 2004.

Klingberg S, Ellegård L, Johansson I, Hallmans G, Weinehall L, Andersson H, Winkvist A: Inverse relation between dietary intake of naturally occurring plant sterols and serum cholesterol in northern Sweden, *Am J Clin Nutr* 87(4):993-1001, 2008.

Koh KK, Han SH, Quon MJ, Yeal Ahn J, Shin EK: Beneficial effects of fenofibrate to improve endothelial dysfunction and raise adiponectin levels in patients with primary hypertriglyceridemia, *Diabetes Care* 28(6):1419-1424, 2005.

Koren-Morag N, Goldbourt U, Tanne D: Relation between the metabolic syndrome and ischemic stroke or transient ischemic attack. A prospective cohort study in patients with atherosclerotic cardiovascular disease, *Stroke* 36(7):1366-1371, 2005.

Krajcovicova-Kudlackova M, Blazicek P: C-reactive protein and nutrition, *Bratisl Lek Listy* 106(11):345-347, 2005.

Kraml P, Potockova J, Koprivova H, Stipek S, Crkovska J, Zima T, Andel M: Ferritin, oxidative stress and coronary atherosclerosis, *Vnitr Lek* 50(3):197-202, 2004.

Kris-Etherton PM, Hu FB, Ros E, Sabaté J: The role of tree nuts and peanuts in the prevention of coronary heart disease: multiple potential mechanisms, *J Nutr* 138(9): 1746S-1751S, 2008.

Kritchevsky SB: A review of scientific research and recommendations regarding eggs, *J Am Coll Nutr* 23(6 Suppl): 596S-600S, 2004.

Kubozono T, Koike A, Nagayama O, Tajima A, Aizawa T, Fu LT, Itoh H: High diastolic blood pressure during exercise is associated with hypercholesterolemia in patients with coronary artery disease, *Int Heart J* 46(1):79-87, 2005.

Larson-Meyer DE, Borkhsenious ON, Gullett JC, Russell RR, Devries MC, Smith SR, Ravussin E: Effect of dietary fat on serum and intramyocellular lipids and running performance, *Med Sci Sports Exerc* 40(5):892-902, 2008.

Lazzer S, Vermorel M, Montaurier C, Meyer M, Boirie Y: Changes in adipocyte hormones and lipid oxidation associated with weight loss and regain in severely obese adolescents, *Int J Obes (Lond)* 29(10):1184-1191, 2005.

Le NA, Brown WV, Davis WW, Herrington DM, Mosca L, Homma S, Eggleston B, Willens HJ, Raines JK: Comparison of the relation of triglyceride-rich lipoproteins and muscular artery compliance in healthy women versus healthy men, *Am J Cardiol* 95(9):1049-1054, 2005.

Li D, Siriamornpun S, Wahlqvist ML, Mann NJ, Sinclair AJ: Lean meat and heart health, *Asia Pac J Clin Nutr* 14(2):113-119, 2005.

Li S, Chen W, Srinivasan SR, Berenson GS: Influence of metabolic syndrome on arterial stiffness and its age-related change in young adults: the Bogalusa Heart Study, *Atherosclerosis* 180(2):349-354, 2005.

Liepa GU, Basu H: C-reactive proteins and chronic disease: what role does nutrition play? *Nutr Clin Pract* 18(3):227-233, 2003.

Liu K, Dyer AR, Vu TH, Pirzada A, Manheim LM, Manning WG, Ashraf MS, Garside DB, Daviglus ML: One-hour postload plasma glucose in middle age and Medicare expenditures in older age among nondiabetic men and women: the Chicago Heart Association Detection Project in Industry, *Diabetes Care* 28(5):1057-1062, 2005.

Lobo RA: Metabolic syndrome after menopause and the role of hormones, *Maturitas* 60(1):10-18, 2008.

Lopes C, Aro A, Azevedo A, Ramos E, Barros H: Intake and adipose tissue composition of fatty acids and risk of myocardial infarction in a male Portuguese community sample, *J Am Diet Assoc* 107(2):276-286, 2007.

Lubianca JN, Moreira LB, Gus M, Fuchs FD: Stopping oral contraceptives: an effective blood pressure-lowering intervention in women with hypertension, *J Hum Hypertens* 19(6):451-455, 2005.

Magnussen CG, Raitakari OT, Thomson R, Juonala M, Patel DA, Viikari JS, Marniemi J, Srinivasan SR, Berenson GS, Dwyer T, Venn A: Utility of currently recommended pediatric dyslipidemia classifications in predicting dyslipidemia in adulthood. evidence from the Childhood Determinants of Adult Health (CDAH) Study, Cardiovascular Risk in Young Finns Study, and Bogalusa Heart Study, *Circulation* 117(1):32-42, 2008.

McCully KS: Homocysteine, vitamins, and vascular disease prevention, *Am J Clin Nutr* 86(5):1563S-1568S, 2007.

McLaughlin T, Carter S, Lamendola C, Abbasi F, Yee G, Schaaf P, Basina M, Reaven G: Effects of moderate variations in macronutrient composition on weight loss and reduction in cardiovascular disease risk in obese, insulin-resistant adults, *Am J Clin Nutr* 84(4):813-821, 2006.

Meyers CD, Kamanna VS, Kashyap ML: Niacin therapy in atherosclerosis, *Curr Opin Lipidol* 15(6):659-665, 2004.

Michalsen A, Dobos GJ: Effects of nutritional factors on haemostasis, *Hamostaseologie* 25(1):13-17, 2005.

Michos ED, Melamed ML: Vitamin D and cardiovascular disease risk, *Curr Opin Clin Nutr Metab Care* 11(1):7-12, 2008.

Milionis HJ, Tambaki AP, Kanioglou CN, Elisaf MS, Tselepis AD, Tsatsoulis A: Thyroid substitution therapy induces high-density lipoprotein–associated platelet-activating factor–acetylhydrolase in patients with subclinical hypothyroidism: a potential antiatherogenic effect, *Thyroid* 15(5):455-460, 2005.

Misra A: C-reactive protein in young individuals: problems and implications for Asian Indians, *Nutrition* 20(5):478-481, 2004.

Monteiro I, Vaz Almeid MD: Dietary fat and ischemic stroke risk in Northern Portugal, *Acta Med Port* 20(4):307-318, 2007.

Moosmann B, Behl C: Selenoprotein synthesis and side-effects of statins, *Lancet* 363(9412):892-894, 2004.

Mori TA, Bao DQ, Burke V, Puddey IB, Watts GF, Beilin LJ: Dietary fish as a major component of a weight-loss diet: effect on serum lipids, glucose, and insulin metabolism in overweight hypertensive subjects, *Am J Clin Nutr* 70(5):817-825, 1999.

Mosdøl A, Witte DR, Frost G, Marmot MG, Brunner EJ: Dietary glycemic index and glycemic load are associated with high-density-lipoprotein cholesterol at baseline but not with increased risk of diabetes in the Whitehall II study, *Am J Clin Nutr* 86(4):988-994, 2007.

Mosekilde L: Vitamin D and the elderly, *Clin Endocrinol (Oxf)* 62(3):265-281, 2005.

Mozaffarian D, Pischon T, Hankinson SE, Rifai N, Joshipura K, Willett WC, Rimm EB: Dietary intake of trans fatty acids and systemic inflammation in women, *Am J Clin Nutr* 79(4):606-612, 2004.

Nakamura Y, Okamura T, Tamaki S, Kadowaki T, Hayakawa T, Kita Y, Okayama A, Ueshima H; NIPPON DATA80 Research Group: Egg consumption, serum cholesterol, and cause-specific and all-cause mortality: the National Integrated Project for Prospective Observation of Non-communicable Disease and Its Trends in the Aged, 1980 (NIPPON DATA80), *Am J Clin Nutr* 80(1):58-63, 2004.

Nowson CA, Worsley A, Margerison C, Jorna MK, Godfrey SJ, Booth A: Blood pressure change with weight loss is affected by diet type in men, *Am J Clin Nutr* 81(5):983-989, 2005.

Ohtsuka S, Yamaguchi I: Magnesium in congestive heart failure, *Clin Calcium* 15(2):181-186, 2005.

O'Keefe JH, Bell DS: Postprandial hyperglycemia/hyperlipidemia (postprandial dysmetabolism) is a cardiovascular risk factor, *Am J Cardiol* 100(5):899-904, 2007.

Olthof MR, Brink EJ, Katan MB, Verhoef P: Choline supplemented as phosphatidylcholine decreases fasting and postmethionine-loading plasma homocysteine concentrations in healthy men, *Am J Clin Nutr* 82(1):111-117, 2005.

Ostchega Y, Paulose-Ram R, Dillon CF, Gu Q, Hughes JP: Prevalence of peripheral arterial disease and risk factors in persons aged 60 and older: data from the National Health and Nutrition Examination Survey 1999-2004, *J Am Geriatr Soc* 55(4):583-599, 2007.

Ozdemir A, Sevinç C, Selamet U, Türkmen F: The relationship between iron deficiency anemia and lipid metabolism in premenopausal women, *Am J Med Sci* 334(5):331-333, 2007.

Pac FA, Ozerol E, Ozerol IH, Temel I, Ege E, Yologlu S, Sezgin N, Sahin K, Emmiler M, Pac M, Aslan H: Homocysteine, lipid profile, nitric oxide, vitamin B_{12}, and folate values in patients with premature coronary artery disease and their children, *Angiology* 56(3):253-257, 2005.

Pasternak K, Dabrowski W, Dobija J, Wro skal J, Rzecki Z, Biernacka J: The effect of preoperative magnesium supplementation on blood catecholamine concentrations in patients undergoing CABG, *Magnes Res* 19(2):113-122, 2006.

Pedrinelli R, Esposti ED, Dell'Omo G: LDL cholesterol and global risk stratification in referred hypertensive patients, *Atherosclerosis* 180(1):137-143, 2005.

Plat J, Jellema A, Ramakers J, Mensink RP: Weight loss, but not fish oil consumption, improves fasting and postprandial serum lipids, markers of endothelial function, and inflammatory signatures in moderately obese men, *J Nutr* 137(12):2635-2640, 2007.

Prada PO, Coelho MS, Zecchin HG, Dolnikoff MS, Gasparetti AL, Furukawa LN, Saad MJ, Heimann JC: Low salt intake modulates insulin signaling, JNK activity and IRS-1ser307 phosphorylation in rat tissues, *J Endocrinol* 185(3):429-437, 2005.

Preobrazhenskiĭ DV, Sidorenko BA, Pataraia SA, Vyshinskaia ID, Borisenko OV: Hypercholesterolemia in men and women of various age. II. The problem of efficacy and safety of statins, *Kardiologiia* 47(11):75-85, 2007.

Rankins J, Wortham J, Brown LL: Modifying soul food for the Dietary Approaches to Stop Hypertension diet (DASH) plan: implications for metabolic syndrome (DASH of Soul), *Ethn Dis* 17(3 Suppl 4):S4-7-12, 2007.

Rasmussen BM, Vessby B, Uusitupa M, Berglund L, Pedersen E, Riccardi G, Rivellese AA, Tapsell L, Hermansen K; The KANWU Study Group: Effects of dietary saturated, monounsaturated, and n-3 fatty acids on blood pressure in healthy subjects, *Am J Clin Nutr* 83(2):221-226, 2006.

Ratliff JC, Mutungi G, Puglisi MJ, Volek JS, Fernandez ML: Eggs modulate the inflammatory response to carbohy-

drate restricted diets in overweight men, *Nutr Metab (Lond)* 20:5-6, 2008.
Richter V, Purschwitz K, Rassoul F, Thiery J, Zunft HJ, Leitzmann C: Effects of diet modification on cardiovascular risk: results from the Leipzig wholesome nutrition study, *Asia Pac J Clin Nutr* 13(Suppl):S106, 2004.
Ridker PM: Inflammation in atherothrombosis: how to use high-sensitivity C-reactive protein (hsCRP) in clinical practice, *Am Heart Hosp J* 2(4 Suppl 1):4-9, 2004.
Rosanoff A: Magnesium and hypertension, *Clin Calcium* 15(2):255-260, 2005.
Rosanoff A, Seelig MS: Comparison of mechanism and functional effects of magnesium and statin pharmaceuticals, *J Am Coll Nutr* 23(5):501S-505S, 2004.
Rubba F, Mattiello A, Chiodini P, Celentano E, Galasso R, Ciardullo AV, Gentile M, Triassi M, Rubba P, Panico S: Menstrual cycle length, serum lipids and lipoproteins in a cohort of Italian Mediterranean women: findings from Progetto ATENA, *Nutr Metab Cardiovasc Dis* 18(10):659-663, 2008.
Sachais BS, Katz J, Ross J, Rader DJ: Long-term effects of LDL apheresis in patients with severe hypercholesterolemia, *J Clin Apher* 20(4):252-255, 2005.
Sadakane A, Tsutsumi A, Gotoh T, Ishikawa S, Ojima T, Kario K, Nakamura Y, Kayaba K: Dietary patterns and levels of blood pressure and serum lipids in a Japanese population, *J Epidemiol* 18(2):58-67, 2008.
Schaefer EJ, McNamara JR, Asztalos BF, Tayler T, Daly JA, Gleason JL, Seman LJ, Ferrari A, Rubenstein JJ: Effects of atorvastatin versus other statins on fasting and postprandial C-reactive protein and lipoprotein-associated phospholipase A_2 in patients with coronary heart disease versus control subjects, *Am J Cardiol* 95(9):1025-1032, 2005.
Scheurig AC, Thorand B, Fischer B, Heier M, Koenig W: Association between the intake of vitamins and trace elements from supplements and C-reactive protein: results of the MONICA/KORA Augsburg study, *Eur J Clin Nutr* 62(1):127-137, 2008.
Sharma N, Okere IC, Duda MK, Chess DJ, O'Shea KM, Stanley WC: Potential impact of carbohydrate and fat intake on pathological left ventricular hypertrophy, *Cardiovasc Res* 73(2):257-268, 2007.
Sharma N, Okere IC, Duda MK, Johnson J, Yuan CL, Chandler MP, Ernsberger P, Hoit BD, Stanley WC: High fructose diet increases mortality in hypertensive rats compared to a complex carbohydrate or high fat diet, *Am J Hypertens* 20(4):403-409, 2007.
Shiina Y, Funabashi N, Lee K, Murayama T, Nakamura K, Wakatsuki Y, Daimon M, Komuro I: Acute effect of oral flavonoid-rich dark chocolate intake on coronary circulation, as compared with non-flavonoid white chocolate, by transthoracic Doppler echocardiography in healthy adults, *Int J Cardiol* 131(3):424-429, 2009.
Shimosawa T, Fujita T: Magnesium and N-type calcium channel, *Clin Calcium* 15(2):239-244, 2005.
Shimosawa T, Takano K, Ando K, Fujita T: Magnesium inhibits norepinephrine release by blocking N-type calcium channels at peripheral sympathetic nerve endings, *Hypertension* 44(6):897-902, 2004.
Sica DA: Loop diuretic therapy, thiamine balance, and heart failure, *Congest Heart Fail* 13(4):244-247, 2007.
Sloth B, Krog-Mikkelsen I, Flint A, Tetens I, Bjorck I, Vinoy S, Elmstahl H, Astrup A, Lang V, Raben A: No difference in body weight decrease between a low-glycemic-index and a high-glycemic-index diet but reduced LDL cholesterol after 10-wk ad libitum intake of the low-glycemic-index diet, *Am J Clin Nutr* 80(2):337-347, 2004.
Soder PO, Soder B, Nowak J, Jogestrand T: Early carotid atherosclerosis in subjects with periodontal diseases, *Stroke* 36(6):1195-1200, 2005.
Sone H, Mizuno S, Fujii H, Yoshimura Y, Yamasaki Y, Ishibashi S, Katayama S, Saito Y, Ito H, Ohashi Y, Akanuma Y, Yamada N: Is the diagnosis of metabolic syndrome useful for predicting cardiovascular disease in Asian diabetic patients? Analysis from the Japan Diabetes Complications study, *Diabetes Care* 28(6):1463-1471, 2005.
Sontia B, Mooney J, Gaudet L, Touyz RM: Pseudohyperaldosteronism, liquorice, and hypertension, *J Clin Hypertens (Greenwich)* 10(2):153-157, 2008.
Strahan TM: Nuts for cardiovascular protection, *Asia Pac J Clin Nutr* 13(Suppl):S33, 2004.
Superko HR, Enas EA, Kotha P, Bhat NK, Garrett B: High-density lipoprotein subclass distribution in individuals of Asian Indian descent: the National Asian Indian Heart Disease Project, *Prev Cardiol* 8(2):81-86, 2005.
Swain JF, McCarron PB, Hamilton EF, Sacks FM, Appel LJ: Characteristics of the diet patterns tested in the Optimal Macronutrient Intake Trial to Prevent Heart Disease (OmniHeart): options for a heart-healthy diet, *J Am Diet Assoc* 108(2):257-265, 2008.
Szapary PO, Rader DJ: The triglyceride-high-density lipoprotein axis: an important target of therapy? *Am Heart J* 148(2):211-221, 2004.
Tande DL, Hotchkiss L, Cotugna N: The associations between blood lipids and the Food Guide Pyramid: findings from the Third National Health and Nutrition Examination Survey, *Prev Med* 38(4):452-457, 2004.
Tannock LR, O'Brien KD, Knopp RH, Retzlaff B, Fish B, Wener MH, Kahn SE, Chait A: Cholesterol feeding increases C-reactive protein and serum amyloid A levels in lean insulin-sensitive subjects, *Circulation* 111(23):3058-3062, 2005.
Taubert D, Roesen R, Lehmann C, Jung N, Schömig E: Effects of low habitual cocoa intake on blood pressure and bioactive nitric oxide: a randomized controlled trial, *JAMA* 298(1):49-60, 2007.
Torres SJ, Nowson CA, Worsley A: Dietary electrolytes are related to mood, *Br J Nutr* 100(5):1038-1045, 2008.
Townsend MS, Fulgoni VL III, Stern JS, Adu-Afarwuah S, McCarron DA: Low mineral intake is associated with high systolic blood pressure in the Third and Fourth National

Health and Nutrition Examination Surveys: could we all be right? *Am J Hypertens* 18(2 Pt 1):261-269, 2005.

Toyohara T, Tanemoto M, Uruno A, Abe M, Abe T, Ito S: A case of rhabdomyolysis induced by the approved daily dose of a traditional Chinese medicine, *Nippon Jinzo Gakkai Shi* 50(2):135-139, 2008.

Trichopoulou A, Bamia C, Trichopoulos D: Mediterranean diet and survival among patients with coronary heart disease in Greece, *Arch Intern Med* 25;165(8):929-935, 2005.

Tully MA, Cupples ME, Chan WS, McGlade K, Young IS: Brisk walking, fitness, and cardiovascular risk: a randomized controlled trial in primary care, *Prev Med* 41(2):622-628, 2005.

Tuomilehto J, Tikkanen MJ, Högström P, Keinänen-Kiukaanniemi S, Piironen V, Toivo J, Salonen JT, Nyyssönen K, Stenman UH, Alfthan H, Karppanen H: Safety assessment of common foods enriched with natural nonesterified plant sterols, *Eur J Clin Nutr*, February 28, 2008 [Epub ahead of print].

Ulmer H, Kelleher C, Diem G, Concin H, Ruttmann E: Estimation of seasonal variations in risk factor profiles and mortality from coronary heart disease, *Wien Klin Wochenschr* 116(19-20):662-668, 2004.

van Dixhoorn J, White A: Relaxation therapy for rehabilitation and prevention in ischaemic heart disease: a systematic review and meta-analysis, *Eur J Cardiovasc Prev Rehabil* 12(3):193-202, 2005.

Vaysse-Boué C, Dabadie H, Peuchant E, Le Ruyet P, Mendy F, Gin H, Combe N: Moderate dietary intake of myristic and alpha-linolenic acids increases lecithin-cholesterol acyltransferase activity in humans, *Lipids* 42(8):717-722, 2007.

Vlachopoulos C, Panagiotakos D, Ioakeimidis N, Dima I, Stefanadis C: Chronic coffee consumption has a detrimental effect on aortic stiffness and wave reflections, *Am J Clin Nutr* 81(6):1307-1312, 2005.

Wells BJ, Mainous AG III, Everett CJ: Association between dietary arginine and C-reactive protein, *Nutrition* 21(2):125-130, 2005.

Welty FK, Nasca MM, Lew NS, Gregoire S, Ruan Y: Effect of onsite dietitian counseling on weight loss and lipid levels in an outpatient physician office, *Am J Cardiol* 100(1):73-75, 2007.

Wierzbicki AS: Homocysteine and cardiovascular disease: a review of the evidence, *Diab Vasc Dis Res* 4(2):143-150, 2007.

Williams CL, Strobino BA: Childhood diet, overweight, and CVD risk factors: the Healthy Start Project, *Prev Cardiol* 11(1):11-20, 2008.

Wolff B, Volzke H, Ludemann J, Robinson D, Vogelgesang D, Staudt A, Kessler C, Dahm JB, John U, Felix SB: Association between high serum ferritin levels and carotid atherosclerosis in the Study of Health in Pomerania (SHIP), *Stroke* 35(2):453-457, 2004.

Wood RJ, Fernandez ML, Sharman MJ, Silvestre R, Greene CM, Zern TL, Shrestha S, Judelson DA, Gomez AL, Kraemer WJ, Volek JS: Effects of a carbohydrate-restricted diet with and without supplemental soluble fiber on plasma low-density lipoprotein cholesterol and other clinical markers of cardiovascular risk, *Metabolism* 56(1):58-67, 2007.

Woroniecki RP, Flynn JT: How are hypertensive children evaluated and managed? A survey of North American pediatric nephrologists, *Pediatr Nephrol* 20(6):791-797, 2005.

Yasue H, Itoh T, Mizuno Y, Harada E: Severe hypokalemia, rhabdomyolysis, muscle paralysis, and respiratory impairment in a hypertensive patient taking herbal medicines containing licorice, *Intern Med* 46(9):575-578, 2007.

Yavasoglu I, Tombuloglu M, Kadikoylu G, Donmez A, Cagirgan S, Bolaman Z: Cholesterol levels in patients with multiple myeloma, *Ann Hematol* 87(3):223-228, 2008.

Ye Z, Song H: Antioxidant vitamins intake and the risk of coronary heart disease: meta-analysis of cohort studies, *Eur J Cardiovasc Prev Rehabil* 15(1):26-34, 2008.

Zieske AW, Tracy RP, McMahan CA, Herderick EE, Homma S, Malcom GT, McGill HC Jr, Strong JP; Pathobiological Determinants of Atherosclerosis in Youth Research Group: elevated serum C-reactive protein levels and advanced atherosclerosis in youth, *Arterioscler Thromb Vasc Biol* 25(6):1237-1243, 2005.

chapter

8

Diabetes Mellitus

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Chapter Topics

Introduction
Basic Facts on Physiology and Types of Diabetes
Symptoms and Clinical Findings of Diabetes
Hormones Involved in Diabetes
Measures of Good Diabetes Management
Medical Nutrition Therapy of Diabetes
Role of Exercise in Diabetes Management
Medications Used in Diabetes Management
Diabetes Complications
Counseling Skills of the Nurse or Other Health Care Professional in Diabetes Management

Objectives

After completing this chapter, you should be able to:

- Describe the different types of diabetes mellitus.
- Describe the symptoms and clinical findings of diabetes mellitus.
- Relate the nutritional management of diabetes mellitus to the 2005 Dietary Guidelines for Americans and the MyPyramid Food Guidance System.
- Discuss differences in the nutritional management of the various forms of diabetes.
- Describe the importance of the self-monitoring of blood glucose.
- Discuss the role and special concerns of exercise in diabetes management.
- Discuss the role of health care professionals in facilitating the nutritional aspects of diabetes management.

Terms to Identify

1800 rule
15:15 rule
Advanced glycosylated end products (AGEs)
Albuminuria
α-glucosidase inhibitors
Antibodies
Autonomic neuropathy
Behavioral Pediatric Feeding Assessment Scale (BPFAS)
Beta cells
Biguanides
Carbohydrate counting
Certified Diabetes Educators (CDEs)
Correction or sensitivity factor
Dawn phenomenon
Diabetes Control and Complications Trial (DCCT)
Diabetes mellitus
Diabetic coma
Diabetic ketoacidosis (DKA)
Diabetic retinopathy
Endocrinology
Epinephrine

GAD antibody
Gastroparesis
Gestational diabetes mellitus (GDM)
Glucagon kit
Glucosuria
Glycated
Glycogenolysis
Hemoglobin A_{1c} (Hgb A_{1c} or A_{1c})
Honeymoon period
Hyperglycemia
Hyperglycemic hyperosmolar nonketotic syndrome (HHNK)
Hypoglycemic unawareness
Insulin reaction
Insulin-to-carbohydrate ratio
Islets of Langerhans
Ketonuria
Latent autoimmune diabetes in adults (LADA)
Macroalbuminuria
Oral hypoglycemic agents
Orthostatic hypertension
Pattern management
Peak action
Peripheral neuropathy
Podiatrist
Polydipsia
Polyphagia
Polyuria
Reactive hypoglycemia
Renal threshold
Retinopathy
Self-monitoring of blood glucose (SMBG)
Somogyi effect
Sulfonylureas
Thiazolidinediones
Type 1 diabetes
Type 2 diabetes
Waist-to-hip ratio (WHR)

INTRODUCTION

According to the Centers for Disease Control and Prevention, almost 14 million Americans have been diagnosed with diabetes. This is more than twice the number from 1980. Many more have diabetes but don't know it. An estimated 18 million Americans have diabetes, and 41 million have prediabetes, according to the National Diabetes Education Program. For online resources, see www.ndep.nih.gov.

The connection has been made from U.S. Department of Agriculture (USDA) records that as sugar intake increased and fiber intake declined from 1909 to 1997, the incidence of type 2 diabetes followed proportionally (Gross and colleagues, 2004). The current epidemic of type 2 diabetes can be contained. For individuals at risk for developing diabetes, it would be advantageous to alter the environment to more easily incorporate physical activity and increase the availability of high-fiber foods.

With regard to type 1 diabetes, tremendous strides have been made in the management of this form of diabetes since the outcomes of the **Diabetes Control and Complications Trial (DCCT)** study were released in 1993. Complications were found to be reduced nearly 75% by achieving near-normal blood glucose (BG) levels. This study was funded by the National Institutes of Health (NIH) and involved more than 1000 individuals and almost 10 years. The United Kingdom Prospective Diabetes Study (UKPDS) in patients with type 2 diabetes mellitus also demonstrated that intensive diabetes therapy reduces the risk of long-term diabetic complications.

As the fields of molecular biology and mechanical technology continue to advance, there will be further developments in the prevention and management of both types of diabetes and the associated complications. This is an exciting time to be practicing in this field of **endocrinology** (the study of hormones).

The person with diabetes is part of the health care team and must feel free to express concerns and personal needs with regard to achieving the goal of normal BG levels. For example, it has been recognized that spirituality is integrally tied with health beliefs among the African American population (Polzer and Miles, 2005).

All health care professionals, especially nurses, should become thoroughly versed in the management of diabetes. Very few people know that diabetes is related to heart disease, stroke, kidney disease, hypertension, blindness, and nerve damage. All health care professionals can play a vital role in educating the public about diabetes, especially those at risk for developing diabetes. Nurses who provide medications and insulin need to understand how they work and how to use carbohydrate counting in determining insulin needs. The team approach is vitally important in achieving the goals of normalized BG levels for the prevention of complications. This chapter is aimed at facilitating this goal.

WHAT ARE THE BASIC FACTS ON PHYSIOLOGY AND TYPES OF DIABETES MELLITUS?

The Latin root of the term **diabetes** (to pass through) **mellitus** (sweet) essentially means "sweet urine." Diabetes, sometimes referred to by the public as "having sugar," is a serious metabolic disorder related to the use of carbohydrate and its end product, glucose (blood glucose or BG). The metabolism of protein and fat is affected by diabetes as well. Obesity, especially with diabetes, is related to higher turnover of body proteins. Evidence suggests dietary protein requirements may be greater in uncontrolled diabetes, especially in men (Gougeon and colleagues, 2008).

The **beta cells** of the pancreas are where insulin is produced. Diabetes occurs as a result of inadequate insulin production or inability of body cells to use insulin (insulin resistance).

Hyperglycemia is any BG level over 140 mg/dL. Blood glucose above this level is associated with changes in immunity, resulting in infections such as urinary tract infections or vaginal yeast infections. Wound healing becomes impaired, skin disorders can result, and a variety of microvascular and macrovascular issues can develop (see section on complications below).

When BG level is over 180 mg/dL, it begins to spill into the urine, making it detectable as **glucosuria** and resulting in wasted energy. This wasted energy can result in weight loss. This is referred to as the **renal threshold.** Increased urination **(polyuria)** occurs as the kidneys try to flush the excess glucose out of the system, resulting in dehydration and increased thirst **(polydipsia).** Weight loss occurs as glucose is lost through the urine. Weight loss can occur even though there is an increased appetite **(polyphagia).** The hunger occurs because the body cells are not receiving adequate fuel. When BG levels become very high, the shape of the lens of the eye changes, resulting in blurred vision.

In 1997 the American Diabetes Association changed the diagnosis of diabetes to two fasting plasma glucose (FPG) levels greater than or equal to 126 mg/dL (Table 8-1). The threshold was lowered to 126 mg/dL to better help prevent complications associated with diabetes. Screening for type 2 diabetes is important because of its slow and gradual development, which is often asymptomatic because the body appears to adjust to the increasing BG levels.

Table 8-1 Diagnostic Thresholds for Diabetes and Lesser Degrees of Impaired Glucose Regulation

Fasting Plasma Glucose or 2-hr OGTT	
Normal	<100 mg/dL (<5.6 mmol/L) fasting <140 mg/dL (<7.8 mmol/L) with 2-hr OGTT
IFG	100-125 mg/dL (5.6-6.9 mmol/L) fasting
IGT	140-199 mg/dL (7.8-11.0 mmol/L) with 2-hr OGTT
Diabetes*	126 mg/dL (7.0 mmol/L) fasting 200 mg/dL (11.1 mmol/L) with 2-hr OGTT

IFG, Impaired fasting glucose; *IGT*, impaired glucose tolerance; *OGTT*, oral glucose tolerance test.
When both tests are performed, IFG or IGT should be diagnosed only if diabetes is not diagnosed by the other test.
*A diagnosis of diabetes needs to be confirmed on a separate day.

TYPE 1 DIABETES

Type 1 diabetes is generally an autoimmune disease. Simply put, an autoimmune disease occurs when a person's immune system gets confused and starts attacking itself. In the case of type 1 diabetes the beta cells are attacked by the body's immune system, with ultimate total destruction of insulin-production capacity. This may be verified by serum laboratory tests for **antibodies** (the part of the immune system that is mobilized for destruction of perceived foreign invaders in the body).

There are several types of antibodies that are used to indicate type 1 diabetes. The most common test is for the antibody called glutamic acid decarboxylase **(GAD antibody)**. Among middle-age persons, women have been found to have higher GAD antibody levels with more severe loss of beta-cell function than males. Women with high GAD antibodies also tend to have other autoimmune diseases, especially autoimmune thyroid disease (Lindholm, Hallengren, and Agardh, 2004). Evidence of GAD antibodies can take a few years to be detectable after initial symptoms and diagnosis of diabetes (Nagai, Imamura, and Mori, 2005).

The peak age of type 1 diabetes onset is during puberty, but it can occur at any age. Winter months are a peak time of onset of type 1 diabetes. It is believed that the body's exposure to a viral illness can precipitate the development of the autoimmune process in susceptible individuals. One study found at least one gastrointestinal viral infection in over 80% of the children who later developed antibodies related to the destruction of the beta cells (Salminen and colleagues, 2004). More recently vitamin D deficiency has been linked with increased risk of autoimmune diseases, including type 1 diabetes. This may, in part, explain the increased prevalence of type 1 diabetes among persons of Northern European descent and during the winter months with decreased sun exposure. Minnesota has the highest incidence of type 1 diabetes with its strong population with Scandinavian heritage.

The onset of this type of diabetes is usually sudden and severe. The person with type 1 diabetes has most, if not all, of the clinical signs and symptoms at the time of diagnosis. Type 1 diabetes in very young children tends to be found with severe insulin deficiency at onset. Young age at the onset of diabetes with preceding febrile illness may provoke severe **diabetic ketoacidosis** or **DKA** (a condition of excess buildup of ketone bodies from breakdown of body fat as an alternative fuel source).

The older the age at onset of type 1 diabetes, the more gradual the development of symptoms. It is now known that persons of any age can develop type 1 diabetes. Therefore it is no longer referred to as "juvenile onset."

Persons with type 1 diabetes tend to have few relatives with diabetes but do have the genetic predisposition for its development. Persons with type 1 diabetes often have other forms of autoimmune diseases such as thyroid and celiac disease. A study of a population with Northern Italian heritage found 4% with autoimmune thyroid disease and a high prevalence of celiac disease (Spadaccino and colleagues, 2008). A study in Spain found 8% of individuals with type 1 diabetes had celiac disease. However, although a gluten-free diet had no effect on metabolic control of diabetes or growth of children, the increased risk of lymphoma and osteoporosis suggests screening, especially among persons with type 1 diabetes (Nóvoa and colleagues, 2008).

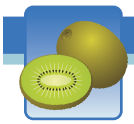
In 1997 the American Diabetes Association proposed two subcategories for type 1 diabetes: type 1A diabetes, with observed autoimmunity, and type 1B, showing no autoimmunity. The latter form of diabetes was found to have variable episodes of insulin deficiency and resulting alterations in insulin requirements with some features of type 2 diabetes (Aguilera and colleagues, 2004). It is perceived in the field of diabetes that there are many variants of diabetes with different classifications and treatments that will one day be better identified.

One subtype of type 1 diabetes is now referred to as **latent autoimmune diabetes in adults (LADA)**. It has been found that in Japan there is a significant number of persons with this form of diabetes. A high level of GAD antibodies predicts the development of insulin deficiency (Kawasaki and Eguchi, 2004). The use of the C-peptide test (see Chapter 5) can rule out LADA. An elevated C-peptide level is found with type 2 diabetes. The more expensive testing for GAD antibodies can be done for those suspected of having LADA who have a low or normal C-peptide level (Bell and Ovalle, 2004). However, to establish a differential diagnosis between type 1 (LADA) and type 2 diabetes in older persons, GAD must be measured (Pfutzner and Kerner, 2005).

Individual differences in detectable autoimmune factors, along with varying levels of insulin sensitivity can make the diagnosis of type 1 versus type 2 diabetes challenging, even for the most experienced endocrinologist (a physician who specializes in the study of hormones). Although most individuals with type 1 diabetes are sensitive to insulin, there are many who also have insulin resistance (Suehiro and colleagues, 2005). In some persons diagnosed with type 2 diabetes, the presence of GAD antibodies has been noted. These individuals had lower fasting insulin levels and had higher high-density–lipoprotein cholesterol (HDL-C) and lower triglyceride levels, such as found with insulin sensitivity and type 1 diabetes (Zinman and colleagues, 2004). With a positive GAD antibody test result, the diagnosis should change to type 1 diabetes.

During the first year after diagnosis of type 1 diabetes, there may be a temporary period of insulin production before the beta cells completely exhaust their production. This is referred to as the **honeymoon period.** Thus a person with newly diagnosed type 1 diabetes may find that he or she needs little or no insulin after initial treatment of hyperglycemia. Individuals experiencing this should be forewarned that the situation will change as the honeymoon period comes to an end.

Without insulin, life cannot exist. In the days before the discovery of injectable insulin, persons with type 1 diabetes simply wasted away from malnourishment. It is for this reason that type 1 diabetes is an insulin-dependent form of diabetes. Control is accomplished only through insulin injection based on carbohydrate intake and BG levels. Persons taking insulin are best advised to consult with **certified diabetes educators (CDEs)—**health care professionals who specialize in diabetes management and are required to demonstrate continued proficiency or document continuing education in diabetes. Figure 8-1 shows the basic differences between type 1 and type 2 diabetes.



Cultural Considerations

Eating disorders are fairly common among women with type 1 diabetes. Very neat BG logs of readings from self-monitoring may be an indication that the record was written to "please the doctor" and have fictitious numbers. Hgb A_{1c} values may contradict the woman's BG log. Withholding or reducing insulin may be used for weight control. This may be particularly true for women who were raised on strict dietary regimens as advocated before the use of carbohydrate counting. Diplomatic attempts to identify eating disorders are important especially with type 1 diabetes. ■

TYPE 2 DIABETES

Type 1 diabetes is relatively rare, occurring in about 5% to 10% of all cases of diabetes with the rest being type 2 diabetes. Type 2 diabetes was once referred to as non–insulin-dependent diabetes mellitus (NIDDM) and is chiefly caused by insulin resistance at the cellular level. Type 2 diabetes is no longer correctly referred to as NIDDM because of the confusion surrounding the term. The confusion began when a person with type 2 diabetes started taking insulin. This did not always mean that the person went from having NIDDM to having insulin-dependent diabetes mellitus (IDDM). To prevent further confusion the American Diabetes Association officially dropped the NIDDM versus IDDM classification and generally prefers the numeric designation of type 1 for autoimmune diabetes and **type 2 diabetes** for all other forms of diabetes.

Increased stress such as with infection, burns, and surgery will raise BG levels, and temporary reliance on injected insulin may be required. Therefore a person with type 2 diabetes may need temporary use of insulin while hospitalized for surgery or during times of illness.

There are varying amounts of insulin production in type 2 diabetes: high, normal, or low. As described previously, it may be that persons with low levels of insulin are slowly evolving into having type 1 diabetes, and they should be screened for antibodies. A person with type 2 diabetes who is underproducing insulin is generally thin and sometimes referred to unofficially as "type 1½." Typically a person with type 2 diabetes actually overproduces insulin and has the associated central obesity found with the metabolic syndrome. It is the insulin resistance at the cellular level that can allow both hyperglycemia and hyperinsulinemia. Heredity plays a critical role in the development of type 2 diabetes. Persons with this form of diabetes generally have many family members with a history of diabetes and the other correlates

	Type 1	Type 2
Gender	Males and females	Increased rate among females
Ethnicity	Increased rates among persons with Northern European heritage	Increased rate among persons with heritage from equatorial countries (highest rates found with Native American, Hispanic, African American, Asian, Pacific Islander, Mediterranean)
Age of onset	Generally under 30 years with peak onset before puberty	Generally over 40 years, although the genetic predisposition is inherited and onset may be seen at younger ages
Weight	Usually normal or underweight; unintentional weight loss often precedes diagnosis	Usually overweight, but may be of normal weight
Treatment	Insulin injections necessary to prevent death; food and exercise have to be balanced with insulin injections	Weight loss usually the first goal; reduction of sugar and fat and increase of fiber (soluble) helpful; oral hypoglycemic agents or insulin or both may be necessary for good blood glucose management but are not necessary to prevent imminent death; exercise important
Beta cell* functioning	Totally absent (no insulin is produced) after the "honeymoon period"; residual insulin is produced for about 1 year after diagnosis	Excess insulin production usually evident (hyperinsulinemia), but due to insulin resistance at the cell level, there is relative insulin insufficiency; insulin production may also be normal or below normal

*Beta cells are found in the pancreas.

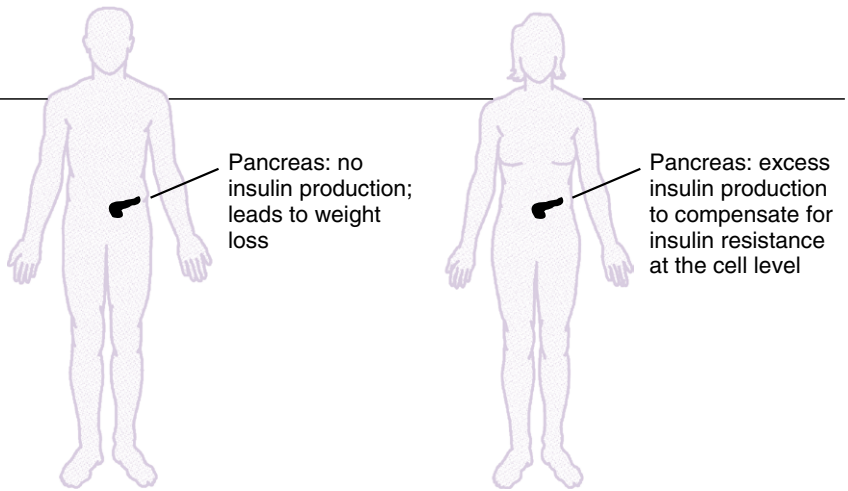


FIGURE 8-1 Differences between type 1 and type 2 diabetes mellitus.

of the metabolic syndrome. The genetic predisposition and incidence of type 2 diabetes increase in persons whose ancestors are from regions nearer the equator, with the highest prevalence being among persons of African, Native American, Asian, Pacific Island, and Southern European heritage, such as the Hispanic population.

Asian Indians have a high rate of diabetes but low rates of obesity. They do, however, have a high **waist-to-hip ratio (WHR)** with high levels of insulin resistance and hyperinsulinemia. In a study of Italian persons the combined incidence of diabetes and impaired glucose tolerance (IGT) was over 15% for men and 10% for women. The prevalence was greatest in the regions of central and southern Italy (Pilotto and colleagues, 2004). The known incidence of type 2 diabetes in Spain is about 6%, and the combined rate with IGT, 19% (Martinez and colleagues, 2004). In Greece the overall prevalence of diabetes type 2 was about 8% in men and 6% in women (Panagiotakos and colleagues, 2007).

GESTATIONAL DIABETES

Gestational diabetes mellitus (GDM) is a temporary form of diabetes that occurs during the latter part of pregnancy. It is often found in women with a family history of type 2 diabetes and therefore is generally related to the genetic predisposition to insulin resistance. Because it occurs after fetal development (see Chapter 11), the risk for birth defects is different than for a woman who has type 1 or preexisting type 2 diabetes. There is virtually no difference in pregnancy outcomes for a woman who has GDM or type 1 or type 2 diabetes, as compared with a woman without diabetes, if near-normal BG level is achieved before conception and maintained throughout the pregnancy. See Chapter 11 for diagnostic criteria of GDM.

Increased placental hormones, produced during the latter stages of pregnancy, that work counter to insulin (see the section on counterregulatory hormones) are the primary cause of GDM. Once the placenta has been expelled at the time of delivery, the woman's BG is likely to normalize. Because GDM is associated with insulin resistance, there is an increased risk of eventually developing type 2 diabetes (refer to Chapter 5 for a review of prevention). A deficiency of zinc and selenium has been noted with GDM or IGT during pregnancy (Bo and colleagues, 2005).

Gestational diabetes mellitus can also be associated with GAD antibodies as found in women with Scandinavian heritage. Arabian women tend to be more insulin resistant than Scandinavian women with GDM, even though the body mass index is the same (Shaat and colleagues, 2004).

WHAT ARE THE SYMPTOMS AND CLINICAL FINDINGS OF DIABETES?

The warning signs of diabetes as they generally occur from moderate to severe hyperglycemia are as follows:

- Abnormal hunger
- Symptoms of hypoglycemia
- Skin disorders
- Infections
- Delayed wound healing
- Unexplained weakness and fatigue
- Frequent urination

- Unusual thirst
- Sudden weight loss
- Blurred vision

Polyphagia

One of the first symptoms of the development of diabetes is an increased appetite, known as polyphagia. This is the body's response to the need for energy. However, this need is not being satisfied because glucose is not readily able to enter the body cells and therefore is not able to be adequately used as a fuel source. A health care professional should inquire about a person's appetite and whether it has changed. Polyphagia may cause weight gain.

Reactive Hypoglycemia

In **reactive hypoglycemia,** excess carbohydrate causes the body to produce too much insulin. However, because the overproduction of insulin is delayed, the BG level first rises too high and then falls too quickly (Figure 8-2 shows the difference between hyperglycemia and hypoglycemia). This form of glucose intolerance is felt to be a precursor to the development of type 2 diabetes.

Reactive hypoglycemia is characterized by serum glucose levels in the range of 50 to 60 mg/dL, with symptoms of hypoglycemia (Box 8-1) that are relieved by eating. However, many physicians use the criteria that BG levels need to be below 50 mg/dL to make an official diagnosis. Anyone who experiences symptoms of hypoglycemia will usually note increased, almost ravenous hunger that can lead to overeating and weight gain. Regardless of the official diagnosis, the symptoms need

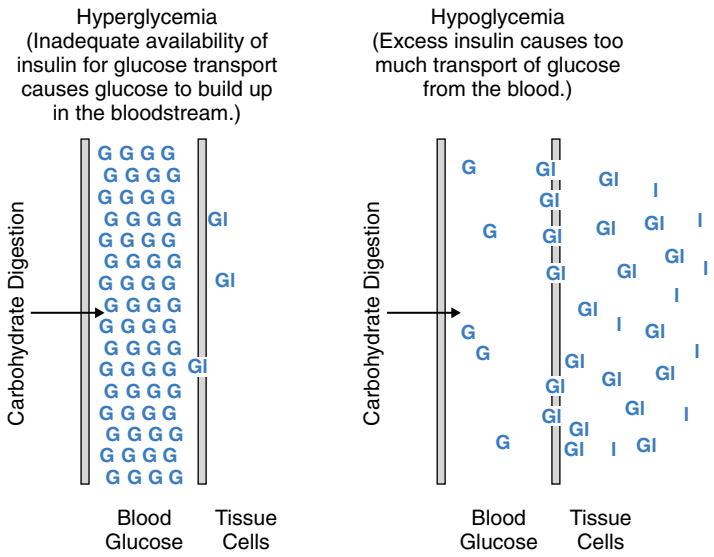


FIGURE 8-2 Hyperglycemia and hypoglycemia.

Box 8-1 Common Symptoms That Signal Hypoglycemia

Weakness	Physical tremors
Mental confusion	Rapid heartbeat
Headache	Numbness of the tongue
Clammy skin	Double or blurred vision

to be taken seriously, and the person needs to be advised on how to prevent them (see medical nutrition therapy [MNT] section below). Only then can serious attempts at weight management be undertaken.

Persons with hypoglycemia may begin to perspire; they may experience hunger and nervousness; their skin may become pale, cold, and clammy; and they may experience mental confusion, physical tremors, weakness, headache, rapid heartbeat, numbness in the tongue, and double or blurred vision (see Box 8-1). Hypoglycemia also alters mood states. Irritability is well known to occur with the combination of stress and hypoglycemia. Hypoglycemia can result in a severe headache, sometimes referred to as a diabetic headache.

However, not all individuals with diabetes experience these symptoms, especially children, elder adults, and persons who have frequent episodes of hypoglycemia. This is referred to as **hypoglycemic unawareness.** Hypoglycemic unawareness can be resolved by meticulous prevention of hypoglycemia for at least 2 weeks. The health care professional or close family member should suspect hypoglycemia, and treat it accordingly, when a child with diabetes becomes unusually quiet or fretful or when the older adult with diabetes becomes weak or faint. A physician should be consulted if the cause is not readily apparent or if hypoglycemia occurs frequently.

Acanthosis Nigricans

A skin condition called acanthosis nigricans (see Figure 5-1) is a risk factor for diabetes. In this condition there is a thickening of the skin, usually in the body folds, which takes on a gray, brown, black, or blue pigmentation. Screening for acanthosis nigricans is an easily performed, noninvasive method for identifying adolescents at risk for type 2 diabetes (see Chapter 5).

Hyperglycemia

Hyperglycemia is associated with the complications of diabetes. It also causes many of the symptoms of diabetes. Infections increase with hyperglycemia because the body's immune system does not work as efficiently. There are conditions under which the body's BG levels rise normally, such as stress of infection, illness, or surgery.

Glucosuria

One way the body tries to lower blood glucose is to flush it out via the kidneys, which results in glucosuria. Frequent urination and excessive thirst are often associated with hyperglycemia. The level of blood glucose has to rise to an unacceptably

high level (more than 180 mg/dL) before glucose is detectable in the urine. Therefore glucosuria tests are generally not recommended except as a very basic screening test and for those persons who refuse or are unable to test blood glucose levels.

Ketonuria

Without adequate insulin, carbohydrate is unavailable for energy. Instead, the body turns to fat as an energy source. Under normal conditions the liver breaks down small amounts of fatty acids to form ketones. These ketones are further metabolized for energy. In uncontrolled diabetes, ketone production exceeds use. The excess is excreted in the urine. This is known as **ketonuria**. If the excess ketones are not removed adequately in the urine, the condition known as diabetic ketoacidosis (DKA) develops. In ketoacidosis the blood pH changes to a more acidic level. Symptoms of drowsiness, lethargy, nausea, and vomiting can occur with excess ketones. The skin becomes hot and dry with dehydration. There is a fruity odor to the breath (acetone). Breathing is deep and labored because the ability to breathe off carbon dioxide is impaired. Death can result if the person is not treated promptly with insulin and fluids. Hospitalization is required for DKA.

This condition is generally limited to type 1 diabetes, but it can also occur in persons with type 2 diabetes who are producing large amounts of counterregulatory or stress hormones, such as with urinary tract infection, pneumonia or other infections and surgery.

Testing for ketones is easy using ketonuria strips. A person with type 1 diabetes who notes a very high BG reading or BG level that remains over 240 mg/dL, especially with nausea and vomiting, should check for ketonuria. Women during pregnancy are advised to test ketonuria on awakening (see Chapter 11). A health care professional should be consulted if ketones are found, because increased insulin is generally required. Fluids should be pushed with ketonuria.

Polydipsia and Polyuria

Increased thirst, known as polydipsia, is experienced as the body senses the need to replace excess fluids lost from frequent urination (polyuria). This is an attempt by the body to remove excess ketones and glucose.

Increased polyuria can lead to nutritional deficiencies of the water-soluble vitamins. In one study plasma thiamin level was decreased about 75% in persons with diabetes. There was an increased renal clearance of thiamin twenty-fourfold among individuals with type 1 diabetes and sixteenfold in type 2 diabetes (Thornalley and colleagues, 2007).

Teaching Pearl

A good assessment question to ask a patient is whether he or she has to get up in the middle of the night to use the bathroom and how often. Persons with undiagnosed diabetes are often relieved to hear they can again expect an uninterrupted night's sleep with improved BG control. This can motivate the person to adhere to medical nutrition therapy and exercise prescriptions. ■

Dehydration

The excess fluid loss associated with high levels of BG and ketones causes water to be taken from body tissues. This can result in dehydration if the water is not replaced and blood glucose controlled.

Dehydration with concentrated amounts of glucose in the blood can cause a condition known as **hyperglycemic hyperosmolar nonketotic syndrome (HHNK)**. This condition used to be commonly found in the elder population, in whom diabetes is much more prevalent and in whom there is a diminished sensation of thirst because of the aging process. Because dehydration of the brain can occur, many elder persons with HHNK have a history of lethargy, sleepiness, and confused state lasting from several days to weeks before progressing into a coma. Dehydration and HHNK are easily treated if caught in the early stages. All older individuals, but especially those with diabetes, should be taught the importance of adequate water intake even when they are not thirsty. Since the use of self-monitoring of BG (SMBG) among the elderly population, HHNK is becoming rare. Medicare covers the supplies for SMBG.

Weight Loss

Because the glucose is staying in the blood or is lost through urination, it is not used for energy, and weight loss can develop. An unintentional rapid weight loss should be assessed to rule out diabetes as the cause. Glucose that does not enter the body cells is excreted in the urine with excess ketones. Both represent wasted energy sources. Weight loss results because the energy demand exceeds available sources. This is more likely to happen with type 1 diabetes or in severe cases of type 2 diabetes in which there is insufficient or no insulin production.

WHAT ARE THE HORMONES INVOLVED IN DIABETES?

INSULIN

Insulin is a hormone that is produced in the beta cells of the **islets of Langerhans** found in the pancreas; it is produced in response to hyperglycemia. Because insulin is composed of protein, oral intake of insulin is not possible because it would be digested before being used. Inhaled insulin is now available, although it has some limitations in its use (see later section on diabetes medications). Therefore persons taking **oral hypoglycemic agents** are not taking insulin, but rather are using the medication to help their own natural insulin production work more effectively (such people are diagnosed as having type 2 diabetes because they are producing insulin). Women with gestational diabetes are generally discouraged from using most oral glycemic agents because of potential birth defects.

Insulin allows BG into body cells, where it can be used for energy. The body normally produces small amounts of insulin at all times because it is needed to metabolize carbohydrates for the continual energy necessary to sustain life. This type of background insulin, used in type 1 diabetes management, is referred to as either the "basal insulin" used with insulin pumps (see later section on medications) or the "long-acting" insulin types used with injections. Lantus (generically known as glargine insulin) is increasingly being used as a long-acting insulin (see the following

discussion of insulin types and use). The basal insulin is similar to the "background" insulin the pancreas normally makes.

Larger amounts of meal-related insulin are normally produced in the pancreas in relation to carbohydrate intake and resulting rise in BG levels. Internal insulin production works like a thermostat. The BG level rises and insulin is produced; the BG level falls and insulin production mostly stops. Thus "meal bolus insulin," using short-acting insulins, is now being used in relation to the BG levels as influenced by the carbohydrate content of the meals, whether by insulin pump or by injection with a syringe.

OTHER HORMONES INVOLVED IN DIABETES

Several hormones act in concert to regulate BG levels. Insulin, produced in the pancreas, is the only hormone that lowers BG levels. Many hormones act to raise glucose levels; the most important of these are glucagon, **epinephrine** (also called adrenaline), cortisol, and growth hormone. These are called counterregulatory hormones because they work in an opposite manner to insulin. Any deviation in the balance of these hormones will cause fluctuations in BG levels.

The **Somogyi effect** may be noted with an increased production of the counterregulatory hormones in response to hypoglycemia. The implication is that hyperglycemia often follows hypoglycemia. In other words, a low blood glucose level is often followed by high blood glucose level. This effect can be noted with records of SMBG levels (see section below on monitoring) and food/activity. Explaining the Somogyi effect to persons who are on insulin is important because they may try to correct hyperglycemia with more insulin. Taking more insulin starts a roller-coaster effect on BG levels. If the Somogyi effect can be determined, a decreased insulin dose may best stop further hyperglycemia. This is because the underlying cause of hypoglycemia is being corrected and the body will stop producing the excess counterregulatory hormones.

The **dawn phenomenon** refers to the hormonal changes that occur to wake us up. It is specifically related to increased production of cortisol and growth hormone (both counterregulatory hormones). Because most individuals wake early in the morning, it is called the dawn phenomenon. However, it will occur whenever a person usually wakes up, which is later in the day for evening workers. This phenomenon is seen with SMBG. The consequence is that the morning BG level will rise, even if a person has not eaten. Furthermore, a person with type 2 diabetes or GDM may require smaller amounts of carbohydrates at breakfast to prevent postprandial hyperglycemia. The person with type 1 diabetes may require a higher dose of short-acting insulin in relation to carbohydrate intake at breakfast than at other meals, or those on insulin pumps may require a higher basal rate of insulin in the early morning hours.

Persons taking insulin should be prescribed a **glucagon kit** that a family member or co-worker can be taught to use if the person with diabetes becomes unconscious from severe hypoglycemia. This kit includes a syringe of sterile water that is injected into a vial containing a glucagon tablet in order to dissolve the tablet and is then drawn back into the syringe for injection in the unconscious person (see section on managing hypoglycemia). Glucagon is a counterregulatory hormone normally produced by the body in response to hypoglycemia.

WHAT ARE MEASURES OF GOOD DIABETES MANAGEMENT?

LABORATORY VALUES

Screening Criteria

Impaired fasting glucose (IFG) (BG level 100 to 125 mg/dL after an overnight fast; see Table 8-1) is now considered diagnostic of prediabetes. The diagnosis of diabetes mellitus requires two FPG (fasting plasma glucose) readings greater than or equal to 126 mg/dL or any BG level greater than 200 mg/dL with signs and symptoms of diabetes. One concern with IFG is that it is not measuring the postprandial rise in BG level. A 2-hour oral glucose tolerance test (OGTT) with 75 g of carbohydrate may be helpful in preventing the complications related to hyperglycemia. IGT is the diagnosis made if the resulting BG level is between 140 and 199 mg/dL after an OGTT. Prediabetes is found with IGT. A value of 200 mg/dL or higher with an OGTT and symptoms indicates diabetes. In one study of those persons who had normal fasting glucose, almost 15% had either IGT or diabetes as determined by an OGTT (Sargeant and colleagues, 2004).

Once the diagnosis is made, the laboratory test called **hemoglobin A_{1c} (Hgb A_{1c}** or now referred to simply as **A_{1c}**) should be assessed. Increasingly A_{1c} is being used as a screening test but is not considered confirmation of the diagnosis of prediabetes or diabetes because uniformity of A_{1c} testing varies from laboratory to laboratory. For now, it has been suggested that with IFG and an Hgb A_{1c} value of 6% or higher is indicative of diabetes, and treatment may be appropriate (Jimeno and colleagues, 2004).

Most people know that hemoglobin is a component of the red blood cells used to carry oxygen throughout the body. The A_{1c} test measures how much glucose has attached to the protein in the hemoglobin (see Figure 8-3 for correlations between

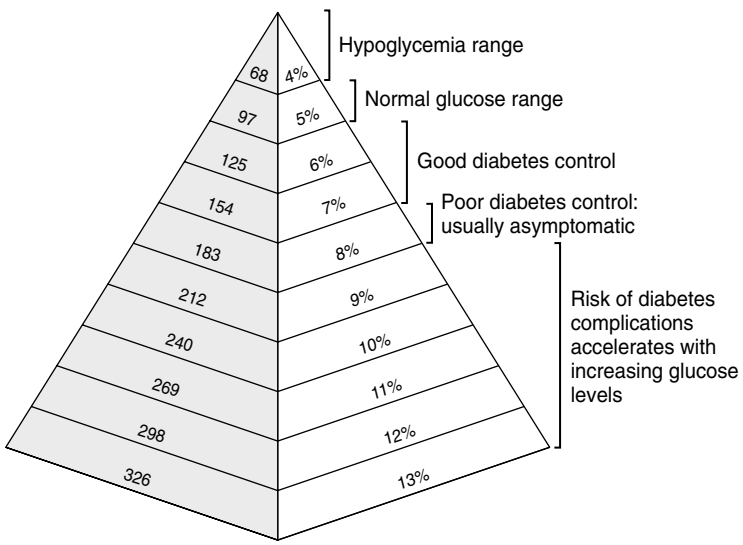


FIGURE 8-3 Hemoglobin A_{1c} and average blood glucose goals.

Hgb A_{1c} and average BG level). The A_{1c} is referred to as a 3-month test, because it measures the average BG level 24 hours a day, 7 days a week, for about 3 months. Because hemoglobin has a lifespan of about 3 months, measuring how much protein has attached to it gives an indication of control over the previous 3 months. The goal is to have the A_{1c} less than 7% for good diabetes control; the 5% range is normal.

It appears that individuals with average fasting glucose level less than 85 mg/dL, A_{1c} of about 6%, and normal triglyceride levels are significantly less likely to develop diabetes within 5 years than those with average fasting blood glucose level of 100 mg/dL, A_{1c} near 7%, triglyceride level over 170 mg/dL, and low HDL-C average of 55 mg/dL (Schulze and colleagues, 2008). The need for screening for type 2 diabetes has been noted for children as young as 12 years old (Whitaker, Davis, and Lauer, 2004). Persons with a strong family history of diabetes or those with health problems associated with the metabolic syndrome should be screened earlier. Because the incidence of diabetes increases with age, screening should begin by at least age 50 for all persons.

Monitoring Criteria

Hemoglobin A_{1c} (A_{1c})

Detecting diabetes through screening is only the beginning. Ongoing monitoring of BG level is essential. The glycated proteins or **advanced glycosylated end products (AGEs)** occur in all body proteins in which glucose is attached permanently and are believed to be a major cause of complications of diabetes. One AGE product that is used is the A_{1c} test. High BG levels as evidenced by elevated A_{1c} levels are associated with complications.

Among adolescents and young adults who had type 1 diabetes for 13 years, a mean A_{1c} level of 8.4% was noted with a prevalence of neuropathy of almost 60%, **retinopathy** was found in about 1 in 4, and nephropathy in 1 in 20 (Nordwall, Hyllienmark, and Ludvigsson, 2006). The DCCT study set the goal of A_{1c} less than 7.2%, but increasingly the goal is routinely in the 6% range, or, if there is no risk of hypoglycemia, a 5% range of A_{1c} to achieve the greatest reduction in diabetes-associated complications.

One problem with attempting to achieve an A_{1c} in the 5% range for a person using insulin is the likelihood that it is masking chronic episodes of hypoglycemia. Because the A_{1c} level reflects average BG management, high BG readings can be offset by low BG readings, leading to a desired A_{1c} number, but not to improved health status because having repeated episodes of hypoglycemia is stressful to the body.

Teaching Pearl

The glycosylation of protein found in body cells can be described as body cells being caramelized. ■

Among the older population, depending on health status and life expectancy, the target A_{1c} may be appropriate at a higher level. This is because the potential risk of hypoglycemia and restricted food intake is weighed against the decreased likeli-

hood of complications that take years to develop. For example, Hgb A_{1c} of 8% indicates an average BG level of about 170 mg/dL, low enough to prevent concerns of dehydration, which may be the chief concern for the frail elder individual.

Self-Monitoring of Blood Glucose

A person with diabetes is generally advised to do **self-monitoring of blood glucose (SMBG)**. With personal BG meters, testing of BG level can be done at home or in other locations, such as at a restaurant or on a football field. Self-monitoring consists of taking a drop of blood and placing it on a strip that is inserted into a BG meter. Several types of meters are available, as are automatic lancet devices. The goals are to keep the BG between 70 and 140 mg/dL or as close as possible, with the higher level for postprandial testing. Having occasional SMBG levels up to 180 mg/dL, although not normal, is considered acceptable.

Although all persons with type 1 diabetes are advised to do SMBG, it is also potentially beneficial with type 2 diabetes. One study of SMBG among persons with type 2 diabetes was associated with decreased diabetes-related morbidity and mortality, and this association remained even among those who were not receiving insulin therapy (S Martin and colleagues, 2006). Use of SMBG can allow a person to recognize direct impacts of types of meals on BG outcomes and plan accordingly. Often by using SMBG to determine carbohydrate tolerance in a person with type 2 diabetes, weight loss will result. However, there appears to be less benefit for persons with non–insulin-treated type 2 diabetes who have A_{1c} at target (Schütt and colleagues, 2006).

Self-monitoring of blood glucose can be used for monitoring BG levels or determining carbohydrate tolerance or insulin-to-carbohydrate ratio (the amount of insulin required to cover carbohydrate intake—see MNT section below). Recommended times to test BG levels include before meals to help determine insulin doses with type 1 diabetes or 1 to 2 hours postprandially to determine carbohydrate tolerance with type 2 diabetes. This is referred to as **pattern management** because patterns may be noted that give an indication of when hyperglycemia or hypoglycemia may be predicted based on SMBG and food and activity records.

Typically a meal can be expected to raise the blood glucose level by 50 points (mg/dL). With a fasting blood glucose level of 100 mg/dL, an ideal meal should keep the blood glucose level at about 150 mg/dL approximately 1 to 2 hours after the meal. If the BG level goes higher than this, it indicates either excess carbohydrates in the meal, per individual needs, or a need for increased medication.

The advantage of SMBG is the knowledge and flexibility it affords in diabetes management. Less guesswork is involved, and SMBG allows the person with diabetes greater objectivity in decision making to prevent both hyperglycemia and hypoglycemia.

Testing postprandial BG (PPG) level further promotes A_{1c} goals. One study found that almost all persons maintaining PPG level of less than 140 mg/dL achieved A_{1c} of less than 7%, whereas only about two thirds of those achieving fasting BG (FPG) targets of less than 100 mg/dL achieved this target. In the majority of persons, achieving an A_{1c} of less than 6.2% was related to PPG levels. Control of postprandial hyperglycemia is essential for achieving recommended Hgb A_{1c} goals (Woerle and colleagues, 2007).

Alternatives to finger sticks for BG monitoring do exist. Increasingly, persons with diabetes are using the forearm to measure glucose levels. A continuous glucose sensor has been developed that works by having a biosensor inserted just below the surface of the skin. Eventually this system will be designed to "talk" with an insulin pump, thus serving as an artificial pancreas. Other devices and means to monitor glucose levels are in the development stage.

Monitoring for detection and treatment of hypoglycemia is another role of SMBG. A BG level of less than 70 mg/dL is indicative of hypoglycemia and should be treated with the **15:15 rule**, whereby 15 g of quick-acting carbohydrate is consumed, followed by a retest of BG in 15 minutes, and the process is repeated as needed to achieve normal BG level. If the BG level is severely low, less than 50 mg/dL, doubling the carbohydrate to treatment with 30 g of carbohydrate is appropriate. At 15 g of carbohydrate the maximum BG level rise will be 50 mg/dL. If BG level rises more than this, it is due either to the Somogyi effect or excess intake of carbohydrate beyond 15 g.

A person may or may not need a follow-up snack to maintain glucose levels in the normal range after hypoglycemia has been corrected with the 15:15 rule. With experience in using SMBG, a person may better gauge the necessity of having a snack. As a general guideline, if the next meal will be several hours later, such as in the middle of the night, it may be beneficial to have a more substantial snack (e.g., half a sandwich) after first correcting hypoglycemia by the 15:15 rule. A bedtime snack containing carbohydrates for a person using insulin is advised if the BG level is less than 100 mg/dL.

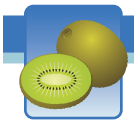
Teaching Pearl

Questions such as "How do I adjust my diet and insulin for exercise?" or "Can I eat a piece of birthday cake safely?" can be addressed through SMBG. For example, a person might find that a half piece of birthday cake with his or her evening meal may raise the blood glucose level an acceptable amount. If the blood glucose level goes above 200 mg/dL 2 hours after eating the cake, the person might consider eating less the next time. ■

Fact & Fallacy

FALLACY Treating hypoglycemia requires adding sugar to a glass of orange juice.

FACT One-half cup, or 4 oz, of orange juice provides the 15 g of carbohydrate needed to correct hypoglycemia. If sugar is added to orange juice, hyperglycemia is likely to develop. Only if the BG level is less than 50 mg/dL should increased amounts of carbohydrate be used. Each teaspoon of sugar contains 4 g of carbohydrate. The 4 oz of orange juice with an additional tablespoon of sugar equates to 30 g carbohydrate, or an expected rise in BG level of about 100 mg/dL. ■



Cultural Considerations

Data from the National Health and Nutrition Examination Survey (NHANES) 1999-2002 found about half of adults with previously diagnosed diabetes had A1c levels less than 7%. Mexican Americans and non-Hispanic African Americans were less likely to achieve good control compared with non-Hispanic whites. This difference did not appear to be due to health care access and use of diabetes treatment (Saydah and colleagues, 2007). ■

WHAT IS THE MEDICAL NUTRITION THERAPY OF DIABETES?

PREVENTION OF DIABETES

As discussed in Chapter 5, factors found to increase the risk of type 2 diabetes are related to evidence of the metabolic syndrome. Other factors associated with risk for type 2 diabetes include excess weight, physical inactivity, low fiber and high saturated fat and trans fatty acid intake, and either no alcohol or excessive alcohol intake. It is estimated that diabetes can be prevented for the majority of persons at risk with diet and lifestyle changes, including a 5% weight loss for those with excess weight, increased fiber intake, and increased exercise. Following the minimum servings of MyPyramid.gov promotes moderate intake while promoting high nutritional quality and is especially good if they are consumed in several small meals throughout the day. Based on general public health recommendations for diet and exercise, diabetes incidence can be reduced by 58% among persons with prediabetes (Roumen and colleagues, 2008).

There is still some controversy regarding the amount of fat in the diet. A 6-month study with up to 45% fat kilocalories but greater than 20% monounsaturated fat had better impact on FBG levels and insulin levels than a low-fat diet with less than 30% fat kcalories. Keeping saturated fat low was important for achieving these goals (Due and colleagues, 2008).

Vitamin D deficiency has been implicated in the development of both type 1 and type 2 diabetes. This finding resulted in part from recognition of vitamin D receptors in the pancreas. Maintaining normal plasma calcium levels through adequate vitamin D intake is necessary to regulate beta-cell function and insulin production (Palomer and colleagues, 2008). Elevated intracellular calcium level found with primary hyperparathyroidism induces glucose intolerance via insulin resistance (Yamaguchi and Sugimoto, 2006).

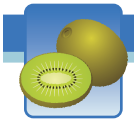
A multitude of research has now implicated arsenic toxicity as a causal agent. Insulin resistance and beta-cell dysfunction can be induced by chronic arsenic exposure, which may be responsible for arsenic-induced diabetes mellitus (Tseng, 2004). Many areas in the world have excess arsenic in the water supplies, partly because of mining and agricultural practices.

A low magnesium level, both inside the cell and out, is implicated in the development of diabetes. Magnesium plays a key role in promoting cellular uptake of glucose and regulating insulin action (Barbagallo and Dominguez, 2007). Aside from dietary deficiency of magnesium, there also may be an inherited structural defect in the plasma membranes of cells of individuals who have type 2 diabetes and sodium-sensitive essential hypertension. Abnormal accumulation of saturated fatty acids in cell membranes further inhibits the entrance of magnesium into the cell (Wells, 2008).

Another explanation of low serum magnesium levels has been linked with excess caffeine. This appears primarily true with acute intake of caffeine pills with ultimate impairment in glucose metabolism. Generally, chronic intake of caffeine exclusively from diet has little effect on glucose metabolism (Du and colleagues, 2007).

Uncontrolled celiac disease (refer back to Chapter 4) may have a role in the development of type 1 diabetes. Persons with celiac disease with chronic exposure to gluten have a significantly higher prevalence of anti–islet cell antibodies, found with type 1 diabetes (Verbeke and colleagues, 2004).

Type 2 diabetes and the metabolic syndrome in general have been linked with inflammation. Elevated levels of C-reactive protein may be of particular importance in the development of type 2 diabetes in women (Thorand and colleagues, 2007).



Cultural Considerations

In a study of Alaskan Eskimos, stressing more traditional foods high in omega-3 fatty acids and less of certain specific store-bought foods high in palmitic acid (having been identified with glucose intolerance and a number of health conditions found with the metabolic syndrome) resulted in improved BG level without loss of body weight. This included improved fasting blood glucose level and glucose tolerance, lower diastolic blood pressure, and lower cholesterol levels (Ebbesson and colleagues, 2005). ■

PREVENTION OF DIABETES COMPLICATIONS WITH MNT

In general several health organizations agree on general nutritional principles:

- Increased emphasis on the role of trained dietitians for educating people with diabetes, allowing for greater individualization of dietary choices based on cultural, regional, and personal preferences with more flexibility
- Carbohydrate intake 40% to 65% of kcalories
- Emphasis on high fiber intake, up to 50 g/day as tolerated
- Increased monounsaturated fat and omega-3 fat consumption with total fat 30% to 35% of kcalories
- Saturated and trans fats less than 10% of kcalories
- Polyunsaturated fats less than 10% of kcalories
- Broadened allowance of sucrose in the diet (up to 10% of total energy)
- Protein intake 10% to 20% of kcalories based on normal kidney functioning
- Weight loss for overweight/obese individuals at risk for diabetes
- Alcohol in moderation for those who are not at risk for alcoholism or breast cancer
- Increased physical activity
- Routine supplementation of the diet with antioxidants and vitamins is not necessary

Meal Planning for Management of Reactive Hypoglycemia

The person with reactive hypoglycemia needs to eat small amounts of carbohydrates (about 30 to 50 g) frequently (approximately every 3 hours) with emphasis on low–glycemic index choices. Including a protein source with meals and snacks further helps to maintain normal BG levels because it slows carbohydrate digestion, causing

Box 8-2 High-Protein Snack Ideas for Reactive Hypoglycemia*

Graham cracker with peanut butter
Apple or banana slices with peanut butter
Celery with peanut butter
Part-skim cheese and crackers
Nuts and raisins (small amount of raisins)
Low-fat cottage cheese and fruit
Unsweetened fruit juice and cheese
Half sandwich (meat, peanut butter, or cheese)
Hard-cooked egg and small glass of low-fat milk
Hot cereal with melted peanut butter
Cold cereal with bite-sized chunks of peanut butter and low-fat milk
Half of a bagel and light cream cheese
Parmesan muffin (English muffin with liquid margarine or olive oil and parmesan cheese—fresh grated parmesan is delicious)
Half a cantaloupe stuffed with low-fat cottage cheese

*Regular meals should be reduced in portion sizes to compensate for the added kcalories consumed through snacks. Regular meals also need to be balanced, including a protein source and excluding large quantities of concentrated sweets. Snacks should be consumed about 2 to 3 hours after regular meals.

only minimal stimulation of insulin secretion (Box 8-2 lists high-protein snack ideas). Emphasis on protein sources that are high in monounsaturated fats, such as nuts and peanut butter, can further lower glycemic index while decreasing the risk of developing diabetes. The need for protein to be included with the carbohydrate is based on individual symptoms. Caffeine and alcohol may exacerbate the symptoms of hypoglycemia because of their hormonal effect on liver glycogen and **glycogenolysis** (the breakdown of glycogen into glucose).

Meal Planning for Type 2 Diabetes

The same basic protocol for managing reactive hypoglycemia can be applied to managing type 2 diabetes. Balanced meals are helpful in the management of diabetes and in the promotion of health. This is true for anyone with insulin resistance, whether or not the person has diabetes. Medical nutrition therapy for management of diabetes needs to be individualized for long-term control. There is no one diabetic diet. The same goals to control insulin resistance and the metabolic syndrome apply to the management of type 2 diabetes. The use of SMBG can help verify carbohydrate tolerance with the expected meal excursion of BG by 50 points.

Teaching Pearl

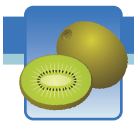
If the FBG is 110 mg/dL, and a breakfast of two slices of toast with peanut butter (30 g of carbohydrate; see Appendix 3 on the Evolve website) raises the 1- to 2-hour postprandial BG level to less than or equal to 160 mg/dL, this indicates good tolerance to 30 g carbohydrate. If a pattern develops indicating tolerance to 30 g carbohydrate, postprandial BG testing for this amount is no longer necessary. Higher amounts of carbohydrate can be further tested to verify the upper limit of carbohydrate tolerance. ■

Although weight loss can normalize BG levels, sometimes simply improving the quality of the diet is adequate, especially with increased levels of physical activity. Quality of fat has bearing with emphasis on monounsaturated and omega-3 fats and avoidance of excess saturated and polyunsaturated fats being beneficial. Adequate hydration status also is helpful to promote optimal cellular function to allow metabolism of glucose.

Teaching Pearl

If two slices of peanut butter toast allows less than a 50-point excursion 1- to 2-hours after meals, but a cheeseburger with a bun (30 g of carbohydrate; see Appendix 3 on the Evolve website) causes a meal excursion greater than 50 points, it may be due to the saturated-fat content of red meat and cheese. ■

Bread high in soluble fiber has been found to help control blood glucose levels, hyperlipidemia, and blood pressure (Nizami and colleagues, 2004). In general, high-fiber meals are beneficial for control of BG levels. This is likely due to the vitamins and minerals found in whole grains and other high-fiber foods that promote cellular metabolism and function. Further, meals with low glycemic load reduce the workload and stress within cells, promoting optimal function. A high–glycemic load breakfast meal with 78 g of carbohydrate and no fiber was found to significantly increase postprandial glucose and insulin levels as compared with a low–glycemic load breakfast of 62 g of carbohydrate and 6.6 g of soluble fiber (Clark and colleagues, 2006). Glycemic load is useful in predicting impact on blood glucose and insulin responses of mixed meals (Galgani, Aguirre, and Díaz, 2006).



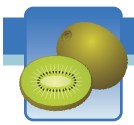
Cultural Considerations

A typical Vietnamese diet includes a high intake of white rice with about 70% of kcalories from carbohydrates. Although this appears to be tolerated in young adults, it may increase postprandial BG levels, especially in the elder Vietnamese population. Increasing intake of vegetables in meals appears to help prevent such an increase in glycemic response (Lin and colleagues, 2007). Dietary carbohydrate intake and consumption of rice also were positively associated with risk of developing type 2 diabetes mellitus among women of Chinese heritage (Villegas and colleagues, 2007). ■

One implication of the benefit of high-fiber foods on improved BG control is colonic fermentation leading to suppressed free–fatty acids levels. This is the presumed explanation of overnight benefits on BG level from a study using cooked barley as a bedtime snack (Nilsson and colleagues, 2008).

Teaching Pearl

If two slices of peanut butter toast causes a postprandial BG excursion of greater than 50 points, an assessment question might be, "Did you have any other food with this or beverage containing sugar (including fruit juice)?" If so, the meal was higher than 30 g of carbohydrate, showing the total amount of carbohydrate is the problem. If the person did have only 30 g of carbohydrate at the meal, another strategy to include this quantity while limiting postprandial BG excursion is to increase the amount of fiber in the meal. ■



Cultural Considerations

There are a variety of low–glycemic index/high-fiber breakfasts consumed around the world. This includes a common Mexican breakfast of huevos rancheros of refried beans (typically no longer fried as found in canned form) with an egg on top. Baked beans on toast is a favorite in England and other regions where persons of English heritage live (such as Bermuda). Other examples are roasted chickpeas with olives and a small piece of feta cheese in Turkey, and fish and vegetables in Japan. ■

An interesting approach is the addition of cinnamon to the diet. One-fifth to 1 heaping teaspoon (1 to 6 g) of cinnamon daily has been found to reduce BG levels approximately 20% to 30% in about 1 month with significant improvement in low-density–lipoprotein cholesterol (LDL-C) and triglyceride levels as well (Anderson, 2008; Khan and colleagues, 2003).

Health care professionals advising a person on improved diet quality need to be aware of issues of diabetes medications (see later section). Those using diabetes medications who try to improve the diet should be alerted to the symptoms of and treatment for hypoglycemia.

Teaching Pearl

You might say to an older adult who likely recalls it that the old adage "oatmeal sticks to the ribs" is absolutely true. This food can be helpful when a person is trying to prevent his or her postprandial BG level from rising too high. Legumes are also very high in soluble fiber. The Italian phrase "beans and greens" further helps a person remember which foods are high in soluble fiber. ■

Medical Nutrition Therapy for Gestational Diabetes Mellitus

Although GDM is essentially similar to type 2 diabetes in physiologic characteristics, weight loss is not an appropriate goal for the woman with gestational diabetes because of the growth needs of the developing fetus. Diet control focuses on slow but steady weight gain, avoidance of concentrated sugar sources (because they are high in carbohydrate content), and frequent, small, balanced meals. A prescribed kcalorie-restricted diet is generally unnecessary and can even be harmful unless the

woman understands that the kcalorie restriction is for control of weight gain, not for weight loss. See Chapter 11 for more information on diabetes and pregnancy.

Meal Planning for Type 1 Diabetes

It was through the DCCT study that **carbohydrate counting** became a tool for planning insulin dosages around meal intake. Before this the Exchange List system was used, and people with type 1 diabetes were expected to follow a rigid meal plan and not deviate insulin dosage from physician advice. With carbohydrate counting, the person with type 1 diabetes can determine how much insulin is needed based on carbohydrate content of a chosen meal, once they have the knowledge to do so correctly.

Meal coverage with short-acting insulin is referred to as the **insulin-to-carbohydrate ratio**, which is usually 1:15—1 unit of short-acting regular insulin is given for every 15 g of carbohydrate. Individuals using this approach need to work closely with registered dietitians (RDs) who are also CDEs.

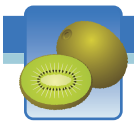
Individuals with type 1 diabetes can also have insulin resistance. This requires a higher amount of insulin in relation to carbohydrate intake. Such an individual may benefit by following meal guidelines for insulin resistance, with the additional goal of providing their needed insulin-to-carbohydrate ratio. Persons with this "double diabetes" appear to be at greater risk of complications of the eyes, kidneys, and cardiovascular system. Weight gain among individuals originally involved in the DCCT study who later gained excess weight also developed health conditions found with the metabolic syndrome (Kilpatrick, Rigby, and Atkin, 2007).

The RD, CDE is best qualified to verify individual insulin-to-carbohydrate ratios (which can range from a high ratio of 1:2 for use with insulin resistance to a low ratio of 1:30 for adults with insulin sensitivity or even lower ratios for young children who are very active). Adequate guidance is necessary before a person can safely and effectively adjust the insulin dose based on meal intake.

Part of the difficulty is determining how much insulin to give for a high-fiber food. For insulin coverage, fiber needs to be subtracted from the total grams of carbohydrates listed on a food label, if there is over 5 g of fiber. However, there is debate on exactly when to subtract fiber. The American Diabetes Association's advice to subtract fiber if over 5 g was to avoid potential hypoglycemia (see Chapter 2 for more on fiber and blood glucose). The fiber does not need to be subtracted from the total carbohydrates listed on the label if less than 5 g of fiber, but this lesser amount of fiber still will not raise blood glucose levels. The American Dietetic Association advises subtracting only one half of fiber content if over 5 g. This is due to some kcalorie provision due to bacteria in the gastrointestinal tract breaking down fiber that can serve as an energy source.

Another confusing aspect to food labeling for available carbohydrates is sugar alcohols. One half of sugar alcohols are counted as carbohydrates for insulin coverage. Therefore an individual gives the meal-coverage insulin based on the following as found in the Nutrition Facts section of the food label:

Total Carbohydrate – Fiber (at least if >5 g) – 1/2 of Sugar Alcohols.



Cultural Considerations

Diabetes within a family can change family dynamics. This is particularly true for families with a child with type 1 diabetes. Before carbohydrate counting, families may have allowed sugar-based foods for all family members but not for the child with diabetes. This would create conflict at mealtimes. Now with carbohydrate counting all foods can be included and insulin adjusted to match carbohydrate intake. Sugar as part of a low–glycemic load meal is acceptable. It was shown that the equivalent of daily intake of 1 tbsp of sucrose had no observable effect on FBG level with type 2 diabetes and no adverse glycemic or weight outcomes (Okoro and colleagues, 2007). One tablespoon of sugar contains 12 g carbohydrate (3 tsp). ■

Family dynamics, however, continue to have an impact. A study involving videotaping of three meals with families of young children with type 1 diabetes assessed eating behaviors. It was found that parents' use of ineffective/coercive parenting strategies was related to children's unwillingness to follow meal guidelines and was reflected in poor BG management (Patton, Dolan, and Powers, 2006a). Within routine diabetes care the **Behavioral Pediatric Feeding Assessment Scale (BPFAS)** is a valid and clinically useful tool to assess dietary adherence and mealtime behaviors in children. This tool contains a total of 35 questions with 25 questions assessing parents' perceptions of their child's mealtime behavior and the remaining 10 questions assessing parents' feelings about the mealtime situations. Questions are based on 1 to 5 Likert scale ratings and yes/no questions, making it easily used in a clinical setting. Monitoring via the BPFAS can identify families in need of behavioral interventions to improve mealtime functioning (Patton, Dolan, and Powers, 2006b). Positive meal environments further help the young child achieve optimal nutritional status for general growth and development needs (see Chapter 12. One study of young children with type 1 diabetes found the daily carbohydrate and kcalorie intake were about 20% lower than recommended and intake of vitamin B_{12} and calcium were less than the Dietary Reference Intake (DRI) (Patton, Dolan, and Powers, 2007). See Chapter 11 for positive meal strategies to promote children's willingness to eat a variety of foods.

Teaching Pearl

The analogy of a coal stove is useful to explain the difference between type 1 and type 2 diabetes management. It can further be related to the coal and shovel for meal-coverage insulin needs. Consider each body cell to be a microscopic coal stove. Carbohydrate in food is the coal. Insulin is the coal shovel (Figure 8-4).

If the door on the coal stove does not open easily, it is difficult to get the coal inside. This is similar to the insulin resistance at the cellular level generally found with type 2 diabetes. In relation to the body cells, if glucose cannot easily enter, the body simply makes more insulin in an attempt to force the fuel inside. Or, in other words, if one soldier can't get into a fort, you call out an army. Hyperinsulinemia is like an army of insulin. For persons with type 2 diabetes who have their own endogenous hyperinsulinemia but require additional insulin by injection, it is like calling for the navy to help the army. By reducing insulin resistance or reducing the need for insulin with a lower carbohydrate intake, a person with type 2 diabetes can send the navy home and may potentially be able to stop insulin by injection. ■

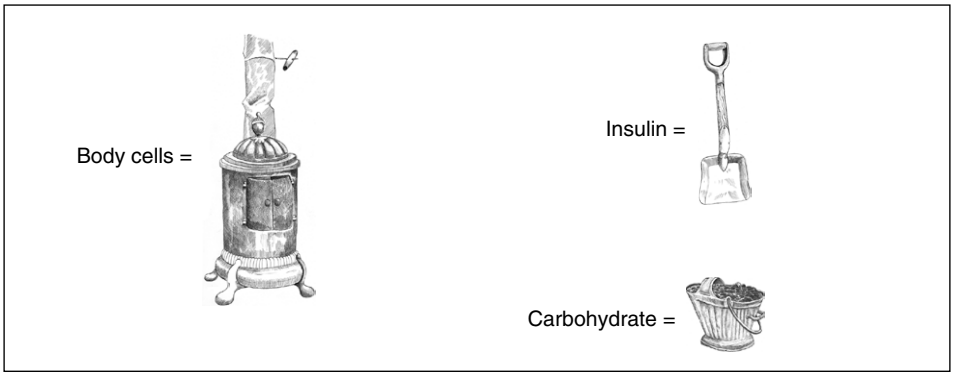


FIGURE 8-4 A coal stove analogy.

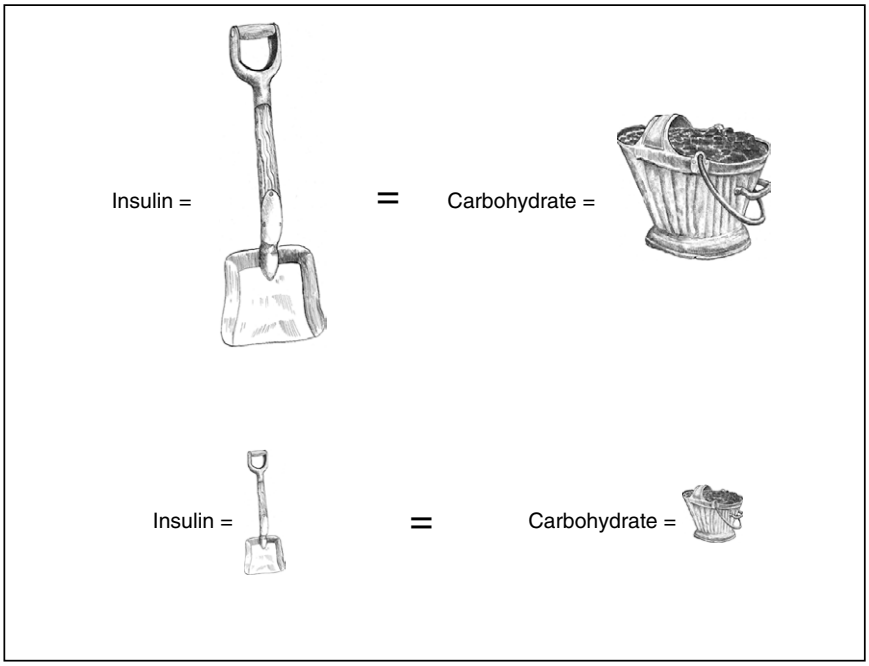


FIGURE 8-5 Insulin-to-carbohydrate ratio.

Teaching Pearl

In the case of type 1 diabetes, the doors of the body cells may open up normally, but there is no shovel to move the coal. Hence insulin by injection, like the coal shovel, is required to move the fuel. However, if there is a very small shovel and a very large bucket of coal, it will take a long time to empty the bucket. Alternatively, if there is a very large shovel with a small bucket of coal, the bucket will be emptied quickly. In carbohydrate counting this is the insulin-to-carbohydrate ratio (big shovel for a big bucket of coal; small shovel for a small bucket [Figure 8-5]). ■

In the past, meals were planned using Exchange Lists. It is important to be aware of this type of meal planning, but carbohydrate counting is a simpler and thus more effective meal plan approach. The complete exchanges take into account the protein, fat, and carbohydrate content of foods, which makes meal planning more complicated than needed, because carbohydrates have the greatest effect on BG levels. In the Exchange List system there is a similar carbohydrate content in the food groups. A person who learned the Exchange List system in the past can find it easy to make the transition to carbohydrate counting. Each serving of grain, fruit, and milk contains about 15 g of carbohydrates. A person may learn this as each being 1 unit of carbohydrates and applied as 1 unit of insulin per 1 unit of carbohydrates (a 1:15 insulin-to-carbohydrate ratio). The nonstarchy vegetable group contains about 5 g of carbohydrates per serving. The full exchange list is shown in Appendix 3 on the Evolve website. It is important that the diet be individually planned to facilitate compliance; therefore dissemination of preplanned diet guides is not in the best interest of persons with diabetes.

Teaching Pearl

A person who has had diabetes long enough to remember, or has heard from family members or friends, the "no sugar" message may restrict fruit intake believing the sugar content is harmful. Explain that each gram of carbohydrate is like a nugget of coal, and therefore the total carbohydrate content of the meal is what needs to be managed, not sugar versus starch. Liquid carbohydrate sources such as fruit juice or milk should still be moderated at mealtimes with 15-g carbohydrate quantity appropriate. ■

Fact & Fallacy

FALLACY A person with diabetes needs to learn the Exchange List system and the number of kcalories in food.

FALLACY Health care professionals who continue to instruct persons with type 1 diabetes only about the Exchange List system or who emphasize a specific kcalorie diet when their weight is normal are doing them a disservice. This is outdated guidance. It is much easier for a person to learn the effect of meals on postprandial BG levels, which empowers the person to understand the connection between carbohydrate and BG outcomes. Institutions that provide diabetic meals should base the meals on the carbohydrate content, not just on preset kcalorie levels. Keeping carbohydrates consistent in meals, such as 50 g per meal, works well for most persons with type 2 diabetes. Those who do SMBG can verify how strict or how flexible they can be with meals and can adjust carbohydrate portions accordingly. Persons taking insulin can learn how to match insulin use to carbohydrate intake—using an insulin-to-carbohydrate ratio—via SMBG. ■

Sugar Substitutes

Sugar substitutes (Table 8-2) can play a positive role in the diet. However, they are not always preferable. Sugar alcohols, such as sorbitol and xylitol, are often found in dietetic foods; they contain kcalories (about 2 kcal/g) and can cause the BG levels to rise and therefore should not be considered free foods. In addition, excess intake may lead to diarrhea. Saccharin, aspartame (NutraSweet), acesulfame-K, and sucralose (Splenda) have no appreciable kcalorie content in amounts commonly consumed

Table 8-2 Nutritive and Nonnutritive Sweeteners*

NAME	COMPOSITION	SOURCES
Nutritive Sweeteners*		
Glucose	Monosaccharide	Found in blood as the end product of starch digestion Occurs naturally in fruit
Fructose	Monosaccharide	Found in fruit and honey
Sucrose	Disaccharide composed of glucose and fructose	Commonly known as "table sugar" and widely used in commercial foods
Lactose	Disaccharide composed of glucose and galactose	Found in milk and unfermented milk products†
Maltose	Disaccharide composed of two glucose molecules	Produced during brewing and bread making; also made commercially
Honey	Mainly fructose and glucose	Made from plants by honeybees
Maple syrup	Primarily sucrose	Made by boiling off the liquid found in sap of mature sugar maple trees
Corn syrup	Composed of glucose	Produced from cornstarch molecules of different chain lengths
High-fructose corn syrup	Contains 40%-100% fructose	Produced enzymatically from cornstarch
Molasses	Contains 50%-75% sucrose	Produced during the processing of table sugar
Sorbitol, mannitol, xylitol	Sugar alcohols	Found naturally in fruit and used as a sugar substitute
Nonnutritive Sweeteners		
Saccharin	Organic compound	Originally banned in 1977 after being implicated as causing bladder tumors in rats fed high doses; currently available as a sugar substitute
Cyclamate	Available as cyclamic acid, calcium cyclamate, and sodium cyclamate	Banned since 1969 after evidence showed it as a possible cancer-causing agent in rats; Food and Drug Administration may reconsider its use given more studies on its safety
Acesulfame potassium	Compound that is not metabolized	Approved by Food and Drug Administration in 1988; now used in a wide variety of foods and beverages; 200 times sweeter than sugar. Referred to as acesulfame K on food labels
Sucralose	Compound made from sugar but not metabolized	Known as Splenda; used in all types of foods and beverages. Can be used in cooking and baking; 600 times sweeter than sugar
Aspartame	Methyl ester of two amino acids: phenylalanine and aspartic acid (aspartate)	Commonly known as NutraSweet and widely used in low-sugar food products; kcalories are insignificant because small amounts are used because it is intensely sweet—180-220 times as sweet as sucrose
Stevia	An herb used in South America for hundreds of years as a sweetener. Available as a dietery supplement; now FDA approved in a highly purified form as a sugar substitute.	Much sweeter than sugar; not metabolized by humans

*Nutritive sweeteners are those that provide kcalories; nonnutritive sweeteners are entirely free of kcalories because they are not metabolized.
†Lactose as found in milk is not harmful to diabetic individuals.

but may be used in foods that contain other sources of kcalories, such as fat. These foods may give a person with diabetes the false perception that if the food is sugar free it is also kcalorie free. Fructose, or fruit sugar, has similar effects on BG level as other sugars and should be considered as part of the total carbohydrate intake.

Fact & Fallacy

FALLACY Although persons with diabetes need to avoid sugar, they can eat honey without a problem.

FACT Honey is composed of glucose and fructose, two simple sugars, and therefore cannot safely be used freely. Occasional and moderate use, especially by a person who practices SMBG and carbohydrate counting, may be appropriate. Grams of sugar are part of the total grams of carbohydrate listed on food labels. Individuals with diabetes may use regular sugar in the diet, but those with type 1 diabetes need to cover with insulin and those with type 2 diabetes need to limit its use. One teaspoon of sugar (4 g of carbohydrates) has no more carbohydrate than a serving of vegetables. ■

Teaching Pearl

The carbohydrate content of a piece of cake can be determined by looking at the food label of the cake and frosting container based on the portion consumed. A homemade cake can be estimated for carbohydrate content knowing that ½ cup of flour contains 45 g of carbohydrates and ½ cup of sugar contains 95 g of carbohydrates (see Box 2-2). The amount of carbohydrate found in a given recipe can thus be calculated for the portion consumed. You can estimate the carbohydrate content of any piece of cake based on its level of sweetness. If a piece of cake is about ½ cup, it has to have at least 15 g of carbohydrates from the flour (½ cup grain-based food is about 15 g of carbohydrates). Depending on the level of sweetness, the cake may range from about 30 g carbohydrates (such as a piece of mildly sweet gingerbread) to usually about 50 g of carbohydrates. The cake cannot have 100 g of carbohydrates because cake is not pure sugar. ■

Fact & Fallacy

FALLACY Individuals with diabetes must give up the foods they love.

FACT The rule of moderation applies to both the general public and individuals with diabetes in achieving the goal of good nutritional intake. Moderate amounts of all foods are acceptable. All food consists of carbohydrates, proteins, fats, or a combination and therefore can be worked into the daily diet using tools such as food labels or the Exchange List system. The potential problem with this approach is individual definitions of moderation. Assessment of weight control and SMBG are two methods that can indicate whether the "moderation" is truly moderate. ■

VITAMINS AND MINERALS

Generally speaking, a person with diabetes may take a multivitamin and mineral supplement if good sense is used in the dose (100% to 200% of the DRI) and quality

assurance of the supplement is confirmed (refer to Chapter 3). Very large doses of vitamins and minerals or use of herbs can have a pharmacologic effect and should be used only in conjunction with the advice of a health care provider. For example, there is some initial research evidence that the mineral chromium (600 mcg) and the B vitamin biotin (2 mg/day) are therapeutic for persons with poorly controlled diabetes for the goal of improved glucose and lipid management (Singer and Geohas, 2006). However, this amount of chromium is over 15 times the DRI and biotin is over 60 times the DRI. Because the Upper Limit of Safety (UL) for these two nutrients is not known, supplements of this magnitude may have adverse impact in other ways, and food intake remains the preferred source for these nutrients.

Information on vitamins and mineral supplementation needs to be taken into consideration when diabetes medications are prescribed. Health care professionals working in the field of diabetes need to be aware of alternative therapies (see Chapter 3 on common herbs). Although evidence regarding the impact of herbs is sparse, they have the potential to affect BG level and should be addressed in relation to prescribed medications. Issues of quality control are of particular importance with herbs owing to potential toxicity from natural alkaloids found in certain herbs.

GUIDELINES FOR ALCOHOL

As discussed in the section on hypoglycemia, this is one area of concern for someone who takes medication for diabetes. Generally alcohol in moderation is considered acceptable as long as it is consumed with meals. Alcohol generally will not raise BG levels. This is particularly true for hard liquor, light beer, and dry wines. This is because the carbohydrate source is converted into alcohol. Sweet wines that have not been fully fermented or fruit juice and soft drinks that are used in mixed drinks will raise BG levels. Excess alcohol can raise BG levels and is also particularly dangerous with diabetes because of impairment of glycogen release to regulate BG levels. Persons who take insulin should not increase the dose for alcohol and should have alcohol as part of a meal or with food. It is wise to test 3 AM BG level after consuming alcohol to verify individual tolerance because alcohol in moderation may result in nighttime hypoglycemia.

HOW CAN A PERSON WITH DIABETES EAT AT RESTAURANTS?

Restaurant eating poses no problem if there is appropriate selection. Sweets should be avoided or included as part of the meal carbohydrate. Portions might also be controlled by ordering a couple of appetizers rather than the entree, which generally is inappropriately large for persons trying to control their weight and blood glucose level. Dessert might be shared with a friend. Eating on the road can be a particular challenge. Low-carbohydrate snack foods might be packed for dealing with the "munchies," whereas other snacks containing carbohydrates are essential for the person taking insulin or other diabetes medication when regular mealtimes may be difficult or impossible to achieve. Persons with type 1 diabetes need to be instructed regarding how to make alternative choices of food based on carbohydrate content. The use of carbohydrate counting can allow for a close approximation of the carbohydrate content of foods (see Chapter 2 and Box 2-2). Many fast-food restaurants now make available the nutritional content of their food selections (see Appendix 1 on the Evolve website).

Teaching Pearl

A person might plan on dessert at a restaurant by skipping the bread and ordering meat and vegetable/salad. This will limit the carbohydrate content of the meal. Using the tactile descriptors of sweetness and density, a reasonably close estimate of carbohydrate content of the dessert can be determined (see Chapter 2). A typical sweet dessert will be +/– 50 g of carbohydrate per ½-cup serving. ■

WHAT IS THE ROLE OF EXERCISE IN DIABETES MANAGEMENT?

Exercise is an integral component in prevention and treatment of type 2 diabetes. It is a factor in weight control and has been found to lower BG levels to the point of reducing or eliminating the need for oral hypoglycemic agents or insulin for persons with type 2 diabetes. All persons, whether diabetic or not, benefit with physical activity to maintain good cardiovascular health.

Exercise by a person with type 2 diabetes may naturally be more challenging because of differences in body composition. Low muscle glycogen levels have been noted in type 2 diabetes (He and Kelley, 2004). Without adequate glycogen stores, fatigue induced by exercise will be more pronounced. For this reason, slow, gradual increases in exercise are likely to be better accepted by the person with type 2 diabetes because endurance is built up.

Because of potential nerve damage from long-standing diabetes, medical input should be sought before exercise is undertaken. For example, the heart rate response to exercise may be impaired. This could result in oxygen deprivation if the activity is too strenuous. Children and adults who are on insulin may need to lower their insulin dose while increasing their carbohydrate intake if their physical activity level is greatly increased over usual amounts.

In type 1 diabetes with a ketotic or hyperglycemic state (when BG level is greater than 240 to 300 mg/dL), exercise can actually increase glucose levels further. This is primarily because insulin is a prerequisite for glucose use in exercising muscles. Hyperglycemia is generally indicative of insufficient insulin availability. Exercise should be avoided unless BG levels are under control. Even the person with well-controlled type 1 diabetes, however, needs to achieve a balance between the extra energy demands of exercise and diet and insulin. The general rule of thumb is to eat at least 15 g of carbohydrates for every 1 hour of exercise as based on weight and intensity of exercise (Table 8-3), to decrease the amount of insulin, or both, and to avoid exercising at the times that insulin is acting at peak levels. These guidelines help prevent the development of severe hypoglycemia, which is caused by excess insulin in relation to the amount of BG available.

The use of SMBG can serve as a valuable tool in determining the best way to adjust diet and insulin before, during, and after exercise. Increased amounts of carbohydrates may need to be consumed for up to 24 hours after strenuous exercise while the body replenishes its glycogen stores and allows for a stable BG level. Testing the 3 AM BG level is warranted after increased exercise to ensure there is no postexercise hypoglycemia. This time of night is when the body cells tend to be the most sensitive to insulin.

Table 8-3 Grams of Carbohydrate Used per Hour Based on Weight and Exercise

ACTIVITY	GRAMS OF CARBOHYDRATE USED PER HOUR (BASED ON AN INDIVIDUAL'S WEIGHT)		
	100 lb	150 lb	200 lb
Walking (3 mph)	14	21	28
Jogging (5 mph)	30	45	60
Running (7 mph)	52	77	103
Running (9 mph)	69	103	138
Bicycling (5 mph)	13	20	27
Bicycling (10 mph)	30	45	60
Bicycling (15 mph)	52	77	103
Swimming (20 yd/min)	24	36	48
Swimming (50 yd/min)	58	87	117
Gardening (light)	8	12	16
Golf (with golf cart)	9	14	19
Mopping floors	12	18	24
Lawn mowing (power, pushing)	13	19	25
Bowling	13	19	25
Golf (pulling cart)	13	20	27
Scrubbing floors	17	25	33
Softball	17	25	33
Badminton	19	28	37
Horseback riding (trot)	19	28	37
Square dancing	19	28	37
Roller skating	19	28	37
Tennis (doubles)	19	28	37
Volleyball	19	28	37
Raking leaves or hoeing	20	30	40
Ice skating or roller skating	23	34	45
Mini trampoline	23	35	47
Digging a garden	23	35	47
Ice skating (10 mph)	23	35	47
Chopping wood	23	35	47
Dancing (disco)	24	36	48
Mowing (hand mower)	25	38	51
Tennis (singles)	25	38	51
Waterskiing	29	44	59
Snow shoveling	30	45	60
Digging ditches	31	46	62
Rock climbing	31	46	62
Dancing (fast step)	31	46	62
Downhill skiing	33	50	67
Basketball (pickup)	39	58	77
Squash	40	60	80
Soccer	40	60	80
Basketball (vigorous)	44	65	87
Racquetball (singles)	60	90	120
Cross-country skiing (6 mph)	70	105	140

Modified from MiniMed Inc., Sylmar, Calif.

HOW ARE DIABETES MEDICATIONS USED IN THE MANAGEMENT OF DIABETES?

ORAL HYPOGLYCEMIC AGENTS

The earliest oral hypoglycemic agents were the **sulfonylureas**. The sulfonylurea medications work to promote increased insulin release by the pancreas and help reduce insulin resistance at the cellular level. Oral medications that can induce hypoglycemia because of the promotion of insulin production include the following:

- Sulfonylureas: glipizide (Glucotrol), glyburide (DiaBeta and Micronase), and glimepiride (Amaryl)
- Meglitinides (Prandin) act in a similar fashion but work in response to the postprandial rise of BG level

The insulin sensitizers work at the cellular level to help a person's natural insulin to work. Because they do not stimulate insulin secretion, they cannot directly induce hypoglycemia. These include the following:

- **Biguanide**s such as metformin (Glucophage), with a long record of safety
- **Thiazolidinediones** such as rosiglitazone (Avandia) and pioglitazone (Actos)

Another form of oral hypoglycemic agent is the **α-glucosidase inhibitors,** which delay the breakdown of disaccharides, resulting in reduced postprandial hyperglycemia. The primary example of this type of medication is acarbose (Precose). If hypoglycemia does occur using acarbose, correction needs to be with a monosaccharide source (glucose or fructose).

Weight gain can occur with all oral hypoglycemic agents, except for biguanides and α-glucosidase inhibitors. The thiazolidinediones can induce edema and subcutaneous body fat; weight monitoring is important when this type of medication is initiated.

A new oral hypoglycemic agent, tagatose, was originally developed as a sugar substitute. It is made by altering the sugar galactose. It has met the Generally Recognized as Safe (GRAS) guidelines (see Chapter 14) for consumption as a food ingredient, Naturlose, but is in clinical trials to be used as an oral hypoglycemic agent (Lu, Levin, and Donner, 2008).

TYPES OF INSULINS

Since the first recognition of insulin's role in treating dogs with diabetes by a Canadian physician after returning from World War I, several developments have occurred. The most recent is the development of peakless, but long-acting insulins; the primary one used is glargine, brand name Lantus. Before this, insulins had buffers added that gave a cloudy appearance and resulted in their being released more slowly into the bloodstream. Examples of these were referred to as NPH, Lente, or Ultralente. However, these insulins had times of **peak action** (times of greatest effect—see Figure 8-6) that often resulted in severe hypoglycemia, causing unconsciousness and trips to the emergency department. The newer long-acting insulins developed, if prescribed correctly, generally do not cause severe hypoglycemia. These older forms of insulin are being phased out of use.

Rapid-acting insulins also have been improved. The older Regular or "R" insulins formed hexamer crystals and required injection 30 minutes before meals for most effective treatment (to allow for the hexamer crystals to disassociate). Their peak action times were typically 2 to 3 hours after injection, and they remained in the

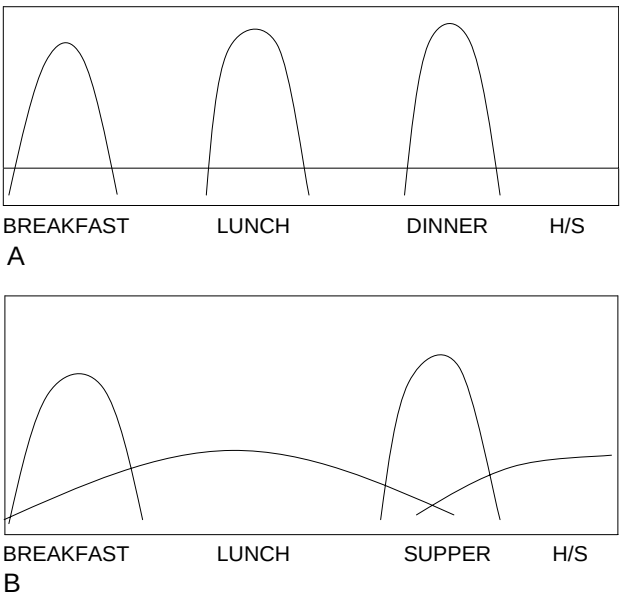


FIGURE 8-6 Insulin actions. **A,** Lantus insulin or other peakless, long-acting insulin with short-acting insulin meal coverage. **B,** NPH long-acting insulin peaks about 4 to 6 hours after injection at breakfast and supper. NPH is advised to be given at bedtime (H/S) to prevent nighttime hypoglycemia but is being phased out of production; premixed insulin (NPH and short-acting insulin) given at supper increases risk of nighttime hypoglycemia. Short-acting insulin is given at breakfast and supper when NPH action is minimal.

system for up to 6 to 8 hours. Consequently, it was not possible to fully mimic the body's own production of meal-related insulin release. Regular "R" insulin also is being phased out of use.

The newer short-acting insulins are produced by changing the order of amino acids in the insulin chain. This has resulted in a short-acting insulin that is used immediately and needs to be taken within 5 minutes of a meal. They also peak earlier at about 30 to 60 minutes and leave the system more rapidly, helping to better match blood glucose levels after a meal. The first ones developed were lispro (created by altering the order of lysine and proline in the insulin chain) and sold as the brand name of Humalog. Another similar type of insulin is aspart, brand name Novolog. The newest short-acting insulin is known as glulisine (Apidra), which is produced with changes to positioning of glutamic acid, lysine, and asparagines. This insulin has been shown to work as well or more rapidly than Humalog or Novolog with improved postprandial BG control for both type 1 and type 2 diabetes, it can be given after a meal because of its rapid action (Ulrich, Snyder, and Garg, 2007).

Teaching Pearl

The "N" insulin as written on a vial of insulin stands for NPH. Novolog, when ordered, should always be written out to prevent confusion with NPH insulin. NPH is cloudy in appearance and is a long-acting insulin. Novolog is clear and is a very fast acting insulin. The insulin type needs to be matched with BG needs (Figure 8-6). ■

Inhaled insulin has enjoyed great appeal to persons with diabetes because there are no injections. However, there can be issues related to health of lungs and less flexibility with dosing with the smallest amount being equivalent to 3 units of insulin.

OTHER COMMON MEDICATIONS IN CONTROLLING COMPLICATIONS OF DIABETES

Angiotensin-converting enzyme (ACE) inhibitors reduce insulin resistance, and they are first-line antihypertensive drugs in treating hypertension related to the metabolic syndrome. The ACE inhibitors also play a protective role in maintaining the health of kidneys. Most β-blockers and diuretics used in treating hypertension can worsen insulin resistance.

Because elevated lipid levels are typically found with diabetes, the anticholesterol medications statins and fibrates may be used. Omega-3 fatty acids improve dyslipidemia as reviewed in Chapter 7. A low dose of aspirin, or other blood thinners, is generally advised to further reduce risk of forming clots.

INTENSIVE INSULIN MANAGEMENT

The term *intensive insulin management* was coined during the DCCT study. To achieve normalized levels of BG safely, dietitians were involved and developed the process of carbohydrate counting. (See Box 2-2 for an easy method to estimate carbohydrate content of plant-based foods based on level of water, sweetness, and density, useful when food labels are not available.) Intensive insulin management uses patterns of BG levels to verify insulin needs and insulin-to-carbohydrate needs. This is referred to as pattern management.

HOW IS INSULIN PRESCRIBED?

Only health care providers licensed to prescribe medications can alter insulin doses. Other health care professionals can advise a person with diabetes to seek medical opinion on dose changes as noted by review of SMBG records. The RD, CDE is able to assess insulin-to-carbohydrate ratios.

The total dose is expected to be about 0.5 units per kilogram of body weight. A person using less than this with good control of BG is either very insulin sensitive or has residual insulin production. A person who is insulin sensitive needs at the most 1 unit of short-acting insulin per 15 g of carbohydrate (may be called a carb serving). It is helpful to determine what an individual has been doing and start from that point, presuming relatively good control has been achieved.

Persons requiring greater insulin amounts than expected and who have good BG control are most likely insulin resistant. Such an individual likely needs more insulin per gram of carbohydrate, such as 3 units for every 15 g of carbohydrate, or a 1:5 ratio. Caution needs to be exercised in particular when giving more than a 1:15 ratio.

If a person has been described as having brittle diabetes with extreme highs and lows, and the amount of daily insulin is greater than 0.5 units per kilogram of body weight, this person will likely find blood glucose levels even out with a reduced amount of insulin. This is because of the Somogyi effect following hypoglycemia.

Intensive insulin management is best done with either Lantus insulin, which is peakless, or the insulin pump. Each meal is then "covered" with short-acting insulin with an insulin-to-carbohydrate ratio. This is called a meal bolus with the insulin pump.

Other long-acting insulins can be very unpredictable in their actions. For example, NPH insulin, which typically has a peak action of about 6 hours, can peak one day at 3 hours and the next day at 8 hours. Therefore when a person takes NPH insulin at breakfast, it is covering lunch, and no short-acting insulin is generally given at this time. If NPH is used, the second injection should be at bedtime, such that it peaks at about the time of the dawn phenomenon, when BG levels naturally rise. The 70/30 insulin types contain 70% long-acting and 30% short-acting insulin. This type of insulin cannot be adjusted based on meal intake; rather, consistency of carbohydrate intake is required to prevent BG highs and lows.

Lantus is determined to be at the correct dose when the morning BG level, after an overnight fast, is in the low 100s (mg/dL). The dose of Lantus is increased or decreased by 10% or more, every 2 to 3 days, until this goal is met. Lantus is essentially peakless and works for about 24 hours, although an estimated 15% of individuals metabolize Lantus quickly and need to inject it twice daily. Lantus is generally advised to be injected at bedtime, but the time of day is less important than having the injection at the same time each day. Once the background, or basal, insulin needs are met in a predictable way, insulin-to-carbohydrate ratios generally become quite simple to determine.

Teaching Pearl

NPH insulin is like a racehorse waiting at the gate. The horse waits and waits, and when the gate opens, the horse charges into a run (the peak action). Lantus, on the other hand, works like an old Belgian workhorse. It just plods along consistently, never running. Lantus therefore does not cause hypoglycemia once the correct dose is determined. ■

The person with type 2 diabetes who is not able to produce enough insulin to compensate for the cell's insulin resistance may use long-acting insulin. If adequate postprandial BG levels are achieved, meal coverage with short-acting insulin is not required for type 2 diabetes.

Insulin pumps (Figure 8-7) use only short-acting insulin. Persons transferring to a pump will likely need about 75% of their usual dose of insulin, which is generally divided into half for the basal rate and half for the meal bolus needs. For example, a person on 60 units of insulin by injection will need about 45 units on the pump (75%). About half of this dose is given in the basal rate (22 units divided by 24 hours, or 0.9 units given per hour via the insulin pump). The other half is used to cover mealtime carbohydrates, based on the insulin-to-carbohydrate ratio the individual requires.

The amount of hourly basal insulin needed in insulin pumps is tested to verify that the BG level remains stable. The basal rate can be slowly increased or decreased by about 0.1 unit per hour based on individual needs. Often an increased basal rate is needed to cover the dawn phenomenon, with lower basal rates needed for other

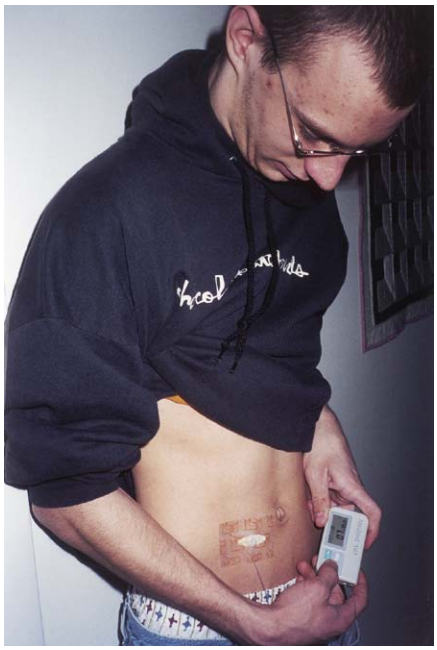


FIGURE 8-7 Mature adolescents can easily work with an insulin pump.

times of the day. A temporary increase in basal rate may be needed during times of illness. Once basal rates are set correctly, the person using the pump can safely have a great deal of flexibility in timing of meals and amounts eaten if the insulin-to-carbohydrate ratio is accurately determined and applied.

Insulin pump therapy is increasingly being used for type 1 diabetes because it allows for flexibility in lifestyle and improved management of glucose. It is also used for women with diabetes during pregnancy.

There are many ways to deliver insulin via the pump. If a person predicts how many grams of carbohydrates are going to be consumed over a period of several hours, such as at a buffet or wedding, the pump can be programmed to give the required meal-coverage insulin over that time period (called a square-wave of insulin delivery).

Eating pizza has caused havoc in BG control for many individuals. This is likely because of an immediate rise in BG from the white-flour crust, but some delayed digestion is caused by the fat of the cheese and toppings. Use of the dual-wave feature (a delivery of an immediate small amount of insulin followed by a slower, prolonged delivery of insulin) of the pump with the bolus extended over an 8-hour period after a pizza meal was found to promote a more-even BG level (Jones and colleagues, 2005).

DETERMINING THE INSULIN-TO-CARBOHYDRATE RATIO

By using SMBG records, the effect of a given amount of carbohydrates consumed for the number of units of short-acting or regular insulin given can be determined.

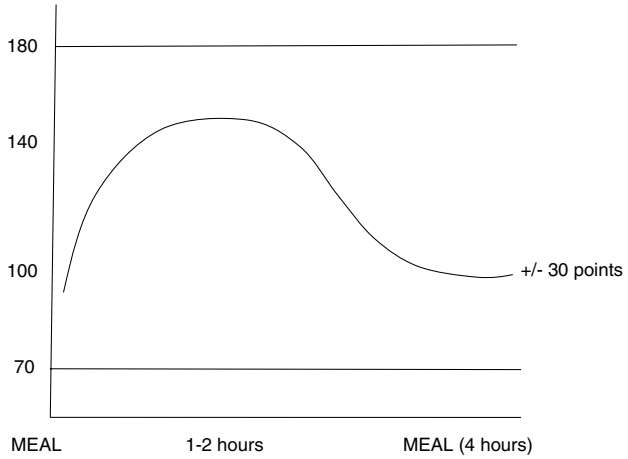


FIGURE 8-8 Testing for insulin-to-carbohydrate ratio

The goal is for the BG level to rise no higher than about 50 points after meals. Generally at 1 to 2 hours after meals the BG level will be highest, except if Humalog or the other newer short-acting insulins are used, in which case the peak BG level is noted about 45 minutes after meals.

After 4 to 5 hours the BG level should end up where it started before the meal (give or take 20 to 30 points); simple math reveals the outcome. For example, if BG level in the morning is 110 mg/dL and the prelunch BG ranges from 80 to 140 mg/dL, the correct amount of insulin-to-carbohydrate was used (see Figure 8-8). To do the math, divide the grams of carbohydrate in the breakfast meal by the number of units of short-acting insulin given at breakfast. The resulting number is the number of grams of carbohydrates for each unit of insulin given. This ratio can then be used to determine the amount of insulin for either more or fewer carbohydrates in another meal. However, before increasing insulin doses for a larger meal, it is advised to verify the outcome first. One example may be a fluke. Use of pattern management or repeat outcomes need to be undertaken to safely apply carbohydrate counting.

Teaching Pearl

Fear of hypoglycemia was found to be the most frequent reason for not adjusting insulin dose according to carbohydrate intake. A person's perception of his or her ability to apply carbohydrate counting with insulin adjustment can affect his or her actions (Reach and colleagues, 2005). Reviewing a person's food log and SMBG can not only help determine insulin-to-carbohydrate ratios but can provide the skills and confidence of the person with diabetes to better take charge of his or her health. ■

Persons with type 2 diabetes, without insulin, generally look at the total amount of carbohydrate grams consumed per meal that allow for these same goals. By reducing postprandial hyperglycemia, Hgb A_{1c} goals can be better achieved with reduction in complications of diabetes. Controlling postprandial BG excursions may further allow for decreased use of insulin or oral diabetes medications.

THE 1800 RULE

The **1800 rule** is an estimate that is used to determine expected point drop of BG per unit of insulin (beyond the carbohydrate content of a meal). This formula is used for additional insulin needed to correct hyperglycemia. It replaces the old sliding-scale insulin regimen. The 1800 rule is used by counting up the usual amount of total units of insulin (including both long-acting and short-acting insulins) and dividing the number of total units of insulin into the number 1800. The resulting number is referred to as the **correction or sensitivity factor** and provides an indication of BG point drop per unit of additional short-acting insulin. For example, a person who takes a total of 100 units of Humalog and Lantus insulin combined will have an expected BG point drop of 18 points per every extra unit of Humalog insulin. To give another example, if the total number of daily units of insulin is 30, the expected point drop for each additional unit of insulin is 60 points (1800 divided by 30 units = 60-point drop).

If a person is using the older "R" insulin, the total daily units of insulin is divided into the number 1500. For example, a person who takes a total of 100 units total of insulin will have an expected BG point drop of 15 points per every extra 1 unit of Humalog insulin. To give another example, if the total number of daily units of insulin is 30, the expected point drop for each additional unit of insulin is 50 points (1500 divided by 30 units = 50-point drop).

Once a person is well versed in predicting BG outcomes, meal-coverage insulin for carbohydrate intake can be added to the amount of high BG correction insulin needed to achieve normal BG level using the 1800 rule. The use of a correction factor is now preferred over the older sliding-scale formulas health care providers have used to determine mealtime insulin use. The American Diabetes Association encourages use of the planned needs for long-acting insulin along with planned insulin for carbohydrate intake at mealtimes and any additional insulin given at mealtime as needed with the correction factor insulin as determined with the relevant 1800 or 1500 rule.

WHAT ARE THE COMPLICATIONS OF DIABETES?

HYPOGLYCEMIA AND HYPOGLYCEMIC UNAWARENESS

Insulin and the sulfonylureas are the primary medications that can induce hypoglycemia. The combination of the usual dose of medication along with increased levels of exercise, especially with a delayed meal, can cause hypoglycemia. This can be as simple as starting a physical therapy program or shoveling snow.

Alcohol in moderation causes increased insulin sensitivity. The combination of increased activity such as mowing the lawn, combined with a cold beer afterward, can induce hypoglycemia. Having alcohol with a meal can help prevent hypoglycemia, but many people have given up drinking alcoholic beverages altogether because of the havoc they wreak on BG level. In the presence of excess alcohol in the blood, the breakdown of glycogen is impaired, which may result in serious hypoglycemia, especially if the person or friends don't distinguish signs of hypoglycemia, such as decreased cognition and loss of muscle coordination, from signs of inebriation. Police officers need to know to look for a medical alert bracelet or necklace if it is suspected a person is driving under the influence when stopped for a traffic infraction.

Box 8-3 Portions for Dietary Treatment of Hypoglycemic Episodes in Conscious Persons

15 g CARBOHYDRATE	30 g CARBOHYDRATE
4 oz apple juice	8 oz apple juice
4 oz orange juice	8 oz orange juice
5 oz regular soda pop	10 oz regular soda pop
4 tsp honey	8 tsp honey
4 tsp sugar	8 tsp sugar
¼ c sherbet	½ c sherbet

The 15:15 rule: Check blood glucose; if low (less than 70 mg/dL), treat with 15 g of carbohydrates. Recheck blood glucose in 15 minutes; if still low, repeat with another 15 g of carbohydrates. If the blood glucose is severely low (less than 50 mg/dL), treat with 30 g of carbohydrates and recheck in 15 minutes.

Treatment with 15 g of carbohydrates needs to be provided if the person has hypoglycemia.

Teaching Pearl

All persons with diabetes need to know the effects of alcohol on blood glucose levels, whether they drink or not. This is because, at a later date, he or she may decide to have a drink such as at a social occasion like a wedding or a Christmas party with co-workers. ■

Type and timing of insulin influences the risk of hypoglycemia. Before the DCCT study, it was routine to give an evening dose of NPH insulin at dinnertime. As a result, the majority of cases of severe hypoglycemia caused by insulin occurred at 3 AM. Giving NPH at bedtime greatly reduces this risk. However, with the goal of intensive insulin management and target Hgb A_{1c} of less than 7%, Lantus has been shown to reduce risk of hypoglycemia better than NPH, especially during the night (Rosenstock and colleagues, 2005).

A person who has repeated episodes of hypoglycemia begins to lose the sensations of hypoglycemia. This is referred to as hypoglycemic unawareness because symptoms of hypoglycemia—shakiness, rapid heartbeat, and so on—will not be felt. This is a major cause of becoming unconscious from hypoglycemia, because its development is not recognized until it is too late. Hypoglycemic unawareness was found to be significantly associated with use of ACE inhibitors—medications used to treat hypertension or to prevent progression of kidney disease (Streja, 2005). β-blockers are also known to blunt the symptoms of hypoglycemia.

Individuals with hypoglycemic unawareness have noted being consciously aware of the need to consume carbohydrates but physically not able to move or speak to indicate this need. This occurs when the nerves and muscles have too little glucose, or fuel, to function. It has been noted that with meticulous avoidance of hypoglycemia, for as little as 2 weeks, the symptoms can return. Although the symptoms are not pleasant, they do serve as a warning of the need to consume a rapidly absorbable source of carbohydrate.

INSULIN REACTION AND DIABETIC COMA

Insulin reaction (or insulin shock) occurs when more insulin is injected than is needed. Box 8-3 describes nutritional management of a conscious person. Insulin shock can result from omitting foods from the diet, increasing activity and exercise (that burn more kcalories than normal), or making an error in insulin injection in relation to carbohydrate intake. See Figure 8-8 on how to test for insulin-to-carbohydrate ratio. The result is hypoglycemia. If the hypoglycemia is not treated promptly, the person becomes mentally confused and disoriented. If this situation is prolonged, seizures, **diabetic coma,** and death can result. All family members should have supplies on hand and know how to inject glucagon to raise blood glucose level for an unconscious person. The primary concern regarding the unconscious person when giving glucagon by injection is the potential for severe nausea and potential vomiting. The person should be positioned on his or her side to help prevent aspiration. (Glucagon, as discussed earlier, is a counterregulatory hormone that acts to release stored glycogen from the liver, thereby providing a blood glucose source; it is available with a health care provider's prescription.) Medical services should be sought in the case of insulin shock to help prevent another occurrence.

HEART DISEASE

Deaths among persons with diabetes are highly related to cardiovascular disease (CVD). Up to 80% of persons with diabetes die of macrovascular complications, including coronary artery disease, stroke, and peripheral vascular disease. The individuals who had been in the intensive diabetes treatment group during the DCCT study now have less atherosclerosis than the control group in the original DCCD study. This is believed to be due to reduced A_{1c} levels while the DCCT study was being conducted (Cleary and colleagues, 2006).

Following a traditional Greek Mediterranean diet can reduce platelet activity (Antonopoulou and colleagues, 2006). Because persons with diabetes generally have increased tendency to clot, the Mediterranean diet may also help reduce cardiovascular events. As discussed in Chapter 5, inflammation is generally found with the metabolic syndrome and type 2 diabetes. Controlling C-reactive protein levels appears to be important in reducing atherosclerosis and coronary heart disease among persons with diabetes (Ahmad and colleagues, 2007).

Postprandial hyperglycemia appears to be a common phenomenon, even in those who have appropriate levels of A_{1c} and FBG. Monitoring and targeting postprandial glucose level with type 2 diabetes is advised (Ceriello and colleagues, 2006). Postprandial hyperglycemia may be linked to CVD through the generation of oxidative stress. Results suggest that lifestyle interventions incorporating diet with or without exercise improve glycemic control, reduce oxidative stress, and improve other cardiovascular risk factors (Leiter and colleagues, 2005; Wycherley and colleagues, 2008). This is best achieved with MNT rather than aggressive use of medications as was shown in an attempt to document A_{1c} in the normal range of 5% with the Action to Control Cardiovascular Risk in Diabetes (ACCORD) trial. In this trial multiple medications were used to achieve normal BG level among persons with type 2 diabetes, but an increased incidence in CVD caused the trial to be stopped. This is believed to be due to altered metabolism of carbohydrates and fats among persons with type 2 diabetes.

There is an increased risk of heart disease in type 1 diabetes that can be a result of dyslipidemia (Wadwa and colleagues, 2005). In uncontrolled type 1 diabetes about 1 in 4 were found to have elevations in LDL-C, and 1 in 10 had triglycerides over 200 mg/dL (the former level considered as high triglycerides—see Chapter 7). In youth with uncontrolled type 2 diabetes, however, the frequency of elevated LDL-C and triglyceride levels was approximately double that of youth with uncontrolled type 1 diabetes (Petitti and colleagues, 2007).

Numerous studies of persons with type 2 diabetes have shown the benefits of aggressive treatment of blood pressure and lipids. The American Diabetes Association recommends that health care providers measure blood lipids and treat associated problems as a primary intervention to reduce the risk of cardiovascular disease among persons with diabetes. The goals for blood pressure are more conservative for a person with diabetes. The American Diabetes Association advises a blood pressure goal of less than 130/80 mm Hg. Refer to Chapter 7 for management of cardiovascular disorders.

There is usually improvement in the blood lipid levels as diet, weight, and BG levels are improved. Medication is sometimes needed as well. A meta-analysis study found low–glycemic index meals reduced total cholesterol and LDL-C levels while improving control of diabetes (Opperman and colleagues, 2004).

Using NHANES 1999-2000 data, it was found that among individuals with diabetes less than one third of men and only one fifth of women achieved the target LDL-C of less than 100 mg/dL. Over half had dyslipidemia. Less than 30% were on lipid-lowering treatment (Jacobs and colleagues, 2005). In one primary care practice, among those with diabetes almost 15% were diagnosed with heart disease, 3% with cerebrovascular disease, and over 75% with hypertension (Robbins, Webb, and Sciamanna, 2005). However, even if the LDL-C level is normal, there is a tendency toward small, dense LDL particles that are more likely to cause cardiovascular disease. Ischemic stroke is frequently found with hypertension, history of myocardial infarction, and high cholesterol in adults with age less than 55 in African Americans and less than 65 in whites (Kissela and colleagues, 2005). Refer to Chapter 7 for more details on lowering risk of cardiovascular disease.

ALBUMINURIA

All persons with diabetes mellitus should have their urine tested for albumin. Persons who have had type 1 diabetes for more than 5 years and all persons with type 2 diabetes should be tested annually because the person may have had diabetes for many years before the diagnosis. **Albuminuria** (albumin in the urine) is associated with advancing kidney disease and should be treated aggressively with ACE inhibitors (a form of blood pressure medication). Once **macroalbuminuria** (very large amounts of albumin in the urine) occurs, a moderate protein intake of 0.8 g of protein per kilogram of body weight is advised, with reduction in sodium intake (2 g of sodium is generally adequate) if the person has concomitant hypertension.

KIDNEY DISEASE

Persons with type 1 diabetes are at particular risk for kidney disease caused by damage to small blood vessels. Kidney disease occurs more frequently in type 2 diabetes because there are many more persons with this type of diabetes. The DCCT

study found that maintaining good blood glucose control will greatly lessen the risk of kidney disease.

Eating protein in more moderate portions is appropriate—almost no one needs more than 6 oz of meat per day—but it becomes necessary only when there is severe kidney damage, as with macroalbuminuria. Controlling blood pressure is critical to preserving kidney functioning. Regular blood pressure screening is necessary, and antihypertensive therapy, particularly the use of ACE inhibitors, helps preserve the functioning of the kidneys when there is mild hypertension with **glycated** albumin (glucose attached to the protein—in this case, the albumin) as found with hyperglycemia. Borderline hypertension (stage 1; see Chapter 7) needs to be treated aggressively in persons with diabetes to preserve kidney function (refer to Chapters 7 and 9).

EYE DISEASE

Diabetic retinopathy (a disease of the back of the eye where visual images are conveyed to the brain) occurs in about half of all persons who have had diabetes for more than 10 years and in the majority of all persons who have had diabetes for more than 25 years. In this condition very tiny, fragile blood vessels grow on the back of the eye. Through annual dilated eye examinations, these abnormal blood vessels can be detected and removed via laser treatment before they break and fill the eye with blood. Controlling BG level with Hgb A_{1c} under 7% was shown to reduce eye diseases by 75% through the DCCT study. Further evidence suggests controlling hypertension and hypercholesterolemia can further help prevent retinopathy (Higgins, Khan, and Pearce, 2007).

NERVE DISEASE

Nerve disease can occur at any location of the body but typically affects peripheral nerves (such as those in the feet and legs) and the autonomic nervous system (composed of the nerves that send unconscious messages to the body, such as in the stomach, heart, or intestines). Problems with peripheral nerves **(peripheral neuropathy)** in the feet can cause burning, pain, and, if severe, no feeling at all. It is paramount for persons with peripheral nerve problems of the feet to practice meticulous foot care, with daily inspection of feet. This can help prevent minor foot infections from becoming major infections and necessitating amputation. Any sign of a problem should immediately be taken care of by a physician or **podiatrist** (foot doctor).

The years of intensive therapy during the DCCT study was initially beneficial in preventing nerve damage, and subsequently for at least 8 years beyond the end of the DCCT (CL Martin and colleagues, 2006). Although there is evidence from the DCCT that normalizing high BG levels can reduce the incidence of nerve damage, there is evidence that hypoglycemia also is problematic. It has been found that during times of energy depletion (i.e., hypoglycemia), nerve damage develops. This has been attributed to an influx of calcium into cells during energy depletion leading to increased production of reactive oxygen species (free radicals as described in Chapter 3). Thus increased intake of foods high in antioxidant nutrients, especially vitamin E as found in nuts, along with avoidance of hypoglycemia can further help protect nerve health (Hernández-Fonseca and colleagues, 2008). This research has

implications for diabetes headaches caused by hypoglycemia and possibly migraines (see Chapter 13) in which there is evidence of increased cellular flux of calcium.

Recently a type of painful neuropathy of the skin layer has been linked with IGT and the metabolic syndrome, before the onset of diabetes. There are many specific types of neuropathy that respond to different medications, such as diuretics, steroids, immune suppressants, and a variety of pain medications (Vinik, 2004). This may explain why some individuals with diabetes are hypersensitive to the finger pricks needed for SMBG and insulin injections.

Taller individuals with diabetes are at higher risk of peripheral nerve damage with sensory loss than shorter persons with diabetes. Because loss of sensation in the feet increases risk of injury to skin tissue, there can be an increased risk of lower-extremity ulcers and amputation among taller individuals. It has been shown that height is an independent predictor of lower-extremity amputation among persons with type 1 and type 2 diabetes mellitus (Tseng, 2006).

Problems with the autonomic nervous system are referred to as **autonomic neuropathy.** This condition is generally believed to be caused by prolonged hyperglycemia, of many years' standing, but as just discussed may involve hypoglycemia as well. **Gastroparesis** is an outcome of autonomic neuropathy. Partial paralysis of the nerves leading to the muscles of the stomach results in diminished movement of food through the stomach. This can be a cause of unexplained hypoglycemia because blood glucose levels can be raised only when food leaves the stomach. When this condition is suspected, a dye test is administered to determine the amount of time it takes for the food to leave the stomach. There is medication for this condition. A person with gastroparesis may benefit from decreased amounts of insoluble fiber, as found in the skin and seeds of plant-based foods. Insoluble fiber has a crunchy texture. A person with gastroparesis will still benefit from soluble fiber sources because the fiber easily dissolves in the liquid content of the digestive tract.

Exercise may be discouraged for a person with autonomic neuropathy because the heart may not be able to speed up to increase the oxygen intake. This is one reason why asking for physician permission before engaging in increased physical activity is important. Other conditions related to autonomic neuropathy include silent heart attacks (no pain associated with myocardial infarction), **orthostatic hypertension** (high blood pressure caused by standing erect), absence of sweating that can result in dry and cracked skin, and impotence or erectile dysfunction.

DENTAL HEALTH

Uncontrolled diabetes results in increased periodontal disease, as has been noted with type 2 diabetes (Campus and colleagues, 2005). With hyperglycemia, saliva production can be diminished due to dehydration. Because saliva neutralizes the acid formation in the mouth, severe periodontal disease can develop with uncontrolled diabetes. Type 1 diabetes also has been associated with dental infection and higher than usual inflammation of the gums resulting from buildup of dental plaque (Salvi and colleagues, 2005).

The impact can also be in the other direction. Unrecognized periodontal disease in pregnancy can contribute to poor glycemic control (Diaz-Romero and colleagues, 2005). Treatment of periodontal disease has been shown to significantly improve Hgb A_{1c} levels in individuals with type 2 diabetes (Kiran and colleagues, 2005). Therefore

health care professionals working in the field of diabetes need to promote routine dental care in order to achieve optimal control of glucose levels.

Dentists also can play a role in identifying individuals with undiagnosed diabetes. Persons with a self-reported family history of diabetes, hypertension, high cholesterol levels, and clinical evidence of periodontal disease bear a probability of 27% to 53% of having undiagnosed diabetes, with Mexican American men exhibiting the highest probability and white women the lowest (Borrell and colleagues, 2007).

TIMES OF ILLNESS

The need for insulin increases when a person is acutely ill, even if there is a diminished intake of food. To prevent excess production of ketones, the person with type 1 diabetes must maintain adequate insulin injections and carbohydrate intake (a minimum of 15 g of carbohydrate per hour or 30 to 50 g of carbohydrates every 3 to 4 hours) and contact a health care provider immediately when ketonuria occurs or when dehydration is a concern because of diarrhea and vomiting.

The quality of the diet is less important than the quantity of carbohydrate consumed during severe illness; therefore, the intake of simple sugars such as those found in regular ginger ale may be recommended. Sipping juice or soft drinks throughout the day may be helpful when the intake of food is greatly diminished, as during an illness. To prevent the loss of needed electrolytes, which can result from vomiting and diarrhea, a source of potassium, such as orange juice, is needed, as is a source of sodium, such as soup. Sports drinks or other commercial drinks containing electrolytes also may be consumed to provide sodium and potassium. Adequate intake of fluid sources without carbohydrates to manage hyperglycemia is imperative because dehydration compounds the undesirable effect of hyperglycemia and ketonuria.

WHAT COUNSELING STRATEGIES CAN NURSES AND OTHER HEALTH CARE PROFESSIONALS USE IN DIABETES MANAGEMENT?

The nurse or other health care professional needs to determine real needs versus perceived needs of persons who have already learned to live with diabetes. People sometimes believe their diabetes is under control because they feel healthy. Others may be in denial, feeling unable to cope with the demands of having diabetes. Positive verbal reinforcement for any attempt at control is always useful. Beyond that, the nurse can help individuals to identify their perceived needs in relation to diabetes management, can make referrals as appropriate (for example, to the physician, dietitian, or diabetes support group), and can advocate gradual changes (small steps) in the control of diabetes. Simply being empathetic about the frustrations and challenges that are likely to be encountered by the individual with diabetes is an important role of the health care professional.

Another area to assess is the person's knowledge of the physiology of diabetes mellitus—such knowledge is necessary for effective decision making in diabetes management. Does the individual have a basic understanding of what makes BG levels increase or decrease? (See the following list.) Does the individual have the skills to determine what course of action is most appropriate for the various situations likely to be encountered, such as for differing food intake or physical activity

levels? Does he or she have the ability to follow through by making adjustments in diet, insulin administration, or activity? Is the person able to accept the reality of having diabetes mellitus and to take responsibility for its control? How does the person's environment (social, economic, and so on) reinforce or inhibit diabetes management? By identifying areas of strength for positive reinforcement and areas of need for referral or personal assistance, the nurse or other health care professional can have an integral and valuable role in facilitating the potential for full and productive lives in individuals with diabetes mellitus.

FACTORS LOWERING BLOOD GLUCOSE LEVELS

- Weight loss or reduced intake of food
- Exercise*
- Insulin and oral hypoglycemic agents

FACTORS RAISING BLOOD GLUCOSE LEVELS

- Weight gain or increased food intake
- Excess carbohydrate intake
- Mental or physical stress
- Steroids, β-blockers, some diuretics
- Infections and illness
- Dawn phenomenon

*If there is insufficient insulin in the body, exercise will raise blood glucose levels. If BG levels are consistently elevated above 240 mg/dL or in cases of ketonuria, exercise should be postponed until diabetes is better controlled.

Chapter Challenge Questions and Classroom Activities

1. Bring some convenience food labels into class. How can they be calculated into a diet for diabetes management?
2. Self-monitor your BG levels using Chemstrips (strips that are visually read without using a BG meter) for at least 1 day, before meals and 2 hours postprandially. Maintain a record of your eating habits, including amounts eaten and times of meals and time and duration of activities. Based on this experience, discuss in class how you feel about advocating SMBG for all individuals with diabetes.
3. Determine what changes, if any, you would have to make if you were diagnosed as having diabetes. Could you consistently follow a low-fat, low-sugar meal plan? How would you feel if you had to reduce the amount of sweets and greasy foods in your diet?
4. Describe why a person with hyperglycemia is at increased risk for heart disease and kidney disease.
5. Become a member of the American Diabetes Association (for about $28 per year) and receive its monthly publication, *Diabetes Forecast.* Each issue contains a feature story about a person with diabetes with other informative articles.
6. If a person with type 1 diabetes takes NPH insulin at 7:00 AM, at what time will the insulin peak? If this person begins to feel shaky at 3:00 PM, what should he or she do?
7. Knowing that milk contains about 15 g of carbohydrates per cup and that the form of carbohydrate in milk is lactose, calculate how many teaspoons of sugar equivalent it contains.
8. Determine whether a person with the following statistics is likely to experience hypoglycemia:

Insulin-to-carbohydrate ratio: 1:15 (1 unit of insulin to 15 g of carbohydrate)
Total units of insulin daily (Hint: 1800 rule): 45 units
Premeal BG level: 175 mg/dL
Meal insulin dose: 10 units regular insulin
Meal carbohydrate consumed: 60 g (Hint: Insulin-to-carbohydrate ratio)

9. Role-play in class a person who refuses to take control of diabetes and who has Hgb A_{1c} of 10% (average BG level of 240 mg/dL). One student should role-play the nurse or other health care professional; the second student can role-play the person with diabetes. Discuss as a class the nurse's communication style and approach. Was it effective? How else might the situation be handled?
10. Have students identify their risk of developing diabetes at the American Diabetes Association website: www.diabetes.org.

Case Study

Kevin and Nick were playing. Kevin had spent the night at his cousin's house. His Aunt Andrea was pregnant, and he watched her as she pricked her finger and put a drop of blood on a stick and into a machine. He wasn't sure why she did that, but then she asked if they would like to have pancakes for breakfast because her glucose level was okay. He and Nick ran to get the syrup from the refrigerator, and Nick told him it was a special kind for his mother that was low in sugar. Kevin was getting used to this because his older sister did some of the same things.

Critical Thinking Applications

1. What form of diabetes occurs during pregnancy?
2. If Andrea's blood glucose level is higher fasting than before other meals, what may be causing this?
3. How many pancakes can be included for a breakfast with 30 g of carbohydrate—see Appendix 3 on the Evolve website, and describe the size.
4. How might testing BG level after eating pancakes be beneficial for Andrea and the baby?
5. If Andrea requires insulin later in her pregnancy, and her FBG level is 80 mg/dL and 4 hours later it is 95 after having a breakfast of one slice whole grain toast, one egg, and 1 cup milk after taking 6 units of short-acting insulin, what is her likely insulin-to-carbohydrate ratio? If she has a lunch of a sandwich, one orange, and one glass of milk, how much short-acting insulin is she likely going to need? If she takes 20 units of short-acting insulin for her lunch, and her BG later goes up to 180 mg/dL, what are some potential causes?
6. If Andrea develops signs and symptoms of hypoglycemia, what should she be advised to do?

REFERENCES

Aguilera E, Casamitjana R, Ercilla G, Oriola J, Gomis R, Conget I: Adult-onset atypical (type 1) diabetes: additional insights and differences with type 1A diabetes in a European Mediterranean population, *Diabetes Care* 27(5): 1108-1114, 2004.

Ahmad J, Ahmned F, Siddiqui MA, Khan AR, Katyal P, Hameed B, Ahmad I: Inflammatory markers, insulin resistance and carotid intima-media thickness in North-Indian type 2 diabetic subjects, *J Assoc Physicians India* 55:693-699, 2007.

Anderson RA: Chromium and polyphenols from cinnamon improve insulin sensitivity, *Proc Nutr Soc* 67(1):48-53, 2008.

Antonopoulou S, Fragopoulou E, Karantonis HC, Mitsou E, Sitara M, Rementzis J, Mourelatos A, Ginis A, Phenekos C: Effect of traditional Greek Mediterranean meals on platelet aggregation in normal subjects and in patients

with type 2 diabetes mellitus, *J Med Food* 9(3):356-362, 2006.

Barbagallo M, Dominguez LJ: Magnesium metabolism in type 2 diabetes mellitus, metabolic syndrome and insulin resistance, *Arch Biochem Biophys* 458(1):40-47, 2007.

Bell DS, Ovalle F: The role of C-peptide levels in screening for latent autoimmune diabetes in adults, *Am J Ther* 11(4):308-311, 2004.

Bo S, Lezo A, Menato G, Gallo ML, Bardelli C, Signorile A, Berutti C, Massobrio M, Pagano GF: Gestational hyperglycemia, zinc, selenium, and antioxidant vitamins, *Nutrition* 21(2):186-191, 2005.

Borrell LN, Kunzel C, Lamster I, Lalla E: Diabetes in the dental office: using NHANES III to estimate the probability of undiagnosed disease, *J Periodontal Res* 42(6):559-565, 2007.

Campus G, Salem A, Uzzau S, Baldoni E, Tonolo G: Diabetes and periodontal disease: a case-control study, *J Periodontol* 76(3):418-425, 2005.

Ceriello A, Davidson J, Hanefeld M, Leiter L, Monnier L, Owens D, Tajima N, Tuomilehto J; International Prandial Glucose Regulation Study Group: Postprandial hyperglycaemia and cardiovascular complications of diabetes: an update, *Nutr Metab Cardiovasc Dis* 16(7):453-456, 2006.

Clark CA, Gardiner J, McBurney MI, Anderson S, Weatherspoon LJ, Henry DN, Hord NG: Effects of breakfast meal composition on second meal metabolic responses in adults with type 2 diabetes mellitus, *Eur J Clin Nutr* 60(9):1122-1129, 2006.

Cleary PA, Orchard TJ, Genuth S, Wong ND, Detrano R, Backlund JY, Zinman B, Jacobson A, Sun W, Lachin JM, Nathan DM; DCCT/EDIC Research Group: The effect of intensive glycemic treatment on coronary artery calcification in type 1 diabetic participants of the Diabetes Control and Complications Trial/Epidemiology of Diabetes Interventions and Complications (DCCT/EDIC) Study, *Diabetes* 55(12):3556-3565, 2006.

Diaz-Romero RM, Casanova-Roman G, Beltran-Zuniga M, Belmont-Padilla J, Mendez JD, Avila-Rosas H: Oral infections and glycemic control in pregnant type 2 diabetics, *Arch Med Res* 36(1):42-48, 2005.

Du Y, Melchert HU, Knopf H, Braemer-Hauth M, Pabel E: Association of serum caffeine concentrations with serum glucose levels in caffeine-drug users and non-users—results of German National Health Surveys, *Diabetes Obes Metab* 9(5):756-758, 2007.

Due A, Larsen TM, Hermansen K, Stender S, Holst JJ, Toubro S, Martinussen T, Astrup A: Comparison of the effects on insulin resistance and glucose tolerance of 6-mo high-monounsaturated-fat, low-fat, and control diets, *Am J Clin Nutr* 87(4):855-862, 2008.

Ebbesson SO, Ebbesson LO, Swenson M, Kennish JM, Robbins DC: A successful diabetes prevention study in Eskimos: the Alaska Siberia project, *Int J Circumpolar Health* 64(4):409-424, 2005.

Galgani J, Aguirre C, Díaz E: Acute effect of meal glycemic index and glycemic load on blood glucose and insulin responses in humans, *Nutr J* 5:22, 2006.

Gougeon R, Morais JA, Chevalier S, Pereira S, Lamarche M, Marliss EB: Determinants of whole-body protein metabolism in subjects with and without type 2 diabetes, *Diabetes Care* 31(1):128-133, 2008.

Gross LS, Li L, Ford ES, Liu S: Increased consumption of refined carbohydrates and the epidemic of type 2 diabetes in the United States: an ecologic assessment, *Am J Clin Nutr* 79(5):774-779, 2004.

He J, Kelley DE: Muscle glycogen content in type 2 diabetes mellitus, *Am J Physiol Endocrinol Metab* 287(5):E1002-E1007, 2004.

Hernández-Fonseca K, Cárdenas-Rodríguez N, Pedraza-Chaverri J, Massieu L: Calcium-dependent production of reactive oxygen species is involved in neuronal damage induced during glycolysis inhibition in cultured hippocampal neurons, *J Neurosci Res* 86(8):1768-1780, 2008.

Higgins GT, Khan J, Pearce IA: Glycaemic control and control of risk factors in diabetes patients in an ophthalmology clinic: what lessons have we learned from the UKPDS and DCCT studies? *Acta Ophthalmol Scand* 85(7):772-776, 2007.

Jacobs MJ, Kleisli T, Pio JR, Malik S, L'italien GJ, Chen RS, Wong ND: Prevalence and control of dyslipidemia among persons with diabetes in the United States, *Diabetes Res Clin Pract* 70(3):263-269, 2005.

Jimeno Mollet J, Molist Brunet N, Franch Nadal J, Morato Griera J, Otzet Gramunt I, Pons Barro P: Diagnosing type 2 diabetes mellitus: in primary care: fasting plasma glucose and glycosylated haemoglobin do the job, *Aten Primaria* 34(5):222-228, 2004.

Jones SM, Quarry JL, Caldwell-McMillan M, Mauger DT, Gabbay RA: Optimal insulin pump dosing and postprandial glycemia following a pizza meal using the continuous glucose monitoring system, *Diabetes Technol Ther* 7(2):233-240, 2005.

Kawasaki E, Eguchi K: Is type 1 diabetes in the Japanese population the same as among Caucasians? *Ann N Y Acad Sci* 1037:96-103, 2004.

Khan A, Safdar M, Ali Khan MM, Khattak KN, Anderson RA: Cinnamon improves glucose and lipids of people with type 2 diabetes, *Diabetes Care* 26(12):3215-3218, 2003.

Kilpatrick ES, Rigby AS, Atkin SL: Insulin resistance, the metabolic syndrome, and complication risk in type 1 diabetes: "double diabetes" in the Diabetes Control and Complications Trial, *Diabetes Care* 30(3):707-712, 2007.

Kiran M, Arpak N, Unsal E, Erdogan MF: The effect of improved periodontal health on metabolic control in type 2 diabetes mellitus, *J Clin Periodontol* 32(3):266-272, 2005.

Kissela BM, Khoury J, Kleindorfer D, Woo D, Schneider A, Alwell K, Miller R, Ewing I, Moomaw CJ, Szaflarski JP, Gebel J, Shukla R, Broderick JP: Epidemiology of ischemic stroke in patients with diabetes: the greater Cincinnati/Northern Kentucky Stroke Study, *Diabetes Care* 28(2):355-359, 2005.

Leiter LA, Ceriello A, Davidson JA, Hanefeld M, Monnier L, Owens DR, Tajima N, Tuomilehto J; International Prandial Glucose Regulation Study Group: Postprandial glucose regulation: new data and new implications, *Clin Ther* 27(Suppl B):S42-S56, 2005.

Lin PY, Nhung BT, Khan NC, Sarukura N, Kunii D, Sakai T, Kassus A, Yamamoto S: Effect of Vietnamese common diet on postprandial blood glucose level in adult females, *J Nutr Sci Vitaminol (Tokyo)* 53(3):247-252, 2007.

Lindholm E, Hallengren B, Agardh CD: Gender differences in GAD antibody–positive diabetes mellitus in relation to age at onset, C-peptide and other endocrine autoimmune diseases, *Diabetes Metab Res Rev* 20(2):158-164, 2004.

Lu Y, Levin GV, Donner TW: Tagatose, a new antidiabetic and obesity control drug, *Diabetes Obes Metab* 10(2):109-134, 2008.

Martin CL, Albers J, Herman WH, Cleary P, Waberski B, Greene DA, Stevens MJ, Feldman EL; DCCT/EDIC Research Group: Neuropathy among the diabetes control and complications trial cohort 8 years after trial completion, *Diabetes Care* 29(2):340-344, 2006.

Martin S, Schneider B, Heinemann L, Lodwig V, Kurth HJ, Kolb H, Scherbaum WA: Self-monitoring of blood glucose in type 2 diabetes and long-term outcome: an epidemiological cohort study, *Diabetologia* 49(2):271-278, 2006.

Martinez Candela J, Gallardo Martin A, Franch Nadal J, Romero Ortiz J, Canovas Dominguez C, Gomez Marco R: Analysis of disturbances in carbohydrate metabolism in the adult population of Yecla (Murcia, Spain), *Aten Primaria* 34(7):345-352, 2004.

Nagai T, Imamura M, Mori M: Seroconversion of glutamic acid decarboxylase antibodies in a patient initially diagnosed as having type 2 diabetes mellitus, *Intern Med* 44(4):299-302, 2005.

Nilsson A, Ostman E, Preston T, Björck I: Effects of GI vs content of cereal fibre of the evening meal on glucose tolerance at a subsequent standardized breakfast, *Eur J Clin Nutr* 62(6):712-720, 2008.

Nizami F, Farooqui MS, Munir SM, Rizvi TJ: Effect of fiber bread on the management of diabetes mellitus, *J Coll Physicians Surg Pak* 14(11):673-676, 2004.

Nordwall M, Hyllienmark L, Ludvigsson J: Early diabetic complications in a population of young patients with type 1 diabetes mellitus despite intensive treatment, *J Pediatr Endocrinol Metab* 19(1):45-54, 2006.

Nóvoa Medina Y, López-Capapé M, Lara Orejas E, Alonso Blanco M, Camarero Salces C, Barrio Castellanos R: Impact of diagnosis of celiac disease on metabolic control of type 1 diabetes, *An Pediatr (Barc)* 68(1):13-17, 2008.

Okoro EO, Funsho SO, Oyedokun OA, Oyejola BA: Effects of dietary sucrose intake on glycaemic control in Nigerians with type 2 diabetes, *Int J Clin Pract* 61(6):916-919, 2007.

Opperman AM, Venter CS, Oosthuizen W, Thompson RL, Vorster HH: Meta-analysis of the health effects of using the glycaemic index in meal-planning, *Br J Nutr* 92(3):367-381, 2004.

Palomer X, González-Clemente JM, Blanco-Vaca F, Mauricio D: Role of vitamin D in the pathogenesis of type 2 diabetes mellitus, *Diabetes Obes Metab* 10(3):185-197, 2008.

Panagiotakos DB, Tzima N, Pitsavos C, Chrysohoou C, Zampelas A, Toussoulis D, Stefanadis C: The association between adherence to the Mediterranean diet and fasting indices of glucose homoeostasis: the ATTICA Study, *J Am Coll Nutr* 26(1):32-38, 2007.

Patton SR, Dolan LM, Powers SW: Mealtime interactions relate to dietary adherence and glycemic control in young children with type 1 diabetes, *Diabetes Care* 29(5):1002-1006, 2006a.

Patton SR, Dolan LM, Powers SW: Parent report of mealtime behaviors in young children with type 1 diabetes mellitus: implications for better assessment of dietary adherence problems in the clinic, *J Dev Behav Pediatr* 27(3):202-208, 2006b.

Patton SR, Dolan LM, Powers SW: Dietary adherence and associated glycemic control in families of young children with type 1 diabetes, *J Am Diet Assoc* 107(1):46-52, 2007.

Petitti DB, Imperatore G, Palla SL, Daniels SR, Dolan LM, Kershnar AK, Marcovina S, Pettitt DJ, Pihoker C; SEARCH for Diabetes in Youth Study Group: Serum lipids and glucose control: the SEARCH for Diabetes in Youth study, *Arch Pediatr Adolesc Med* 161(2):159-165, 2007.

Pfutzner A, Kerner W: Pitfalls in the diagnosis and treatment optimization of type 2 diabetes, *MMW Fortschr Med* 147(12):47-50, 2005.

Pilotto L, Gaggioli A, Lo Noce C, Dima F, Palmieri L, Uguccioni M, Pede S, Giampaoli S, Vanuzzo D: Diabetes in Italy: a public health problem, *Ital Heart J Suppl* 5(6):480-486, 2004.

Polzer R, Miles MS: Spirituality and self-management of diabetes in African Americans, *J Holist Nurs* 23(2):230-250, 2005.

Reach G, Zerrouki A, Leclercq D, d'Ivernois JF: Adjusting insulin doses: from knowledge to decision, *Patient Educ Couns* 56(1):98-103, 2005.

Robbins JM, Webb DA, Sciamanna CN: Cardiovascular comorbidities among public health clinic patients with diabetes: the Urban Diabetics Study, *BMC Public Health* 5(1):15, 2005.

Rosenstock J, Dailey G, Massi-Benedetti M, Fritsche A, Lin Z, Salzman A: Reduced hypoglycemia risk with insulin glargine: a meta-analysis comparing insulin glargine with human NPH insulin in type 2 diabetes, *Diabetes Care* 28(4):950-955, 2005.

Roumen C, Corpeleijn E, Feskens EJ, Mensink M, Saris WH, Blaak EE: Impact of 3-year lifestyle intervention on postprandial glucose metabolism: the SLIM study, *Diabet Med* 25(5):597-605, 2008.

Salminen KK, Vuorinen T, Oikarinen S, Helminen M, Simell S, Knip M, Ilonen J, Simell O, Hyoty H: Isolation of enterovirus strains from children with preclinical type 1 diabetes, *Diabet Med* 21(2):156-164, 2004.

Salvi GE, Kandylaki M, Troendle A, Persson GR, Lang NP: Experimental gingivitis in type 1 diabetics: a controlled clinical and microbiological study, *J Clin Periodontol* 32(3):310-316, 2005.

Sargeant LA, Boyne MS, Bennett FI, Forrester TE, Cooper RS, Wilks RJ: Impaired glucose regulation in adults in Jamaica: who should have the oral glucose tolerance test? *Rev Panam Salud Publica* 16(1):35-42, 2004.

Saydah S, Cowie C, Eberhardt MS, De Rekeneire N, Narayan KM: Race and ethnic differences in glycemic control among adults with diagnosed diabetes in the United States, *Ethn Dis* 17(3):529-535, 2007.

Schulze MB, Boeing H, Häring HU, Fritsche A, Joost HG: Validation of the German Diabetes Risk Score with metabolic risk factors for type 2 diabetes, *Dtsch Med Wochenschr* 133(17):878-883, 2008.

Schütt M, Kern W, Krause U, Busch P, Dapp A, Grziwotz R, Mayer I, Rosenbauer J, Wagner C, Zimmermann A, Kerner W, Holl RW: Is the frequency of self-monitoring of blood glucose related to long-term metabolic control? Multicenter analysis including 24,500 patients from 191 centers in Germany and Austria, *Exp Clin Endocrinol Diabetes* 114(7):384-388, 2006.

Shaat N, Ekelund M, Lernmark A, Ivarsson S, Nilsson A, Perfekt R, Berntorp K, Groop L: Genotypic and phenotypic differences between Arabian and Scandinavian women with gestational diabetes mellitus, *Diabetologia* 47(5):878-884, 2004.

Singer GM, Geohas J: The effect of chromium picolinate and biotin supplementation on glycemic control in poorly controlled patients with type 2 diabetes mellitus: a placebo-controlled, double-blinded, randomized trial, *Diabetes Technol Ther* 8(6):636-643, 2006.

Spadaccino AC, Basso D, Chiarelli S, Albergoni MP, D'Odorico A, Plebani M, Pedini B, Lazzarotto F, Betterle C: Celiac disease in North Italian patients with autoimmune thyroid diseases, *Autoimmunity* 41(1):116-121, 2008.

Streja D: Can continuous glucose monitoring provide objective documentation of hypoglycemia unawareness? *Endocr Pract* 11(2):83-90, 2005.

Suehiro T, Osaki F, Ikeda Y, Arii K, Nakayama F, Ota K, Hashimoto K: Type 1 diabetes developed in a type 2 diabetic patient with severe insulin resistance, *Diabetes Res Clin Pract* 70(3):298-302, 2005.

Thorand B, Baumert J, Kolb H, Meisinger C, Chambless L, Koenig W, Herder C: Sex differences in the prediction of type 2 diabetes by inflammatory markers: results from the MONICA/KORA Augsburg case-cohort study, 1984–2002, *Diabetes Care* 30(4):854-860, 2007.

Thornalley PJ, Babaei-Jadidi R, Al Ali H, Rabbani N, Antonysunil A, Larkin J, Ahmed A, Rayman G, Bodmer CW: High prevalence of low plasma thiamine concentration in diabetes linked to a marker of vascular disease, *Diabetologia* 50(10):2164-2170, 2007.

Tseng CH: The potential biological mechanisms of arsenic-induced diabetes mellitus, *Toxicol Appl Pharmacol* 197(2):67-83, 2004.

Tseng CH: Prevalence of lower-extremity amputation among patients with diabetes mellitus: is height a factor? *CMAJ* 174(3):319-323, 2006.

Ulrich H, Snyder B, Garg SK: Combining insulins for optimal blood glucose control in type I and 2 diabetes: focus on insulin glulisine, *Vasc Health Risk Manag* 3(3):245-254, 2007.

Verbeke S, Cruchet S, Gotteland M, Rios G, Hunter B, Chavez E, Brunser O, Araya M: Risk markers for insulin-dependent diabetes mellitus and duration of exposure to gluten in celiac patients, *Rev Med Chil* 132(8):979-984, 2004.

Villegas R, Liu S, Gao YT, Yang G, Li H, Zheng W, Shu XO: Prospective study of dietary carbohydrates, glycemic index, glycemic load, and incidence of type 2 diabetes mellitus in middle-aged Chinese women, *Arch Intern Med* 167(21):2310-2316, 2007.

Vinik AI: Advances in diabetes for the millennium: new treatments for diabetic neuropathies, *MedGenMed* 6(2):13, 2004.

Wadwa RP, Kinney GL, Maahs DM, Snell-Bergeon J, Hokanson JE, Garg SK, Eckel RH, Rewers M: Awareness and treatment of dyslipidemia in young adults with type 1 diabetes, *Diabetes Care* 28(5):1051-1056, 2005.

Wells IC: Evidence that the etiology of the syndrome containing type 2 diabetes mellitus results from abnormal magnesium metabolism, *Can J Physiol Pharmacol* 86(1-2):16-24, 2008.

Whitaker JA, Davis KL, Lauer C: Is there a need for screening for type 2 diabetes in seventh graders? *J Am Acad Nurse Pract* 16(11):496-501, 2004.

Woerle HJ, Neumann C, Zschau S, Tenner S, Irsigler A, Schirra J, Gerich JE, Göke B: Impact of fasting and postprandial glycemia on overall glycemic control in type 2 diabetes: importance of postprandial glycemia to achieve target HbA1c levels, *Diabetes Res Clin Pract* 77(2):280-285, 2007.

Wycherley TP, Brinkworth GD, Noakes M, Buckley JD, Clifton PM: Effect of caloric restriction with and without exercise training on oxidative stress and endothelial function in obese subjects with type 2 diabetes, *Diabetes Obes Metab* 10(11):1062-1073, 2008.

Yamaguchi T, Sugimoto T: Calcium homeostasis and diabetes mellitus, *Clin Calcium* 16(8):1270-1275, 2006.

Zinman B, Kahn SE, Haffner SM, O'Neill MC, Heise MA, Freed MI; ADOPT Study Group: Phenotypic characteristics of GAD antibody–positive recently diagnosed patients with type 2 diabetes in North America and Europe, *Diabetes* 53(12):3193-3200, 2004.

chapter 9

Renal Disease

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Chapter Topics

Functions of the Kidneys
Diagnostic Parameters of Renal Disease
Screening and Prevention of Complications of Renal Disease
Types and Physiology of Renal Disorders
Medical Nutrition Therapy for Renal Disorders
Role of Exercise in Preventing and Managing Renal Disease
Dialysis Methods and Complications
Nutritional Renal Transplant Issues
Special Considerations for Treatment of Children With Renal Disease
Causes and Nutritional Management of Kidney Stones
Relationship of Dietary Guidelines to Renal Disease
The Role of Health Care Professionals in the Management of Renal Disease

Objectives

After completing this chapter, you should be able to:

- Describe the basic functions of the kidneys.
- Identify the clinical symptoms and serum parameters of renal disease.
- Identify risk factors for the development of renal disease.
- Discuss the principles of nutritional management, including the control of disease and promotion of good nutritional status.
- Discuss the role of the nurse and other health care professionals in the management of renal disease.

Terms to Identify

Acid-base balance
Albuminuria
Anasarca
Anemia of chronic disease (ACD)
Anuria
Azotemia
Blood urea nitrogen (BUN)
Carnitine
Chronic kidney disease (CKD)
CKD-mineral and bone disorder (CKD-MBD)
Continuous ambulatory peritoneal dialysis (CAPD)
Creatinine
Diabetic nephropathy
Dry weight
End-stage renal disease (ESRD)
Erythropoietin (EPO)
Glomerular filtration rate (GFR)
Glomeruli
Glomerulonephritis
Glomerulosclerosis
Hematuria
Hemodialysis
Hypercalciuria
Hyperkalemia

Interdialytic weight gain
Macroalbuminuria
Nephritic syndrome
Nephrologist
Nephrons
Nephrosclerosis
Nephrotic syndrome
Oliguria
Osteomalacia
Osteoporosis
Positive nitrogen balance
Proteinuria
Renal insufficiency
Renal osteodystrophy
Rhabdomyolysis
Thrombocytopenia
Uremia

INTRODUCTION

The prevalence of renal (kidney) disease is increasing worldwide, especially in developed countries. In the United States chronic kidney disease (CKD—see later section) has increased in prevalence from just 10 years ago. This is attributed to the increasing incidence of diabetes and hypertension (Coresh and colleagues, 2007). Measures to prevent or reduce obesity in order to reduce the incidence of diabetes and hypertension are critical to the prevention of renal disease (see Chapter 6).

Managing renal disease is like a juggling act. Usually not just one, but several nutritional components need to be controlled. Because of clearance problems, protein, phosphorus, sodium, and potassium need to be limited. If renal disease results from complications of diabetes, carbohydrate intake needs to be managed to control blood glucose levels. The other major source of kilocalories—fat intake—needs to be maintained at a level that allows for slow weight loss or weight stabilization without promoting hyperlipidemia. However, once a person with renal disease begins dialysis, the restrictions are often reversed to compensate for the excess losses resulting from dialysis.

Managing renal disease is complex and difficult for the individual with renal disease and the entire health care team. However, renal failure and the need for dialysis may be lessened or even prevented if the person is willing and able to control the diverse, interrelated dietary factors that allow for a normal nutritional balance. Nurses and other health care professionals need to use excellent communication skills to best identify individual needs for self-management of renal disease (see Chapter 1). Registered dietitians are now able to be providers recognized by Medicare (a health program for older adults or those with chronic illnesses) for predialysis renal disease and for diabetes mellitus.

WHAT ARE THE FUNCTIONS OF THE KIDNEYS?

Kidneys have three basic functions: helping to maintain proper metabolism and hormonal balance, reabsorbing important body constituents, and excreting waste material. The kidney is an extremely complex organ.

Selective reabsorption of nutrients as necessary is a basic function of the kidneys that serves an important role in maintaining the **acid-base balance** (pH level) and the balance of various body constituents. The kidneys help maintain appropriate

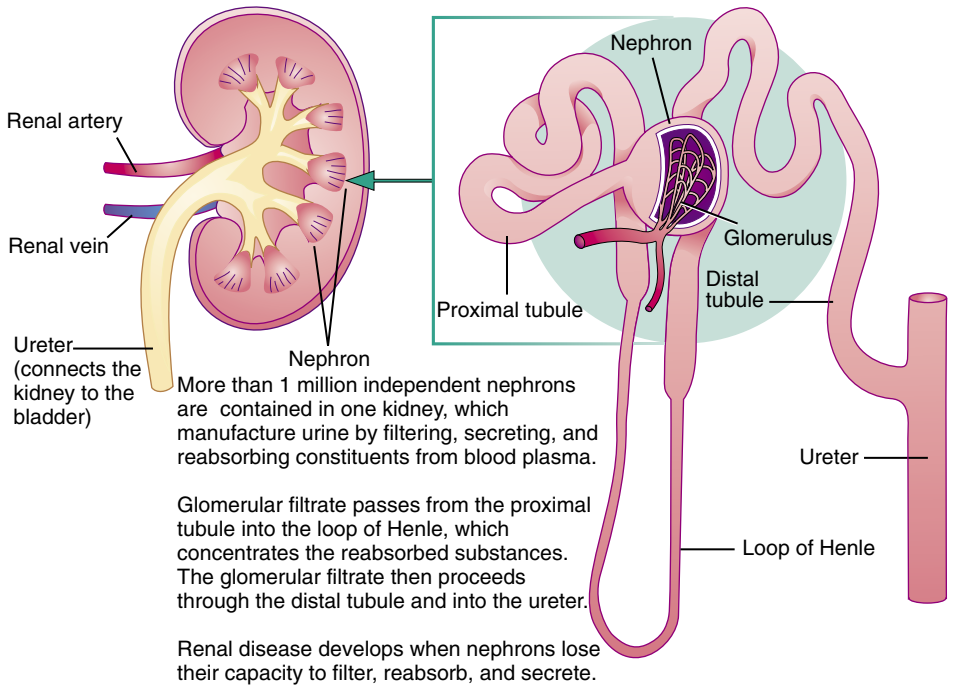


FIGURE 9-1 Anatomy of a kidney.

levels of water, electrolytes, nitrogen, fixed acids, bicarbonates, and other body constituents, in part, through the function of reabsorption of important nutrients.

The kidneys play a key role in the maintenance of metabolism and hormonal balance. The kidneys convert the inactive form of vitamin D from foods into the active form. They also produce the enzyme renin, which affects systemic blood pressure, and the hormone **erythropoietin (EPO),** which stimulates red blood cell production by the bone marrow. Figure 9-1 illustrates the composition of the kidneys.

The most widely known function of the kidneys is to filter body wastes, including urea, drugs, and toxins. This filtering process occurs in the **nephrons,** of which there are more than 1 million (see Figure 9-1). With renal disease, medications need to be adjusted to reflect diminished clearance through the kidneys. Persons on diabetes medications may develop hypoglycemia and need to lower the dose of insulin or oral hypoglycemic agents. Health care professionals should be alert to signs and symptoms of various medication toxicities found with reduced renal clearance.

Individuals with chronic kidney disease have a higher need for kcalories, but appetite can be low because of acidosis and for other reasons. Growth failure is common in children with kidney disease. Muscle mass tends to be replaced with adipose tissue because of loss of protein.

WHAT ARE DIAGNOSTIC PARAMETERS OF RENAL DISEASE?

The general criteria for diagnosing renal disease center on the functions of the normal kidney. Given that kidneys excrete excess nitrogen, protein, electrolytes, water, and

Box 9-1 Stages of Chronic Renal Disease and Medical Nutrition Therapy

STAGE 1 (GFR >90) AND STAGE 2 (GFR 60-89)* INCLUDES PROTEINURIA/NEPHRITIS
GOAL: Prevent Clinical Signs of Renal Disease
MNT to promote normal BP (optional <130/80 mm Hg) with DASH diet
MNT to promote normal lipids with TLC diet for metabolic syndrome
MNT to promote normalized BG level with A_{1c} <7% with carbohydrate counting
As needed, protein up to 1.5g/kgBW (for goal albumin >4 g/dL without raising creatinine)
Maintain healthy diet to meet DRI; supplement as needed

STAGE 3 (GFR 30-59* or CREATININE >2 mg/dL) RENAL INSUFFICIENCY
GOAL: Prevent Further Damage and Other Complications
Continue above strategies
MNT to maintain stable body weight with 25 to 35 kcal/kg BW
Moderate protein intake to 0.8-1.0 g/kg BW to reduce demands on kidneys
Restrict potassium if serum K^+ elevated (citrus/banana/potato/tomato/legumes/greens)
If anemia, undertake iron studies to rule out need for $FeSO_4$ (see Table 13-2)
Monitor need for vitamin D3 supplementation with serum 25(OH)D level (goal > 32 ng/mL)

STAGE 4 (GFR 15-29)* CHRONIC KIDNEY DISEASE (CKD)
GOAL: Delay Dialysis
Continue above strategies
Restrict protein further to 0.6-0.8 g/kg BW
Limit phosphorus intake (if PO_4 elevated) with low-protein diet and limit milk to 2 cups/day
Monitor for hypercalcemia; limit calcium to 1.5 to 2 g/day (including phosphate binders)
Avoid vitamin A based supplements due to risk of toxicity and etiology of hypercalcemia

STAGE 5 (GFR <15)* END-STAGE RENAL DISEASE (ESRD)/UREMIA
GOAL: Maintain Good Nutritional Status With Dialysis
Continue above strategies
Provide supplement of water-soluble vitamins and vitamin D_3 (renal preparation)
Increase protein intake as needed for goal albumin >4g/dL
Limit fluid intake to 500-1000 mL plus urine output as needed

BG, Blood glucose; *BP*, blood pressure; *BW*, body weight; *DASH*, Dietary Approaches to Stop Hypertension; *DRI*, Dietary Reference Intake; *GFR*, glomerular filtration rate; *MNT*, medical nutrition therapy; *TLC*, Therapeutic Lifestyle Changes.
*GFR (mL/min/1.73m^2)

other substances, tests for abnormal levels of these constituents provide an indication of whether renal disease is present and if so, how severe it is. Renal disease progresses along a continuum based on the rate kidneys filter (Box 9-1). Clinical manifestations of renal disease include **hematuria** (blood in the urine); **albuminuria** (albumin in the urine); **azotemia** (nitrogen in the blood); hypertension; edema; hypoalbuminemia (low level of serum albumin; caused by loss of protein in the urine with renal disease); hyperlipidemia; and **proteinuria** (protein in the urine). A lack of urinary excretion **(anuria)** and decreased urinary output (**oliguria—**reduced production of urine to less than 500 mL/24 hours) suggest either significant loss of nephron function or obstruction that can lead to irreversible renal damage.

Specific serum indicators routinely used for assessing the degree of renal failure and response to dietary control are the **blood urea nitrogen (BUN)** level and **creatinine** (a nitrogenous compound formed in muscle). An elevated BUN level typically occurs before an increased level of creatinine but can be altered based on hydration status. For this reason nephrologists use creatinine levels, in part, to assess renal function. Other serum values are used to assess renal function, including albumin, potassium, phosphorus, sodium, and calcium determinations. All laboratory values are susceptible to error in measurement and interpretation for a variety of reasons. It is because of this that a referral to a **nephrologist** (a physician specializing in kidney disease) is advised when kidney function reaches stage 4 or 5 (see Box 9-1).

One test used to determine renal functioning is the 24-hour urine collection test. A less-reliable version of the 24-hour urine test, but with similar assessment of renal functioning, is the spot urine protein-creatinine ratio. This allows the measurement of **glomerular filtration rate (GFR)** and gives an indication of how rapidly the kidneys are excreting wastes. A normal GFR is 125 mL/min. A GFR less than 60 mL/min is equated with renal insufficiency, also called **chronic kidney disease (CKD;** stage 3), and testing for common complications of renal disease is advised. A GFR less than 10 to 15 mL/min (stage 5) is associated with uremia and may involve dialysis treatment (see later section). Stages of kidney disease are based on GFR. The five stages are shown in Box 9-1.

Uremia is found with elevated BUN and high creatinine levels. Normal creatinine concentration is less than 1.5 mg/dL, and a value over 5 mg/dL generally indicates dialysis is warranted.

HOW IS RENAL DISEASE SCREENED AND ITS COMPLICATIONS PREVENTED?

The primary goal in managing kidney disease is aimed at preventing complications. The best course of action is to diagnose the condition as early as possible. The Kidney Early Evaluation Program (KEEP), sponsored by the National Kidney Foundation (NKF), is a free screening program that targets people who are at high risk of developing kidney disease. This includes persons who have diabetes and hypertension or the parents, grandparents, or siblings of those with diabetes, hypertension, or CKD.

Concerning screening and early diagnosis of CKD, serum creatinine level alone is an inadequate parameter for the evaluation of renal function. Proteinuria is both an indicator of renal damage as well as a progression factor for ongoing loss of renal function. Reduction of proteinuria toward levels less than 0.5 g/day is optimal to help prevent decline in renal function and help prevent cardiovascular disease (Brandenburg and Floege, 2006).

Early stages of CKD can be found with increased rates of kidney filtering, known as a high creatinine clearance rate or high GFR. It is at this point that angiotensin-converting enzyme (ACE) inhibitors are advised. This form of blood pressure medication is known to preserve renal function and may be used for this purpose rather than simply for management of hypertension.

Predictors of the final point of renal function, called **end-stage renal disease (ESRD)**, include proteinuria as well as reduced GFR less than 10 to 15 mL/min. Other factors associated with ESRD include age, and other risk factors found with CKD include cigarette smoking, hypertension, low high-density–lipoprotein cholesterol (HDL-C) level, and elevated fasting glucose level (Ishani and colleagues, 2006).

Ten areas have been identified as important for optimal care of the persons with CKD:

- Hypertension (see Chapter 7 for Dietary Approaches to Stop Hypertension [DASH] diet)
- Anemia
- Glucose control
- Lipid control (see Chapter 7)
- Smoking cessation
- Aspirin prophylaxis
- Use of a β-blocker following myocardial infarction
- Use of ACE inhibitors or angiotensin II receptor blockers
- Diet and weight control (see Chapter 6)
- Exercise (Manley, 2007)

Kidney disease may be the cause or a consequence of hypertension. Persons with type 1 diabetes generally develop hypertension as a consequence of renal disease. The opposite is true with the metabolic syndrome with many associated conditions found with it linked with risk of renal disease.

Hypertension affects one out of four adults in the United States and is part of the metabolic syndrome. Elevated blood pressure is the most significant risk factor for developing CKD. A population at high risk for hypertension and renal disease with proteinuria is African Americans (Lea and colleagues, 2008)

Tight blood pressure (less than or equal to 125/75) control has been shown to reduce protein loss in the urine and to delay progression of renal disease (Barri, 2008). In males, albuminuria (another form of protein loss in the urine) was found to be a strong independent predictor for renal function decline (Halbesma and colleagues, 2008). In nondiabetic kidney disease, lower blood pressure slows the decline in GFR (Sarnak and colleagues, 2005). Other factors with risk of CKD include factors found with the metabolic syndrome:

- Obesity
- Insulin resistance
- Dyslipidemia with elevated triglycerides
- Endothelial dysfunction and
- Sleep disorders (Chalmers, Kaskel, and Bamgbola, 2006)

Inflammation is now recognized as being involved in the metabolic syndrome. Reduction of inflammation is important to help prevent or manage renal disease. An elevated serum C-reactive protein (CRP) level is strongly associated with morbidity and mortality with CKD in both predialysis and dialysis patients. Elevated levels of CRP are associated with other indicators of inflammation and with reduced GFR (Razeghi and colleagues, 2008).

Managing blood glucose and lipid levels also is critical in preventing or preserving renal function. Because obesity is linked with hypertension, hyperlipidemia, inflammation, and diabetes, it plays a critical role in the development of renal disease. The Therapeutic Lifestyle Changes (TLC) diet of the American Heart Association is recommended to manage the metabolic syndrome and is an appropriate strategy to promote weight management and reduce the risk of renal disease. Physical activity can help prevent obesity and manage associated conditions such as diabetes.

WHAT ARE SOME TYPES AND PHYSIOLOGY OF RENAL DISORDERS?

There are many diverse diseases related to kidney function. In a broad sense they can be divided into the following issues:

1. Inflammation or **glomerulonephritis**
2. Loss of protein caused by damage to the glomerular barrier, which leads to the nephrotic syndrome
3. Damage or scarring to the nephrons, or **glomerulosclerosis**, which includes diabetic nephropathy as described later

GLOMERULONEPHRITIS

In general, the condition of glomerulonephritis, or nephritis, can be temporary or chronic. It is a result of inflammation or damage to the **glomeruli** (each glomerulus serves as a tiny filter contained within each nephron; see Figure 9-1). The **nephritic syndrome** commonly follows a streptococcal infection and usually lasts for only a short time, allowing for complete recovery. Symptoms can include hematuria caused by inflammation of the nephrons, mild loss of kidney function, and salt-sensitive hypertension induced by proteinuria and nephritis. Nephritis can develop into the chronic nephrotic syndrome or ESRD.

There are a variety of causes of the damage other than infections, such as autoimmune disorders like lupus. There have been case reports of renal dysfunction, including acute interstitial nephritis, associated with use of creatine supplements by athletes (Thorsteinsdottir, Grande, and Garovic, 2006). Warning signs of damage caused by chronic nephritis include hypertension, edema, changes in urine color, nausea and vomiting, and headaches. Diagnosis is often confirmed with a biopsy of kidney tissue.

NEPHROTIC SYNDROME

Nephrotic syndrome is a set of symptoms including proteinuria, edema, and hyperlipidemia. Protein excretion is considered normal up to 150 mg (0.15 g) daily. The nephrotic syndrome is associated with loss of several grams of protein daily, resulting in impaired nutritional status. Greater excretion values are found with renal insufficiency, as well as with diabetes, hypertension, and other causes such as pregnancy. Reduced levels of branched-chain amino acids (see Chapter 2) are recognized to occur with CKD. This is, in part, related to renal changes in amino acid metabolism.

The nephrotic syndrome is caused by increased permeability of the glomerular capillary wall for proteins (see Figure 9-1). One form of protein lost in the urine is albumin, the condition being called microalbuminuria, or a higher rate of protein lost in the urine (greater than 200 mcg/min) is referred to as **macroalbuminuria.** The loss of protein in the urine in turn causes a decreased serum albumin level. Albumin less than 3.0 g/dL is found with peripheral edema, ascites (see Chapter 4), and **anasarca** (generalized massive edema). With low levels of protein, fluid leakage into the interstitial space occurs; it also causes sodium retention. Ascites further inhibits food intake because of a feeling of fullness, exacerbating concerns about poor protein status.

Issues of protein loss are multiple. Several vitamin D–binding proteins result in depletion of activated vitamin D metabolites, which promotes the development of

osteomalacia (softening of the bones). The loss of lipid carrier proteins results in hyperlipidemia. Blood clotting is enhanced because of loss of protein related to anticlotting factors. This results in increased risk of thrombosis (see Chapter 7).

Inflammation can be found with the nephrotic syndrome. Corticosteroids are often the standard first-line treatment of the nephrotic syndrome, in order to reduce inflammation. Various antiinflammatory agents are being researched as alternatives to steroid use. The elevated serum ferritin level found with proteinuria and the nephrotic syndrome is likely part of the inflammatory state (Branten and colleagues, 2004).

GLOMERULOSCLEROSIS

The broad condition of glomerulosclerosis is often referred to as **nephrosclerosis** and is related to the many causes of scarring of the glomeruli contained within the nephrons. Chronic hyperhomocysteinemia can cause injury in the kidney, and increased intake of folate and other B vitamins (B_1, B_2, B_6, and B_{12}) is advised. Creatinine clearance was found to decline with elevated plasma homocysteine concentration (Kumagai and colleagues, 2002). A variety of toxic substances, medications, and painkillers are known to cause damage to the kidneys. Diabetic nephropathy is related to sclerosis (scarring) and is a major factor in the development of ESRD.

DIABETIC NEPHROPATHY

The earliest clinical evidence of **diabetic nephropathy** is microalbuminuria. Microalbuminuria is associated with prediabetes, most likely because of the higher insulin resistance (Suzuki and colleagues, 2004). Approximately one third of individuals with both type 2 diabetes and microalbuminuria develop nephropathy within a 10-year period.

Newly diagnosed type 2 diabetes may already be found with nephropathy because of a possible delay in diagnosis of this form of diabetes. Therefore anyone newly diagnosed with type 2 diabetes is advised to have renal function assessed; assessments should be made every 5 years for either type 1 or type 2 diabetes. Persons with diabetes should be regularly monitored for microalbuminuria and not gross proteinuria to best detect kidney dysfunction (Al-Homrany and Abdelmoneim, 2004).

About 20% of persons with type 2 diabetes and nephropathy progress to ESRD. The percentage is much higher in type 1 diabetes, with 50% developing ESRD within 10 years and 75% within 20 years without adequate treatment. Factors connected to the development of diabetic nephropathy include the following:

- Genetic susceptibility
- Hypertension
- Hyperglycemia
- Smoking
- Older age
- Male gender
- A high-protein diet (Ayodele, Alebiosu, and Salako, 2004)

As discussed in Chapter 8, the Diabetes Control and Complications Trial (DCCT) found that normalizing blood glucose levels to an average of less than 155 mg/dL or hemoglobin A_{1c} (Hgb A_{1c}) under 7.2% was found to reduce kidney disease by

about half. It is hoped that achieving even more-normal blood glucose levels may further reduce the development of nephropathy and ESRD with the goal A_{1c} being in the 6% range. If there is no risk of hypoglycemia, a goal for the A_{1c} in the 5% range is appropriate as achieved by medical nutrition therapy (MNT) (see Chapter 8). The glycosylation of renal structures may be the cause of nephropathy, as found with uncontrolled diabetes.

Although there generally seems to be a protection from renal disease for women, as compared with men, this is not the case with diabetic nephropathy. However, management of estrogen levels in menopausal women may help reduce risk of renal disease, especially diabetic nephropathy (Maric and Sullivan, 2008).

In one case study, acute kidney injury from oxalate nephropathy has been associated with increased fat malabsorption and frequent loose oily stools due to use of orlistat for weight loss. Discontinuation of orlistat allowed steady improvement in renal function (Singh and colleagues, 2007). This has potential ramifications with bariatric weight loss surgery that leads to fat malabsorption (see Chapter 6 and later section on kidney stones). Avoidance of excess vitamin C supplementation also is important to prevent high oxalate levels.

Contrast-induced nephropathy continues to be a common complication of coronary angiography. The administration of intravenous saline or possibly sodium bicarbonate and the antioxidant acetylcysteine may reduce the risk of contrast-induced nephropathy (Iyisoy and colleagues, 2008).

IGA NEPHROPATHY

An immune factor called immune globulin A (IgA) has been linked with one form of nephropathy. In a case study involving IgA nephropathy, unrecognized celiac disease was found and both conditions improved with a gluten-free diet (La Villa and colleagues, 2003). Omega-3 fatty acids have been found beneficial, as evidenced with the purified form called Omacor, lowering proteinuria (Hogg and colleagues, 2006).

ACUTE RENAL FAILURE

Acute renal failure (ARF) occurs when there is a sudden decrease in the GFR. Oliguria may occur with ARF. Other associations that may indicate ARF include fluid and electrolyte imbalances and uremia. Depending on the cause, ARF may be short-lived and may require no nutritional intervention. Nutritional intervention is required if uremia or other problems develop, such as fluid or electrolyte imbalances.

Rhabdomyolysis (the breakdown of cells) associated with use of statin medications for hypercholesterolemia can lead to ARF. Other causes of ARF include physical trauma, infection, inflammation, exposure to toxic chemicals, severe dehydration, and hypotension. Toxic wastes may need to be removed by short-term use of dialysis in order to restore renal health.

CHRONIC KIDNEY DISEASE

Chronic kidney disease is a term used to describe the long-term condition of **renal insufficiency** (reduced kidney function) and may be referred to as chronic renal insufficiency (CRI). Symptoms of CKD are found with GFR less than 60 mL/min.

Symptoms include increased serum levels of potassium and sodium, fluid retention, imbalances in calcium and phosphate levels, anemia, and uremia.

Renal osteodystrophy is found with CKD and consists of a group of bone diseases, resulting from altered metabolism, such as poor bone development in children, osteomalacia, and **osteoporosis** (brittle bones). Specifically, renal osteodystrophy is caused by a combination of high serum phosphorus levels, low serum calcium levels, and altered parathyroid (PTH) function. Close monitoring and adherence to a controlled diet can help prevent or delay these complications. Maintaining normal phosphorus levels is critical.

A new term is now advised to describe the broader clinical syndrome of disordered mineral and bone metabolism: **CKD-mineral and bone disorder (CKD-MBD)**. CKD-MBD includes an abnormality of one or more of the following: altered levels of calcium, phosphorus, PTH, or vitamin D metabolism; bone changes; and calcification of the vascular system or other soft-tissue calcification (Moe and colleagues, 2007).

END-STAGE RENAL DISEASE

Despite treatment of diabetes, hypertension, and hyperlipidemia, the incidence of ESRD, or renal failure, continues to increase worldwide. Individuals with ESRD require either dialysis or renal transplantation (see later sections). For persons electing not to undergo these procedures, good nursing and nutritional support is needed. Issues likely to be encountered include development of a metallic taste, nausea and vomiting, intense itching of the skin, and altered consciousness. Limiting intake of protein can help to control the level of uremia and prolong life.

WHAT IS MEDICAL NUTRITION THERAPY IN RENAL DISEASE?

NEPHRITIC SYNDROME

Because the nephritic syndrome is generally of a self-limiting nature, MNT is primarily aimed at maintaining nutritional well-being until recovery has occurred. Mild restrictions of protein and potassium may be indicated but should be based on serum laboratory values. Edema may necessitate a moderate salt restriction to help preserve renal function with glomerulonephritis, especially if there is high blood pressure (Box 9-2). A beneficial effect of fish oil on survival of individuals with lupus nephritis has been observed and may be a result of decreased atherosclerosis (Muthukumar and colleagues, 2003).

NEPHROTIC SYNDROME

The therapeutic level of protein intake with the nephrotic syndrome needs to be determined on an individual basis, and some trial and error may be needed with laboratory monitoring for guidance on goals of MNT. A moderately low-protein diet can help reduce proteinuria (see Box 9-1 for protein guidelines based on GFR). If the loss of protein is excessive, leading to severe hypoalbuminemia, generally an increased intake of protein is warranted. If increased protein intake does not result in improved albumin levels, a reduction in protein intake, paradoxically, may be beneficial. This is due to proteinuria being exacerbated with a high-protein diet.

Box 9-2 Foods for Management of Renal Disease*

≤50 mg SODIUM, POTASSIUM, AND PHOSPHORUS

Fruits

Cranberry juice cocktail, ≤2 c
Lemonade, ≤1 c

Sugars

Granulated, ≤8 c
Hard candy, ≤1½ lb
Jelly beans, ≤5 c
Marshmallows, ≤3½ oz
Jam, ≤2 tbsp
Jelly, ≤3 tbsp

Fats

Cooking oil (vegetable), unlimited
Lard, unlimited
Salt-free margarine, ≤1 c
Salt-free butter, ≤1 c

≤100 mg SODIUM, POTASSIUM, AND PHOSPHORUS

Fruits and Vegetables

Blueberries, ≤½ c
Grapes, ≤½ c
Lettuce, ≤½ c
Watermelon, ≤½ c

Sugars

Honey, ≤½ c
Alcohol
Beer, ≤12 oz
Table wine, ≤4 oz

*Refer to food composition table (see Appendix 4 on the Evolve website). Specific dietary advice should be given in conjunction with a registered dietitian and a physician. Foods contributing >2 g of protein in common portions are not included.

Close monitoring of laboratory values is necessary. If BUN and creatinine levels increase, protein intake needs to be reduced, regardless of the albumin level.

Because the cause of edema in nephrotic syndrome is secondary to hypoalbuminemia, typical treatment of edema (low-sodium diet and diuretic medications) does not apply. The underlying hypoalbuminemia and subsequent edema will be corrected by achieving a **positive nitrogen balance** (the amount of protein needed in the diet to allow for tissue growth; that is, intake of protein that exceeds output) through increased protein availability. This in turn is achieved by an adequate kcaloric intake. Thus a high-protein, high-calorie diet can help correct the edema associated with nephrotic syndrome. Slow weight loss can be beneficial, in part due to weight loss being associated with lowered indicators of inflammation.

Another means to correct microalbuminuria is to treat underlying hypertension. An ACE inhibitor medication can further help correct proteinuria through improved pressure within the kidney. Sodium should be restricted only mildly (about 3 g/day), because further reductions can cause hypotension. Hypoalbuminemia causes a low blood volume, which would be exacerbated with a very low sodium intake (less than 2g/day).

Because the nephrotic syndrome is related to hypertension and type 2 diabetes—two conditions found with the metabolic syndrome—dietary measures to manage insulin resistance may be of further help. Such measures include limiting saturated fat and moderating carbohydrate content by emphasizing high-fiber foods in several small meals. Meeting the goal of the American Heart Association to include 6 oz of fatty fish weekly or the equivalent of 250 to 300 mg of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) fish oil capsules daily will help lower triglyceride levels and reduce the risk of clot formation. Increased physical activity is generally

advised. There is some evidence that dietary fiber may be associated with improvement of renal damage (Sato and colleagues, 2005).

How Much Protein Is Needed to Achieve a Positive Nitrogen Balance?

The amount of protein recommended to achieve a positive nitrogen balance is based on individual needs. In the past the recommended protein intake was doubled from the needs of adults with normal renal function (1.5 g/kg of body weight, compared with the normal recommendation of 0.8 g/kg). The amount can be individualized based on the outcomes of improved laboratory values and diminishing edema.

The assessment of nitrogen balance is equivalent to intake minus loss. The amount of the nitrogen intake (through diet) must be greater than what is lost through urine and other body losses to have enough protein for building purposes (anabolism). An increase in serum albumin level indicates a positive nitrogen balance. However, depending on the function of the liver and kidneys, achieving a normal serum albumin level may not be possible. Other indicators may be used, such as healing of wounds and skin integrity.

DIABETIC NEPHROPATHY

Management of diabetic nephropathy includes the goal of achieving optimal blood pressure and normalized blood glucose level (see Chapters 7 and 8). This is to help prevent further damage and loss of renal function. Because urinary tract infections (UTIs) are common with uncontrolled diabetes, close monitoring and prompt treatment are needed. Use of cranberry juice or cranberry extract is advised to help prevent UTIs. Because cranberry juice has a high glycemic index, limiting servings to 4 oz will help prevent hyperglycemia. A daily total intake of 8 oz (4 oz twice daily) of cranberry juice may be required to prevent reoccurrence of UTIs. Adequate fluid intake is needed, especially during treatment with antibiotics with the goal of 35 mL per kilogram of body weight.

WHAT IS MEDICAL NUTRITION THERAPY IN CHRONIC KIDNEY DISEASE?

PROTEIN

With regard to renal insufficiency, there is controversy concerning the ideal amount of protein required to slow the progression of CKD. Low-protein diets of 0.6 g/kg of body weight can be nutritionally sound, especially with use of supplemental essential amino acids. This level of protein restriction has been shown to help suppress progressive loss of kidney function (Mitch, 2005). The National Kidney Foundation Clinical Practice Dialysis Outcomes Quality Initiative (K/DOQI) guidelines state that predialysis individuals with CKD should receive 0.6 to 0.8 g of protein per kilogram of body weight per day. An alternative to this has been suggested for predialysis individuals, with a maximum goal of 1.0 g/kg/day. This is to ensure avoidance of malnutrition in attempting to meet protein restriction. Protein intake is increased once dialysis begins (see later section). Determining protein goals for an obese person should be based on adjusted body weight (see Chapter 15).

Box 9-3 Sample Menu ■ For a 60-g Protein Diet, Low Phosphorus, Low Potassium

Breakfast
½ c cranberry juice
½ c cream of wheat cereal
2 slices toast
2 tsp butter
2 tsp honey
½ c whole milk
2 tsp sugar
¾ c coffee

Lunch
2 oz tuna salad
2 slices toast
½ c carrot sticks
6 slices cucumber with leaf lettuce
Italian salad dressing
½ c pineapple rings
1 tsp sugar
1 c Kool-Aid

Supper/Dinner
Pear and peach halves on lettuce served with
¼ c cottage cheese and 1 deviled egg
1 c pasta in olive oil and garlic sauce
½ c green beans
½ c whole milk
2 tsp butter
Dinner roll
1 high-sugar, low-protein popsicle
1 tsp sugar

Although the precise amount of protein restriction is subject to debate, any reduction in protein intake by a person with CKD will likely be of help. Specific recommendations for protein intake are based on an individual's nutritional status and physical tolerance as demonstrated by laboratory values and other clinical indicators, along with the person's desire or perceived ability to follow a set protein restriction.

Dietary fiber can lead to the same urea-lowering effect of low-protein diets by increasing nitrogen excretion through the feces. Combining fiber with a low-protein diet may be further helpful in controlling CKD (Younes, Alphonse, and Deteix, 2004). Many high-fiber foods are high in potassium. However, high-potassium foods do not need to be restricted until the serum potassium level is elevated. See Box 9-2 for some low-potassium fiber-based foods.

Teaching Pearl

A person who needs to limit potassium in the diet will likely be surprised to hear that more than limiting bananas and orange juice is needed. Explain that because potassium is a vital element for all life, all foods contain potassium with the exception of fats/oils and sugars. White bread has less potassium than whole-grain bread because the potassium is concentrated in the fiber portion (the germ portion). Iceberg lettuce has less potassium than dark-green leafy vegetables. ■

See Box 9-3 for sample menu of a 60-g protein diet, which is commonly prescribed; high-sugar, high-fat foods and beverages are included to show how caloric intake might be increased. Emphasis on monounsaturated or omega-3 fatty acids can provide adequate caloric intake without adverse effects on diabetes, hypertension,

or hyperlipidemia. The goal of maintaining adequate body weight is necessary to maintain a positive nitrogen balance with appropriate levels of serum albumin. Enteral liquid supplements have been developed to assist in providing amino acids (for protein) and kcalories while contributing low levels of the electrolytes sodium and potassium (see Appendix 1 on the Evolve website for websites of pharmaceutical companies). These products need to be considered part of the total dietary intake. They may serve as an alternative to diet restrictions or as a supplement to meet the MNT goals.

VITAMIN AND MINERALS

Phosphorus (PO_4)

High serum phosphorus levels occur with the decline in GFR. Although dietary restriction may be required, a reduction in protein intake will indirectly reduce phosphorus intake. Milk, however, is very high in phosphorus and may need to be restricted to a maximum of 16 oz daily with optimal 1 cup daily to allow for other milk sources in the diet. A phosphorus intake of 600 to 1200 mg should maintain desirable levels. Phosphate binders can be used as well. The use of calcium carbonate can decrease serum phosphorus while increasing serum calcium.

Calcium (Ca++)

An increased calcium intake, whether from supplements or as found in phosphate binders, has been found to improve relaxation of blood vessels and enhance loss of sodium. A high-calcium diet reduced blood pressure and albuminuria in a rat study of renal failure (Porsti and colleagues, 2004). Excess calcium supplementation should be avoided; a maximum intake of 2000 mg is generally advised, although the UL is 2500 mg. Limiting milk to 1 cup daily at 300 mg Ca++ will help prevent exceeding the UL. The calcium content of phosphate binders needs to be included in assessment of intake to avoid potential harm. Research suggests that increased intake of calcium, along with vitamins C and E, lowers microalbuminuria in men (Daviglus and colleagues, 2005).

Vitamin D

Secondary hyperparathyroidism is a common complication in patients with chronic kidney disease, and treatment with vitamin D is a mainstay of therapy. Because the kidney is involved in activating vitamin D, deficiency of this vitamin is common in kidney disease. This further affects calcium metabolism because vitamin D is needed to promote the absorption and use of calcium. Approximately 40% of patients with stage 3 CKD (see Box 9-1) and 80% of patients with stage 4 have secondary hyperparathyroidism as a result of low serum 25(OH)D levels (see Chapter 3). Appropriate treatment involves suppression of PTH to normal levels with active vitamin D therapy and phosphate binders. Active vitamin D therapy, even in the absence of elevated serum phosphorus level and reduced serum calcium level, is critical (Andress and colleagues, 2008). The best approach is debated with concerns of hypercalcemia and hyperphosphatemia because excess vitamin D is related to excess buildup of calcium, especially when phosphorus levels are not controlled.

Sodium

Sodium is usually restricted in patients with CKD as well. A typical restriction is 2000 mg/day (see Table 7-4). The amount of sodium permitted is based on laboratory values and fluid retention.

Potassium (K^+)

As renal function continues to decline and renal failure begins, a variety of nutritional issues arise. One is **hyperkalemia** (serum potassium level greater than 5.5 mEq/L). This can be a life-threatening situation owing to possible cardiac arrhythmia. If high levels of serum potassium occur, a 1500- to 2000-mg limit on potassium intake is appropriate. A normal diet may contain as much as 3000 to 8000 mg because potassium is widely distributed in foods. Cooking water and the juices from canned fruits and vegetables should be discarded because potassium is water soluble. Box 9-2 lists foods low in sodium, potassium, and phosphorus; Box 9-3 shows a daily menu using foods low in potassium.

IRON AND ANEMIA

Renal disease has a high incidence of anemia. Although this is often thought to be due to iron deficiency, there are many forms of anemia. The term *anemia* simply means *an* (without) and *emia* (blood), or the blood is missing something. **Anemia of chronic disease (ACD)** is a mild to moderate anemia seen with many infections, inflammatory disorders, and renal disease. In ACD storage iron is often abundant but not free to be used for erythropoiesis (the production of red blood cells). There is a low serum iron level, but high serum ferritin levels. This appears to be due to altered metabolism leading to inhibited absorption of iron from the duodenum, and poor release of iron into the circulation (Matsumura and Kanakura, 2008).

Anemia found with renal disease is often due to inflammation and altered metabolism and not due to true iron deficiency. The red blood cells tend to be younger and more flexible cells, which are more susceptible to oxidative stress. This may contribute to the reduced life span of red blood cells in CKD (Brzeszczynska, Luciak, and Gwozdzinski, 2008).

Differentiating between iron deficiency that should be treated with iron and ACD that should not be treated with iron is more difficult. Failure to show a response to a dietary iron supplement suggests ACD, and iron supplementation should be stopped. This is due to its serving no positive role and to its potential to cause harm. Excess iron, through oxidation reactions, can create harmful free radicals linked to cardiovascular disease, which occurs with CKD.

With dialysis there is a complex pattern of anemia, generally due to inflammation and poor production of red blood cells, but also due to changes in nutritional intake, losses through dialysis, or apparent anemia due to increased blood volume from edema. Erythropoietin (EPO), a hormone normally produced by the kidney to promote red blood cell production, along with intravenous iron may be provided at the time of dialysis (Handelman and Levin, 2008). Increased amounts of EPO per kilogram of body weight are required with indicators of inflammation (Costa and colleagues, 2008). Approximately 5% to 10% of patients with chronic kidney disease demonstrate hyporesponsiveness to erythropoiesis-stimulating agents. This may be due to inflammation or iron deficiency. Correcting iron deficiency and

supplementing with vitamins C and E has been shown beneficial in promoting red blood cell production with these agents. Other well-established causes of hyporesponsiveness include inadequate dialysis, hyperparathyroidism, nutrient deficiencies (vitamin B_{12}, folate, carnitine), and certain medications, including ACE inhibitors (Johnson, Pollock, and Macdougall, 2007).

ANTIOXIDANTS

Regular intake of red grape juice has been implicated in reduced inflammation and reduced low-density–lipoprotein cholesterol (LDL-C) levels among dialysis patients, which may reduce cardiovascular risk (Castilla and colleagues, 2008). Including a variety of colorful plant-based foods remains important, as it is for the general population, to enhance the intake of a variety of antioxidants. Grape juice has the advantage of being low in potassium, which generally needs to be restricted at later stages of renal failure (see below).

HYPERVITAMINOSIS A

As a result of altered metabolism with CKD, hypervitaminosis A can occur. This can be a cause of anemia not commonly considered. In one case study, hypervitaminosis A was found to be the cause of severe anemia and **thrombocytopenia** (a condition of decreased blood platelets) (Perrotta and colleagues, 2002). Another consequence of hypervitaminosis A was shown in a case study of an 86-year-old woman who consumed up to 3600 International Units of retinol palmitate (about 150% of the Dietary Reference Intake [DRI]) in supplement form and developed hypercalcemia because of chronic vitamin A ingestion. Hypercalcemia can occur as a result of bone loss with excess vitamin A. Risk factors for vitamin A toxicity are age, body weight, and renal insufficiency (Beijer and Planken, 2001). Vitamin A supplements need to be avoided in documented renal disease and should be considered a potential problem with older ages due to a general decline in renal function with age. Acute hypervitaminosis A intoxication can lead to the following:

- Increased intracranial pressure
- Vomiting
- Lethargy
- Pruritus (itching)
- Muscle and bone tenderness
- Failure to thrive
- Osteoporosis, fracture, and other bone complications (Saltzman and King, 2007)

FLUIDS

Although renal function is adequate to allow normal urine output, fluid restriction is not necessary unless there is severe edema or hyponatremia. Fluid intake needs to be increased, as tolerated, for antibiotic treatment or kidney stones. Once stage 4 or 5 CKD has developed to the point of reduced urine output, fluids are restricted. The general guideline is 500 to 1000 mL (about 2 to 4 cups) plus the amount lost in daily urine production and other body fluids, such as perspiration. For example, if the person has anuria, the maximum advised fluid intake is 1000 mL. Quantifying urinary output needs to be estimated for persons with oliguria before recommended daily amounts of fluids can be determined.

Teaching Pearl

A person who needs to restrict fluids will typically find it very challenging, especially if diuretic treatment is being used. Thirst and dry mouth can be problematic. Use of sugar-free candies and commercial products can help keep the mouth moist. Individuals receiving dialysis may be motivated to limit fluid intake due to reduced time needed for dialysis. ■

WHAT IS THE ROLE OF EXERCISE IN PREVENTING AND MANAGING RENAL DISEASE AND ITS COMPLICATIONS?

Exercise helps lower insulin resistance and health conditions found with the metabolic syndrome. Evidence is growing that exercise by persons with CKD may reduce cardiovascular disease, as is well known for persons without renal disease, along with other benefits such as increased strength and lowered blood pressure (Moinuddin and Leehey, 2008). There is growing evidence that aerobic exercise interventions are effective in promoting quality of life with impaired renal function. Resistance training, as used for muscle development, has been shown to improve clinical, physical, and functional outcomes (Chan and colleagues, 2007).

WHAT ARE THE DIFFERENT TYPES OF DIALYSIS AND COMPLICATIONS?

There are two forms of dialysis, both of which have the goal of maintaining and balancing protein, electrolytes (potassium and sodium), and fluid levels. The traditional form is **hemodialysis,** which generally requires a person to travel to a dialysis unit about three times weekly. For several hours the patient's blood is extracted and filtered through a dialysis solution. The dialyzed blood is then returned through the patient's venous system.

Continuous ambulatory peritoneal dialysis (CAPD) was developed to improve the quality of life for the person needing dialysis in that it does not require attachment to a machine. It entails filling the abdominal cavity with dialysis fluid, which has a high glucose content. The dialysis fluid then absorbs toxins from the blood. After several hours, the dialysis fluid is drained and fresh dialysis fluid is reinserted. This form of dialysis also can be performed intermittently, usually during sleep.

Dialysis has become commonplace since the U.S. Congress passed legislation allowing federal funds to be used for the procedure. Kidney transplants were also covered in this legislation, which was passed in 1972.

WHAT ARE SOME ISSUES OF DIALYSIS?

Having good nutritional status promotes health and well-being. This also is true for persons undergoing dialysis. Malnutrition is a relatively common problem in patients on hemodialysis and is associated with increased morbidity and mortality in these individuals. It has been found that normal body weight with midarm muscle circumference greater than or equal to 90th percentile (see Figure 1-9) increases survival

during dialysis and overweight persons with inadequate midarm muscle circumference have the worst survival (Araújo and colleagues, 2006).

Initiation of dialysis allows more liberal intake of protein and promotes increased nutrient intake as a consequence. However, there may be losses of nutrients through dialysis. The DOQI guidelines state that for stable maintenance hemodialysis individuals the protein goal is 1.2 g/kg/day, and for chronic peritoneal dialysis 1.2 to 1.3 g/kg/day. A higher intake of protein may be warranted based on laboratory values and general nutritional status. Issues of depression and other factors may impair an individual's ability to comply with these recommendations.

A decreased concentration of essential and nonessential amino acids has been observed after 2 years of dialysis. This was particularly true for the branched-chain amino acids, but 16 out of 20 amino acids were all found to be lower than expected. This was in spite of perceived good nutritional status. Adequate kcalorie intake and reduced inflammation can be beneficial in increasing protein status, especially among persons receiving long-term hemodialysis (Małgorzewicz and colleagues, 2008). Oral supplementation of branched-chain amino acids can improve appetite and nutritional status among persons receiving dialysis (Cano, Fouque, and Leverve, 2006). One consequence of low levels of the amino acid lysine appears to be reduced carnitine—see section below (Tanner and colleagues, 2008).

The dialysis procedure will be of longer duration if goals of MNT are not maintained between dialysis sessions. This is particularly true if fluid restrictions are not followed.

One goal of dialysis is to remove excess fluid buildup. **Interdialytic weight gain** is an easy measure in the dialysis unit, and weight is routinely assessed at the beginning and end of dialysis sessions. The weight after dialysis is referred to as the **dry weight** and is the weight at which calculations for nutritional needs are made. Dry weight after dialysis is the person's weight when normal blood pressure is achieved. The interdialytic weight gain is used along with clinical symptoms and signs and predialysis blood pressure readings to make decisions regarding the amount of fluid removal during a dialysis session. Fluid and salt restrictions may be advised if there is excess weight gain between dialysis sessions. With good control of weight gain between dialysis sessions of less than 5.7% of dry weight, no further restrictions are imposed. This is, in part, due to the potential gain of actual body mass, such as muscle, and tighter control of fluid and salt intake might not be warranted (Sarkar, Kotanko, and Levin, 2006). Weight stabilization between dialysis sessions, without undue fluctuation, is one means to determine appropriate fluid intake.

With CAPD, hypertension is one complication and appears to be caused by fluid overload resulting in elevated systolic blood pressure (Wong and colleagues, 2004). High blood pressure is frequent and a challenge to control in the dialysis population. Normalizing blood pressure in these individuals includes dietary salt and fluid restriction in combination with a lower sodium concentration of the dialysate solution (Horl and Horl, 2003). The dextrose concentration of the dialysate can also be an issue with the potential to cause deterioration of the peritoneal membrane. The lowest concentration of dextrose that will allow adequate filtration is the most practical measure currently used to prevent this potential problem (Tzamaloukas and colleagues, 2008).

Teaching Pearl

Health care professionals working with individuals with oliguria or anuria can explain the reason for fluid restriction. It can be explained that every extra 8 oz of fluid intake beyond the kidneys' ability to excrete fluid results in a ½-lb weight gain. Knowing that duration of dialysis can be shortened with careful intake of fluid sources may be adequate incentive to follow MNT goals. Alternative suggestions to minimize dry mouth, such as the use of lozenges or chewing gum or sucking on lemon wedges, can be made. Products sweetened with saccharine, NutraSweet, or Splenda do not contribute to dental decay or diarrhea. ■

Fact & Fallacy

FALLACY With dialysis, the person with renal disease need not restrict food intake.

FACT It is true that to compensate for incurred losses, some of the dietary restrictions are reversed during hemodialysis (e.g., protein, potassium, and sodium for the normotensive patient), but in general there are still restrictions. In fact, the frequency and duration of hemodialysis can be reduced when strict dietary controls are followed. For individuals using dialysis, a more liberal dietary intake may be possible. ■

MICRONUTRIENT SUPPLEMENTATION WITH DIALYSIS

Water-Soluble Vitamins

Water-soluble vitamins are removed through the dialysis procedure, and supplementation of the B vitamins is advised. Avoidance of excess vitamin C intake is also advised. This is due to increased risk of oxidation, especially with elevated ferritin levels. The potential benefits of restored vitamin C status and improved erythropoiesis in combination with iron may be outweighed by the adverse effects of oxidative tissue injury (De Vriese and colleagues, 2008). Renal vitamin preparations are available.

Fat-Soluble Vitamins

Vitamin A should not be supplemented because toxic levels can develop and should be suspected in the presence of hypercalcemia and a form of anemia. Renal multivitamin preparations are low in vitamin A content. The other fat-soluble vitamins, D and E, have beneficial roles via supplements. Dialysis-associated leg cramps may be helped with supplementation of vitamin E (Guay, 2008).

Guidelines issued by the National Kidney Foundation DOQI recommend the use of vitamin D_2 (ergocalciferol) when serum 25(OH)D levels are less than 30 ng/mL. The vast majority of hemodialysis patients are vitamin D–deficient. Monthly supplementation of 50,000 International Units of vitamin D_2 has been found to be safe and effective in normalizing serum 25(OH)D levels among persons receiving hemodialysis (Saab and colleagues, 2007). The use of the active form of vitamin D, vitamin D_3, may be advisable owing to concerns of inefficient metabolism by the kidneys (Watanabe, 2004). Treatment with active vitamin D (paricalcitol) has been associated with greater muscle size and strength among persons receiving hemodialysis (Gordon and colleagues, 2007).

Minerals

Minerals are not generally advised for supplementation. However, research support supplementation of some minerals. Zinc deficiency has been associated with infectious complications, and the use of phosphate binders may be the cause (Skarupskiene and colleagues, 2005). Hemodialysis is often associated with heart problems, including arrhythmia. There is some evidence that magnesium may play a role in preventing arrhythmia in people who undergo hemodialysis (Yokoyama, Kikuchi, and Kawamura, 2005). Magnesium is now known to help reduce the inflammation process that has been implicated in renal disease and poor outcomes with dialysis.

Anemia, as noted with reduced hemoglobin and hematocrit, is common; however, iron studies should be undertaken to verify the need for iron supplementation. Intravenous iron therapy used in dialysis may elevate the serum ferritin level, which has been implicated in coronary artery disease (Reis and colleagues, 2005).

Increased renal potassium excretion can be the result of magnesium deficiency. Hypokalemia can occur with long-term poor intake of potassium, but peritoneal dialysis increases filtration of potassium, leading to hypokalemia. This is particularly a concern for children who generally use peritoneal dialysis (Factor, 2007).

Other Nutrients

Although not a micronutrient, **carnitine**, produced in the kidneys, is a substance that oxidizes fatty acids, primarily of the heart and skeletal muscle. Deficiency of carnitine becomes an issue for long-term hemodialysis patients because of decreased availability of lysine, methionine, vitamin C, niacin, vitamin B_6, and iron to synthesize this substance. Studies have shown that L-carnitine supplementation improves the response to erythropoietin and reduces insulin resistance; it was shown that intravenous L-carnitine (20 mg/kg, given at the end of each dialysis session for 6 months) decreased C-reactive protein levels (Savica and colleagues, 2004).

WHAT ARE SOME NUTRITIONAL RENAL TRANSPLANT ISSUES?

An initial concern is delayed graft function, which occurs in almost one third of renal transplants, requiring extended hospitalization and resulting in enhanced graft loss. Delayed graft function is associated with free radical production and inadequate levels of adenosine triphosphate (ATP) (see Chapter 4). Thiamin content of donor kidneys may be low for a variety of reasons, and supplementation may be of benefit to enhance suppressed free radicals and production of ATP (Klooster and colleagues, 2007).

Weight gain is a common occurrence due to the use of steroids to prevent rejection of the new kidneys. Lowering caloric intake may be prescribed, but it should still be high enough to ensure a positive nitrogen balance, which is important for healing and maintaining a healthy immune system.

Cardiovascular morbidity and mortality are extremely high in all stages of renal failure and remain after renal transplantation. This is, in part, due to hypertension. In one study 95% of transplant individuals had hypertension 3 months after transplantation, which decreased in prevalence by only 10% at the 1-year mark (Sqalli and colleagues, 2008). Following the DASH diet may be beneficial (see Chapter 7).

Elevated levels of homocysteine can contribute to cardiovascular disease after transplantation. Increased folate and vitamin B_6 intakes appear to reduce hyperho-

mocysteinemia among transplant recipients and could contribute to reducing the risk of coronary artery disease (Biselli and colleagues, 2007).

Elevated cholesterol levels, while contributing to heart disease, have also been linked with progressive decline in renal function in some transplant recipients. This is referred to as chronic allograft nephropathy (CAN). In a study of children who had received kidney transplantation, it was found hypercholesterolemia and high LDL-C levels have significant association with CAN (Valavi and colleagues, 2008).

Calcification also has been linked with cardiovascular disease. Hypercalcemia due to persistent hyperparathyroidism can cause renal graft dysfunction and cardiovascular calcification. Although serum parathyroid hormone concentrations decrease within the first few months after successful renal transplantation, persistent levels have been shown to remain 1 year after transplantation in some cases. In this situation treatment with vitamin D and calcium, in some cases parathyroidectomy, has to be considered (Negi, Okamoto, and Shigematsu, 2007).

WHAT ARE THE SPECIAL CONSIDERATIONS FOR TREATING CHILDREN WITH RENAL DISEASE?

Growth can be stunted among children with renal disease. One cause may be a disturbance in the calcium-phosphorus balance, resulting in insufficient availability of calcium for bone growth. Once phosphorus levels are under control, the calcium and vitamin D intake can be increased to help promote bone growth. Human growth hormone treatment can help to increase growth rate and bone strength among children (Gorman and colleagues, 2005).

Children need appropriate amounts of food for the macronutrients and micronutrients needed for growth and development (see Chapter 12) without causing undue stress on the kidneys. Liquid supplements designed for renal management can be given popular names such as "SpongeBob Milkshake" for young children. Health care professionals, and certainly families, interacting with children should try to make foods sound appealing, provide small portions frequently, arrange for favorite foods, and encourage diversity in intake to meet the variety of nutrients needed for growth and development.

Exercise is important to promote bone strength and good development. However, it may be a challenge to achieve sufficient levels of exercise among children with renal disease. It has been found that aerobic capacity is decreased in the early stages of CKD in children. Lower capacity for aerobic exercise can be predicted by the presence of elevated diastolic blood pressure (Weaver and colleagues, 2008).

WHAT ARE CAUSES AND NUTRITIONAL MANAGEMENT OF KIDNEY STONES (NEPHROLITHIASIS)?

There are several forms of kidney stones, each with its own medical or nutritional treatment. The best way to prevent kidney stones is an adequate fluid intake (1½ to 2 L or more per day). Adequate fluid intake helps to keep the urine dilute, which inhibits crystal formation needed for stone formation. Once a stone has formed, treatment may best be decided after a chemical analysis of the stone.The prevalence of nephrolithiasis in Western countries continues to increase. This may be related to the obesity epidemic, because obesity and weight gain increase the risk of kidney stone formation (Taylor, Stampfer, and Curhan, 2005). Fructose intake is indepen-

dently associated with an increased risk of incident kidney stones (Taylor and Curhan, 2008). This perhaps is due to the higher kcalorie intake associated with high-fructose corn syrup and its use in soft drinks and other sweetened beverages. Ironically, bariatric weight loss surgery has been implicated in increased risk of stone formation. One form of weight loss surgery was abandoned in 1980 because of kidney stones that led to renal failure.

CALCIUM OXALATE STONES

The most common forms of kidney stones are calcium oxalate and phosphate stones. Calcium oxalate stones come in many forms. Medical input is necessary to determine nutritional intervention, and some calcium stones even require medical or surgical intervention. Severe renal stones at an unusually early age may indicate high levels of oxalate in the urine. All persons with stones should be assessed for the type of stone formation, including ruling out urine oxalate as the cause (Chung and colleagues, 2004).

The most common form of bariatric weight loss surgery currently performed, Roux-en-Y gastric bypass, has been associated with an earlier increase in urinary oxalate excretion and higher risk for calcium oxalate stones than previously thought (Duffey and colleagues, 2008). Individuals undergoing current forms of bariatric surgery have been found to have an average urine oxalate excretion double that of other kidney stone formers, and almost triple of non–stone formers, but still less than the banned form of weight loss surgery from 30 years ago. This level of hyperoxaluria, found in many persons undergoing Roux-en-Y for weight loss, is at a level that could lead to kidney failure (Asplin and Coe, 2007).

Low urine volume appears to increase risk of calcium oxalate stone formation. However, the hyperoxaluria also may be related to fat malabsorption, even with near-normal absorption levels. The unrelated research linking orlistat, as discussed earlier, with kidney stones supports this finding. Because the stone formation generally occurs after significant weight loss 6 months to 2 years after surgery it is hoped that prevention strategies can be developed (Sinha and colleagues, 2007). After Roux-en-Y it is important for patients to maintain high urine outputs, to limit fat intake, and to ingest adequate amounts of calcium (Kleinman, 2007). A low-oxalate diet and use of calcium as an oxalate binder is further advised, but still may not be adequate to prevent stone formation and subsequent renal failure (Lieske, Kumar, and Collazo-Clavell, 2008). Foods containing phytate appear to reduce risk of kidney stone formation, as does a higher intake of dietary calcium in younger women. Patients with calcium oxalate kidney stones are advised to decrease the consumption of foods that contain oxalate (Box 9-4). Eliminating oxalate from the diet decreases not only urinary oxalate but also calcium oxalate crystal deposits in the kidneys and improves their function (Khan, Genton, and Byer, 2007). A registered dietitian should be consulted for such a diet because foods high in oxalate (legumes and nuts; dark-green, leafy vegetables; and berries) are very nutritious. A diet aimed at controlling oxalate stone formation needs to be evaluated for nutritional adequacy.

Calcium intake was not found to increase risk of stone formation and decreased the risk in men less than 60 years of age. Only normal-weight men had increased risk of stone formation with intake of animal protein. A high intake of vitamin C

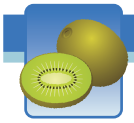
Box 9-4 Oxalate Content of Common Foods per 100 g

HIGH SOURCES (>500 mg)	MODERATE HIGH SOURCES (100-500 mg)
Beets	Okra
Swiss chard	Parsley (some cultures use as a vegetable)
Spinach	Almonds, peanuts
Rhubarb	Chocolate
	Berries

(e.g., in supplements) appears to increase risk, whereas magnesium intake decreases the risk (Taylor, Stampfer, and Curhan, 2004).

A low incidence of kidney stones has been noted in Greenland Eskimos, which has been attributed to the high intake of oily fish and omega-3 fatty acids. One study suggests that the omega-3 fatty acid EPA reduces urinary calcium, which may explain the reduced risk of calcium stone formation with cold-water fish consumption (Yasui and colleagues, 2001).

Even if **hypercalciuria** (high levels of calcium in the urine) is noted to be the cause of stone formation, treatment with a low-calcium diet may not be appropriate. Only one type of hypercalciuria will improve with a low-calcium diet. The calcium restriction is now more moderate than previous guidelines—in the range of 800 to 1200 mg of calcium per day. A mild sodium restriction (4 to 5 g/day) can decrease urinary calcium levels in another form of hypercalciuria.



Cultural Considerations

Truck drivers are at risk for a number of health conditions. Because of little physical activity, a tendency to restrict fluids to save time by not stopping at rest areas, and the quality of foods available on the road, many issues can result. High-salt foods are typically found at restaurants frequented by truck drivers. Guidance on improving nutritional intake might involve the inclusion of salt-free nuts or a small can of beans (if the truck driver likes cold beans, as some people do) as alternative protein sources. Fresh fruits and vegetable sticks can help maintain potassium intake to help control blood pressure; conversely, apples and grapes are low in potassium and may be used by individuals who need to limit potassium intake. Yogurt travels well, with refrigeration not being as critical as for milk. Fluid intake might be in small amounts throughout the day to facilitate the body's use of fluids while limiting output when pressed for time. However, at least 6 cups of fluids are necessary, and more if there is a history of kidney stones. ■

URIC ACID STONES

Uric acid stones account for 10% of kidney stones and are the second most common form of urinary stones. Acidic urine is the primary cause. Kidney stones affect hypertensive patients disproportionately compared with individuals with normal blood pressure. This connection appears to be explained by the metabolic syndrome. A history of nephrolithiasis is associated with a greater tendency to develop hypertension. Higher body mass index and insulin resistance as found with the metabolic syndrome may cause uric acid nephrolithiasis as increasing body weight is associated with decreasing urinary pH (Obligado and Goldfarb, 2008).

Adequate hydration is important in prevention. Promoting alkaline urine through potassium citrate or sodium carbonate is an effective means to allow uric acid stones to dissolve (Ferrari and Bonny, 2004). Limiting protein to about 50 g/day meets basic body needs and is useful for treating uric acid stones. Emphasis on milk as the primary source of protein will help prevent acidic urine. Increased consumption of fruit (except cranberries, plums, and prunes) and decreased consumption of bread products may also help to prevent acidic urine. Persons with type 2 diabetes with stones tend to have uric acid stones. These persons tend to have unusually acidic urine, with retention of urate (Pak and colleagues, 2003). The greater incidence of kidney stones in the obese may be due to an increase in uric acid nephrolithiasis (Taylor and Curhan, 2006). A study of stone analysis found approximately two thirds of obese patients had uric acid calculi. Recommendations to decrease animal protein intake can significantly improve the risk of recurrent stone formation (Ekeruo and colleagues, 2004). Positive associations between body mass index and urinary calcium excretion likely are due to differences in animal protein and sodium intake.

CYSTINE STONES

Treatment and prevention of cystine stones require a high fluid intake (greater than 4 L/day). Nighttime fluid intake is needed. Dietary restriction of methionine, as with a vegetarian diet, can help decrease the excretion of cystine. One goal is to reduce acidity of the urine. However, because of the complexity of factors that control urine acidity, dietary impact cannot be accurately predicted. Increased intake of fruits and vegetables may be helpful to decrease acidity of the urine.

STRUVITE STONES

Struvite stones are generally not managed nutritionally. They are usually seen in women and require long-term antibiotic therapy with surgical or ultrasonic stone removal. Avoidance of UTIs appears to be helpful, indicating that cranberry juice may be prophylactic.

Fact & Fallacy

FALLACY A person with kidney stones should follow a low-calcium diet.

FACT Only recently has it been found that calcium restriction may be counterproductive for a person with kidney stones. Kidney stone formation now appears to be more related to oxalate intake. Oxalate is found in beets, chocolate, nuts, rhubarb, spinach, strawberries, tea, and wheat bran. Megadoses of vitamin C also contribute oxalate. The best course appears to be to avoid excess oxalate and protein while including the recommended amount of milk and increasing the intake of potassium and water. ■

HOW DO THE DIETARY GUIDELINES RELATE TO MANAGEMENT OF RENAL DISEASE?

Although healthy persons are typically advised to avoid sugar and fat, their consumption may become mandatory for the person with renal disease to maintain adequate kcalorie intake without contributing protein and electrolytes. The recommendation to increase sugar and fat may be met with resistance because of long-standing attempts to control health. Emphasis on the unsaturated fats, especially

monounsaturated and omega-3 fats, are helpful in managing hyperlipidemia found with renal disease (see Chapter 7).

A variety of vegetables and fruits is important for the inclusion of antioxidant vitamins and minerals that can protect against cardiovascular disease associated with renal disease. However, a balance is in order for those with CKD because of the high potassium content of most vegetables and fruits (see Box 15-2). Monitoring serum potassium levels will allow for individualized guidance (see Box 9-2 for low-potassium food choices).

Reduced sodium to the DRI level of 2300 mg (2400 mg as found on food labels) is appropriate for the general population and the person with renal disease. Moderate protein intakes are recommended, especially for persons with renal disease, unless dialysis and issues of hypoalbuminemia are present. Alcohol may contribute a significant source of kcalories but should be avoided. Maintenance of ideal body weight (see Chapter 6) and regular exercise of at least 30 minutes on most days applies to the person with renal disease and to the general population.

WHAT IS THE ROLE OF THE NURSE AND OTHER HEALTH CARE PROFESSIONALS IN THE MANAGEMENT OF RENAL DISEASE?

The nurse should be aware that nutritional treatment of kidney stones should not be approached lightly. Dietary changes may not be necessary, and restrictions can cause nutritional inadequacy and hardship for the patient. Nutritional advice should be made only in consultation with the individual's health care provider.

A person with chronic renal disease has difficult decisions to make. Life expectancy with CKD or ESRD can be extended, but only at the expense of an impaired quality of life. Stress on other family members will likely occur. As a consequence, an individual with newly diagnosed CKD can be expected to experience typical grief reactions—denial and anger first, with the need for information and acceptance of responsibility for management of the disease appearing only later. A nurse or other health care professional can help a person with renal disease to express concerns and develop plans to address issues of quality of life.

Through a sensitive approach and strong communication and listening skills, the health care professional can begin to determine what grief stage the person with renal disease has reached and can develop an appropriate plan of action, with referrals as a cornerstone of therapy: a referral to a social worker might be indicated if the patient is exhibiting anger or denial; a referral to a dietitian is imperative when the person is ready to accept responsibility for dietary control; in addition, a referral to a nurse at a dialysis center is beneficial with regard to dialysis issues such as the control of dry mouth. The nurse can further help the person with renal disease identify the available options and the advantages and disadvantages of each. Social workers can be helpful in this area to identify resources available in the community. Finally, the health care professional can help the person perceive that life is inherently valuable irrespective of the diminished quality.

For the individual who has begun to take responsibility for the control of chronic renal disease, the health care professional can help serve as a reality tester. The person with renal disease cannot make drastic long-term dietary changes easily and therefore should be verbally rewarded for the attempts made, reassured that mistakes and overindulgences will happen, and encouraged not to give up the fight.

Chapter Challenge Questions & Classroom Activities

1. What foods can the person with renal disease generally consume freely, in moderate amounts, and in restrictive amounts?
2. Why does the person with CKD need to restrict protein, electrolytes, and fluid?
3. What causes uremic symptoms to develop?
4. Record a 24-hour diet recall on yourself. Calculate the amount of protein, phosphorus, sodium, and potassium in your diet.
5. As a class, visit a dialysis unit. Arrange to have a nurse, a dietitian, and if possible, a person with renal disease consult with the class on the dietary control of renal disease as it pertains to dialysis.

Case Study

Nellie's children and grandchildren were being screened for kidney disease. This was because her mother had died of ESRD. Nellie had recently been diagnosed with chronic kidney disease. Although she was limiting her total protein intake, she still included some with meals, especially breakfast, to help prevent her symptoms of hypoglycemia. Her mother had been Native American, and along with her own obesity had been advised she had hyperinsulinemia that could develop into diabetes. So far Nellie didn't have the diagnosis, but her nurse practitioner advised that she have a 2-hour oral glucose tolerance test to help verify hyperglycemia wasn't the cause of her kidney disease.

Critical Thinking Applications

1. What factors increase the risk of Nellie's developing diabetes?
2. In general, how many grams of protein should she limit herself to in a day if she is 65 inches tall and weighs 180 lb?
3. What are some low-potassium foods Nellie may need to limit as her renal function declines?
4. What tests determine risk of CKD-mineral and bone disorder; what guidance is appropriate if Nellie is diagnosed with CKD-MBD?
5. What could Nellie do to prevent symptoms of hypoglycemia if she needs to restrict protein?

REFERENCES

Al-Homrany MA, Abdelmoneim I: Significance of proteinuria in type 2 diabetic patients treated at a primary health care center in Abha City, Saudi Arabia, *West Afr J Med* 23(3):211-214, 2004.

Andress DL, Coyne DW, Kalantar-Zadeh K, Molitch ME, Zangeneh F, Sprague SM: Management of secondary hyperparathyroidism in stages 3 and 4 chronic kidney disease, *Endocr Pract* 14(1):18-27, 2008.

Araújo IC, Kamimura MA, Draibe SA, Canziani ME, Manfredi SR, Avesani CM, Sesso R, Cuppari L: Nutritional parameters and mortality in incident hemodialysis patients, *J Ren Nutr* 16(1):27-35, 2006.

Asplin JR, Coe FL: Hyperoxaluria in kidney stone formers treated with modern bariatric surgery, *J Urol* 177(2):565-569, 2007.

Ayodele OE, Alebiosu CO, Salako BL: Diabetic nephropathy—a review of the natural history, burden, risk factors and treatment, *J Natl Med Assoc* 96(11):1445-1454, 2004.

Barri YM: Hypertension and kidney disease: a deadly connection, *Curr Hypertens Rep* 10(1):39-45, 2008.

Beijer C, Planken EV: Hypercalcemia due to chronic vitamin A use by an elderly patient with renal insufficiency, *Ned Tijdschr Geneeskd* 145(2):90-93, 2001.

Biselli PM, Sanches de Alvarenga MP, Abbud-Filho M, Ferreira-Baptista MA, Galbiatti AL, Goto MT, Cardoso MA, Eberlin MN, Haddad R, Goloni-Bertollo EM, Pavarino-Bertelli EC: Effect of folate, vitamin B_6, and vitamin B_{12} intake and MTHFR C677T polymorphism on homocysteine concentrations of renal transplant recipients, *Transplant Proc* 39(10):3163-3165, 2007.

Brandenburg V, Floege J: Early diagnosis of chronic kidney disease. New insights into creatinine and proteinuria, *Med Klin (Munich)* 101(Suppl 1):158-162, 2006.

Branten AJ, Swinkels DW, Klasen IS, Wetzels JF: Serum ferritin levels are increased in patients with glomerular diseases and proteinuria, *Nephrol Dial Transplant* 19(11): 2754-2760, 2004.

Brzeszczynska J, Luciak M, Gwozdzinski K: Alterations of erythrocyte structure and cellular susceptibility in patients with chronic renal failure: effect of haemodialysis and oxidative stress, *Free Radic Res* 42(1):40-48, 2008.

Cano NJ, Fouque D, Leverve XM: Application of branched-chain amino acids in human pathological states: renal failure, *J Nutr* 136(Suppl 1):299S-307S, 2006.

Castilla P, Dávalos A, Teruel JL, Cerrato F, Fernández-Lucas M, Merino JL, Sánchez-Martín CC, Ortuño J, Lasunción MA: Comparative effects of dietary supplementation with red grape juice and vitamin E on production of superoxide by circulating neutrophil NADPH oxidase in hemodialysis patients, *Am J Clin Nutr* 87(4):1053-1061, 2008.

Chalmers L, Kaskel FJ, Bamgbola O: The role of obesity and its bioclinical correlates in the progression of chronic kidney disease, *Adv Chronic Kidney Dis* 13(4):352-364, 2006.

Chan M, Cheema BS, Fiatarone Singh MA: Progressive resistance training and nutrition in renal failure, *J Ren Nutr* 17(1):84-87, 2007.

Chung TT, Summers S, Sheaff M, Cunningham J: Always look beyond the stones: hyperoxaluria overlooked, *Clin Nephrol* 62(1):58-61, 2004.

Coresh J, Selvin E, Stevens LA, Manzi J, Kusek JW, Eggers P, Van Lente F, Levey AS: Prevalence of chronic kidney disease in the United States, *JAMA* 298(17):2038-2047, 2007.

Costa E, Pereira BJ, Rocha-Pereira P, Rocha S, Reis F, Castro E, Teixeira F, Miranda V, do Sameiro Faria M, Loureiro A, Quintanilha A, Belo L, Santos-Silva A: Role of prohepcidin, inflammatory markers and iron status in resistance to rhEPO therapy in hemodialysis patients, *Am J Nephrol* 28(4):677-683, 2008.

Daviglus ML, Greenland P, Stamler J, Elliott P, Appel LJ, Carnethon MR, Chan Q, Claeys G, Kesteloot H, Miura K, Nakagawa H, Pirzada A, Steffen L, Yan LL, Zhou B, Dyer AR: Relation of nutrient intake to microalbuminuria in nondiabetic middle-aged men and women: International Population Study on Macronutrients and Blood Pressure (INTERMAP), *Am J Kidney Dis* 45(2):256-266, 2005.

De Vriese AS, Borrey D, Mahieu E, Claeys I, Stevens L, Vanhaeverbeke A, Roelens M, Langlois MR: Oral vitamin C administration increases lipid peroxidation in hemodialysis patients, *Nephron Clin Pract* 108(1):c28-34, 2008.

Duffey BG, Pedro RN, Makhlouf A, Kriedberg C, Stessman M, Hinck B, Ikramuddin S, Kellogg T, Slusarek B, Monga M: Roux-en-Y gastric bypass is associated with early increased risk factors for development of calcium oxalate nephrolithiasis, *J Am Coll Surg* 206(6):1145-1153, 2008.

Ekeruo WO, Tan YH, Young MD, Dahm P, Maloney ME, Mathias BJ, Albala DM, Preminger GM: Metabolic risk factors and the impact of medical therapy on the management of nephrolithiasis in obese patients, *J Urol* 172(1):159-163, 2004.

Factor KF: Potassium management in pediatric peritoneal dialysis patients: can a diet with increased potassium maintain a normal serum potassium without a potassium supplement? *Adv Perit Dial* 23:167-169, 2007.

Ferrari P, Bonny O: Diagnosis and prevention of uric acid stones, *Ther Umsch* 61(9):571-574, 2004.

Gordon PL, Sakkas GK, Doyle JW, Shubert T, Johansen KL: Relationship between vitamin D and muscle size and strength in patients on hemodialysis, *J Ren Nutr* 17(6):397-407, 2007.

Gorman G, Fivush B, Frankenfield D, Warady B, Watkins S, Brem A, Neu A: Short stature and growth hormone use in pediatric hemodialysis patients, *Pediatr Nephrol* 20(12): 1794-1800, 2005.

Guay DR: Are there alternatives to the use of quinine to treat nocturnal leg cramps? *Consult Pharm* 23(2):141-156, 2008.

Halbesma N, Brantsma AH, Bakker SJ, Jansen DF, Stolk RP, De Zeeuw D, De Jong PE, Gansevoort RT: Gender differences in predictors of the decline of renal function in the general population, *Kidney Int* 74(4):505-512, 2008.

Handelman GJ, Levin NW: Iron and anemia in human biology: a review of mechanisms, *Heart Fail Rev* 13(4):393-404, 2008.

Hogg RJ, Fitzgibbons L, Atkins C, Nardelli N, Bay RC; North American IgA Nephropathy Study Group: Efficacy of omega-3 fatty acids in children and adults with IgA nephropathy is dosage- and size-dependent, *Clin J Am Soc Nephrol* 1(6):1167-1172, 2006.

Horl MP, Horl WH: Hypertension and dialysis, *Kidney Blood Press Res* 26(2):76-81, 2003.

Ishani A, Grandits GA, Grimm RH, Svendsen KH, Collins AJ, Prineas RJ, Neaton JD: Association of single measurements of dipstick proteinuria, estimated glomerular filtration rate, and hematocrit with 25-year incidence of end-stage renal disease in the multiple risk factor intervention trial, *J Am Soc Nephrol* 17(5):1444-1452, 2006.

Iyisoy A, Celik T, Yuksel UC, Bugan B, Isik E: The value of hydration and acetylcysteine in the prevention of contrast-induced nephropathy: a potentially catastrophic complication of the percutaneous coronary interventions, *Int J Cardiol*, May 21, 2008 (Epub ahead of print).

Johnson DW, Pollock CA, Macdougall IC: Erythropoiesis-stimulating agent hyporesponsiveness, *Nephrology (Carlton)* 12(4):321-330, 2007.

Khan SR, Glenton PA, Byer KJ: Dietary oxalate and calcium oxalate nephrolithiasis, *J Urol* 178(5):2191-2196, 2007.

Kleinman JG: Bariatric surgery, hyperoxaluria, and nephrolithiasis: a plea for close postoperative management of risk factors, *Kidney Int* 72(1):8-10, 2007.

Klooster A, Leuvenink HG, Gans RO, Bakker SJ: Tissue thiamine deficiency as potential cause of delayed graft function after kidney transplantation: thiamine supplementation of kidney donors may improve transplantation outcome, *Med Hypotheses* 69(4):873-878, 2007.

Kumagai H, Katoh S, Hirosawa K, Kimura M, Hishida A, Ikegaya N: Renal tubulointerstitial injury in weanling rats with hyperhomocysteinemia, *Kidney Int* 62(4):1219-1228, 2002.

La Villa G, Pantaleo P, Tarquini R, Cirami L, Perfetto F, Mancuso F, Laffi G: Multiple immune disorders in unrecognized celiac disease: a case report, *World J Gastroenterol* 9(6):1377-1380, 2003.

Lea J, Cheek D, Thornley-Brown D, Appel L, Agodoa L, Contreras G, Gassman J, Lash J, Miller ER 3rd, Randall O, Wang X, McClellan W; AASK Study Investigators: Metabolic syndrome, proteinuria, and the risk of progressive CKD in hypertensive African Americans, *Am J Kidney Dis* 51(5):732-740, 2008.

Lieske JC, Kumar R, Collazo-Clavell ML: Nephrolithiasis after bariatric surgery for obesity, *Semin Nephrol* 28(2):163-173, 2008.

Małgorzewicz S, Debska-Slizień A, Rutkowski B, Lysiak-Szydłowska W: Serum concentration of amino acids versus nutritional status in hemodialysis patients, *J Ren Nutr* 18(2):239-247, 2008.

Manley HJ: Disease progression and the application of evidence-based treatment guidelines diagnose it early: a case for screening and appropriate management, *J Manag Care Pharm* 13(9 Suppl D):S6-S12, 2007.

Maric C, Sullivan S: Estrogens and the diabetic kidney, *Gend Med* 5(Suppl A):S103-S113, 2008.

Matsumura I, Kanakura Y: Pathogenesis of anemia of chronic disease, *Nippon Rinsho* 66(3):535-539, 2008.

Mitch WE: Beneficial responses to modified diets in treating patients with chronic kidney disease, *Kidney Int Suppl* (94):S133-S135, 2005.

Moe SM, Drüeke T, Lameire N, Eknoyan G: Chronic kidney disease-mineral-bone disorder: a new paradigm, *Adv Chronic Kidney Dis* 14(1):3-12, 2007.

Moinuddin I, Leehey DJ: A comparison of aerobic exercise and resistance training in patients with and without chronic kidney disease, *Adv Chronic Kidney Dis* 15(1):83-96, 2008.

Muthukumar A, Zaman K, Lawrence R, Barnes JL, Fernandes G: Food restriction and fish oil suppress atherogenic risk factors in lupus-prone (NZB x NZW) F1 mice, *J Clin Immunol* 23(1):23-33, 2003.

Negi S, Okamoto M, Shigematsu T: Parathyroid and bone: secondary hyperparathyroidism after renal transplantation, *Clin Calcium* 17(12):1880-1887, 2007.

Obligado SH, Goldfarb DS: The association of nephrolithiasis with hypertension and obesity: a review, *Am J Hypertens* 21(3):257-264, 2008.

Pak CY, Sakhaee K, Moe O, Preminger GM, Poindexter JR, Peterson RD, Pietrow P, Ekeruo W: Biochemical profile of stone-forming patients with diabetes mellitus, *Urology* 61(3):523-527, 2003.

Perrotta S, Nobili B, Rossi F, Criscuolo M, Iolascon A, Di Pinto D, Passaro I, Cennamo L, Oliva A, Della Ragione F: Infant hypervitaminosis A causes severe anemia and thrombocytopenia: evidence of a retinol-dependent bone marrow cell growth inhibition, *Blood* 15;99(6):2017-2022, 2002.

Porsti I, Fan M, Koobi P, Jolma P, Kalliovalkama J, Vehmas TI, Helin H, Holthofer H, Mervaala E, Nyman T, Tikkanen I: High calcium diet down-regulates kidney angiotensin-converting enzyme in experimental renal failure, *Kidney Int* 66(6):2155-2166, 2004.

Razeghi E, Parkhideh S, Ahmadi F, Khashayar P: Serum CRP levels in pre-dialysis patients, *Ren Fail* 30(2):193-198, 2008.

Reis KA, Guz G, Ozdemir H, Erten Y, Atalay V, Bicik Z, Ozkurt ZN, Bali M, Sindel S: Intravenous iron therapy as a possible risk factor for atherosclerosis in end-stage renal disease, *Int Heart J* 46(2):255-264, 2005.

Saab G, Young DO, Gincherman Y, Giles K, Norwood K, Coyne DW: Prevalence of vitamin D deficiency and the safety and effectiveness of monthly ergocalciferol in hemodialysis patients, *Nephron Clin Pract* 105(3):c132-138, 2007.

Saltzman MD, King EC: Central physeal arrests as a manifestation of hypervitaminosis A, *J Pediatr Orthop* 27(3):351-353, 2007.

Sarkar SR, Kotanko P, Levin NW: Interdialytic weight gain: implications in hemodialysis patients, *Semin Dial* 19(5):429-433, 2006.

Sarnak MJ, Greene T, Wang X, Beck G, Kusek JW, Collins AJ, Levey AS: The effect of a lower target blood pressure on the progression of kidney disease: long-term follow-up of the modification of diet in renal disease study, *Ann Intern Med* 142(5):342-351, 2005.

Sato S, Hori Y, Yamate J, Saito T, Kurasaki M, Hatai A: Protective effect of dietary adzuki bean (*Vigna angularis*) seed coats against renal interstitial fibrosis of rats induced by cisplatin, *Nutrition* 21(4):504-511, 2005.

Savica V, Calvani M, Benatti P, Santoro D, Monardo P, Peluso G, Bellinghieri G: Carnitine system in uremic patients: molecular and clinical aspects, *Semin Nephrol* 24(5):464-468, 2004.

Singh A, Sarkar SR, Gaber LW, Perazella MA: Acute oxalate nephropathy associated with orlistat, a gastrointestinal lipase inhibitor, *Am J Kidney Dis* 49(1):153-157, 2007.

Sinha MK, Collazo-Clavell ML, Rule A, Milliner DS, Nelson W, Sarr MG, Kumar R, Lieske JC: Hyperoxaluric nephrolithiasis is a complication of Roux-en-Y gastric bypass surgery, *Kidney Int* 72(1):100-107, 2007.

Skarupskiene I, Kuzminskis V, Abdrachmanovas O, Ryselis S, Smalinskiene A: Zinc and aluminum concentrations in blood of hemodialysis patients and its impact on the frequency of infections, *Medicina (Kaunas)* 41(Suppl 1):65-68, 2005.

Sqalli TH, Laboudi A, Faik M, Benamar L, Amar Y, Ouzeddoun N, Bayahia R, Rhou H: Hypertension in related living donor renal allograft recipients, *Saudi J Kidney Dis Transpl* 19(2):256-259, 2008.

Suzuki H, Fukushima M, Usami M, Ikeda M, Taniguchi A, Nakai Y, Matsuura T, Yasuda K, Hosokawa M, Seino Y, Yamada Y: IGT with fasting hyperglycemia is more strongly associated with microalbuminuria than IGT without fasting hyperglycemia, *Diabetes Res Clin Pract* 64(3):213-219, 2004.

Tanner LM, Näntö-Salonen K, Rashed MS, Kotilainen S, Aalto M, Venetoklis J, Niinikoski H, Huoponen K, Simell O: Carnitine deficiency and L-carnitine supplementation in lysinuric protein intolerance, *Metabolism* 57(4):549-554, 2008.

Taylor EN, Curhan GC: Body size and 24-hour urine composition, *Am J Kidney Dis* 48(6):905-915, 2006.

Taylor EN, Curhan GC: Fructose consumption and the risk of kidney stones, *Kidney Int* 73(2):207-212, 2008.

Taylor EN, Stampfer MJ, Curhan GC: Dietary factors and the risk of incident kidney stones in men: new insights after 14 years of follow-up, *J Am Soc Nephrol* 15(12):3225-3232, 2004.

Taylor EN, Stampfer MJ, Curhan GC: Obesity, weight gain, and the risk of kidney stones, *JAMA* 293(4):455-462, 2005.

Thorsteinsdottir B, Grande JP, Garovic VD: Acute renal failure in a young weight lifter taking multiple food supplements, including creatine monohydrate, *J Ren Nutr* 16(4):341-345, 2006.

Tzamaloukas AH, Raj DS, Onime A, Servilla KS, Vanderjagt DJ, Murata GH: The prescription of peritoneal dialysis, *Semin Dial* 21(3):250-257, 2008.

Valavi E, Otukesh H, Fereshtehnejad SM, Sharifian M: Clinical correlation between dyslipidemia and pediatric chronic allograft nephropathy, *Pediatr Transplant* 12(7):748-754, 2008.

Watanabe Y: Vitamin D supplementation for chronic kidney disease according to the guideline issued by DOQI, *Clin Calcium* 14(5):778-785, 2004.

Weaver DJ Jr, Kimball TR, Knilans T, Mays W, Knecht SK, Gerdes YM, Witt S, Glascock BJ, Kartal J, Khoury P, Mitsnefes MM: Decreased maximal aerobic capacity in pediatric chronic kidney disease, *J Am Soc Nephrol* 19(3):624-630, 2008.

Wong PN, Mak SK, Lo KY, Tong GM, Wong AK: Factors associated with poorly-controlled hypertension in continuous ambulatory peritoneal dialysis patients, *Singapore Med J* 45(11):520-524, 2004.

Yasui T, Tanaka H, Fujita K, Iguchi M, Kohri K: Effects of eicosapentaenoic acid on urinary calcium excretion in calcium stone formers, *Eur Urol* 39(5):580-585, 2001.

Yokoyama A, Kikuchi K, Kawamura Y: Heart rate variability, arrhythmia and magnesium in hemodialysis patients, *Clin Calcium* 15(2):226-232, 2005.

Younes H, Alphonse JC, Deteix R: Role of dietary fiber in the nutritional management of chronic renal failure, *Nephrologie* 25(7):283-285, 2004.

chapter

10

Cancer: *Nutrition Prevention and Treatment*

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Chapter Topics

Definition of Cancer
Causes of Cancer and Lifestyle Recommendations to Reduce Cancer Risk
How Nutrition Increases or Decreases Risk of Specific Cancers
The Effect of Cancer on Nutritional Status
Nutritional Problems and Goals With Treatment
The Role of the Nurse and Other Health Care Professionals in Nutritional Counseling for Cancer Prevention and Treatment

Objectives

After completing this chapter, you should be able to:

- Describe cancer prevention strategies.
- Explain how cancer and its treatments affect nutritional status.
- Discuss the eating problems associated with cancer and possible solutions.
- Explain why nutritional needs must be met during cancer treatment.
- Discuss the role of the nurse in counseling for the prevention or management of cancer.

Terms to Identify

Acrylamide
Aflatoxins
Angiogenesis
Barrett's esophagus
Cancer
Cancer cachexia
Chemotherapy
Dysgeusia
Endometrial
Epidemiologic research
Esophagitis
Glossitis
Glutathione
Nitrosamines
Oncology
Radiation therapy
Stomatitis
Systemic

INTRODUCTION

The incidence of a variety of cancers has increased since World War II. Cancer as a whole is the second leading cause of death in the United States, following heart disease. There are many causes of cancer, including genetic predisposition and environmental factors. Although much is known regarding the prevention and treatment of cancer, there are still many unanswered questions. Issues regarding the impact of diet continue to be examined.

The metabolic syndrome has now been associated with many types of cancer, including breast, colon, pancreatic, liver, and **endometrial** (involving the lining of the uterus). Although there are other reasons these cancers develop, Westernized lifestyles with decreased levels of physical activity and increased obesity appear to play a major role. It is generally well accepted that a Westernized diet with high meat intake and few fruits and vegetables is a significant factor in the development of cancer. The role of inflammation, linked to the metabolic syndrome, is now being examined with regard to its impact on cancer risk (see later sections).

The best advice to give the public regarding preventive nutritional practices is to follow the dietary guidelines that emphasize moderation, balance, and variety, with emphasis on high-fiber plant foods (whole grains, legumes, vegetables, and fruits), monounsaturated fats, and lean meats, such as fish and chicken. This chapter explores current knowledge regarding the prevention of cancer, discusses nutritional goals for the individual with cancer, explains how cancer treatment affects nutritional needs, and reviews issues confronting the increasing numbers of survivors of cancer.

WHAT IS CANCER?

Cancer is characterized by the uncontrolled growth and spread of abnormal cells, which continue to reproduce until they form a mass of tissue known as a tumor. A malignant tumor interrupts body functions and takes away the food and blood supply from normal cells. Cancers develop in various sites and require different methods of management. **Oncology** is the study and the sum of knowledge of tumors; an oncologist is a medical doctor who specializes in the treatment of cancer.

WHAT ARE THE CAUSES OF CANCER AND HOW CAN ONE REDUCE CANCER RISK?

Most nutrition research in the field of oncology is based on observed associations or population studies referred to as **epidemiologic research.** This implies that populations with cancer are found to have certain risk factors in tandem, at a statistically significant level, that are not found in populations with low risk of cancer. This is an association, not a cause-and-effect relationship. It will be many years before the mechanisms of the causes and effects of dietary patterns and specific nutrient influences on the risk of cancer development are fully understood.

Chronic inflammation is now recognized to promote cancer and is one of the common features found with the metabolic syndrome. Inflammation promotes gene mutations leading to cells more prone to cancer development. An inflammatory response is typically accompanied by generation of free radicals (Dobrovolskaia and Kozlov, 2005). Free radicals are known to induce chromosomal changes in deoxyribonucleic acid (DNA). **Angiogenesis** (the creation of blood vessels) is now known to be linked with cancer development and is influenced by inflammation.

Excess body weight, whether overweight or obesity, is linked with the metabolic syndrome and risk of cancer. Hyperinsulinemia is felt to contribute through its promotion of tumor growth. Hyperinsulinemia should be managed with diet and exercise (see Chapters 5 and 8) and/or insulin-sensitizing agents to avoid an increased risk for cancer. Use of insulin by injection should not be undertaken lightly for a person with type 2 diabetes because there may be a resultant increased risk of cancer

(Frasca and colleagues, 2008). The list of cancers related to obesity, hyperinsulinemia, and elevated blood glucose levels include the following:

- Gynecologic cancers (postmenopausal breast and endometrial cancers)
- Cancers connected to the digestive tract (oral cavity, esophagus, gastric, colon, pancreatic, kidney, liver, and gallbladder)
- Bladder and prostatic cancers
- Leukemia
- Non-Hodgkin's lymphoma (Pisani, 2008; Pischon, Nöthlings, and Boeing, 2008; Renehan, Roberts, and Dive, 2008; Suba and Ujpál, 2006).

A number of environmental and dietary factors have been implicated beyond weight concerns. Of major concern are outdoor air pollution by carbon particles, indoor air pollution by environmental tobacco smoke, radon gas released from rock structures below buildings, formaldehyde in housing materials and other chemicals, and nitrates in processed meats (Irigaray and colleagues, 2007).

Evidence is building that at least 17 different types of cancer are vitamin D–sensitive. A significant reduction in risk for pancreatic cancer has been found with high levels of serum vitamin D levels as noted with the laboratory value 25(OH)D (see Chapter 3). Poor vitamin D status as generally found in African Americans contributes to their higher incidence and mortality from various cancers, such as pancreatic cancer (Giovannucci, 2009). It is estimated that there is up to a 50% reduction in risk for developing colorectal, breast, and prostate cancer by raising blood levels of 25(OH)D greater than 30 ng/mL by either sun exposure or supplemental vitamin D (Holick, 2008).

Total meat and processed meat intake have been directly related to the risk of several cancers related to the digestive tract and to lung, breast, and testicular cancers. Intake of fish and poultry was related to lower risk of several cancers (Hu and colleagues, 2008). Iron, as found in red meat, promotes oxidation that can damage DNA. This damage is similar to that resulting from radiation (Tappel, 2007). The condition of iron overload, or hemachromatosis, has been linked with cirrhosis and increased risk of liver cancer (Horvath and David, 2004). However, no association was found with iron in the development of colorectal cancer in women (Chan and colleagues, 2005). One explanation of differing outcomes related to iron and risk of cancer is fecal occult blood loss with the onset of colorectal cancer (Beale, Penney, and Allison, 2005).

The mineral arsenic has been implicated in cancer development. The inorganic form, which is the most toxic and carcinogenic, may be found in drinking water around the world (see Chapter 14). In humans, chronic ingestion of inorganic arsenic (greater than 500 mg/L) has been associated with cancer of the skin, bladder, lung, liver, and prostate. Other micronutrients, many of which are antioxidants, can help reduce the risk associated with arsenic (Anetor, Wanibuchi, and Fukushima, 2007).

Maintaining or returning to more traditional eating patterns is important for a number of population groups to prevent chronic illnesses such as cancer. Diets consumed historically were high in fiber and a number of nutrients that appear protective against cancer. These include the following:

- Antioxidants (found in dark-green leafy vegetables and deep-orange vegetables and fruits: phytochemicals and a variety of others—see Chapter 3)
- Vitamin E (found in nuts and the germ portion of whole grains)
- Vitamin C (found in berries, dark-green leafy vegetables, and citrus fruits)

The inclusion of foods containing antioxidants helps prevent damage to DNA, thereby promoting genetic stability and reduced cancer risk. Exercise, weight management, and reduced kilocalorie and protein intake has been linked with improved hormonal status and lower risk of cancer (Fontana, Klein, and Holloszy, 2006).

The American Institute for Cancer Research (www.aicr.org) notes a reduction in risk of cancer by 30% to 40% through following the Diet and Health Guidelines for Cancer Prevention. These guidelines can serve as appropriate advice for individuals on prevention of cancer. These guidelines are described in the following sections.

CHOOSE A DIET RICH IN A VARIETY OF PLANT-BASED FOODS

Increase intake of vitamins, minerals, and phytochemicals as naturally found in plant-based foods. This includes a variety of cruciferous vegetables (broccoli, spinach, cabbage, and Brussels sprouts), legumes, fruits, and whole grains that has long been associated with reduced cancer risk.

With a focus on a plant-based diet, sugar intake is indirectly inhibited. Avoidance of sugar-based drinks is part of the 2005 Dietary Guidelines. Following this guideline helps normalize hyperinsulinemia among persons with the metabolic syndrome and likely minimizes risk of cancer development for such individuals. This is because of the reduced production of insulin-like growth factor that occurs in the presence of hyperinsulinemia.

EAT PLENTY OF VEGETABLES AND FRUITS

Increase fiber intake by increased intake of vegetables and fruits. Insoluble fiber (generally the skin and seeds of vegetables and fruits; see Chapter 2) is believed to lower cancer risk in part because the fiber moves food through the gastrointestinal tract faster. This rapid transit of food through the intestines decreases the amount of time carcinogens are in contact with the gastrointestinal mucosa.

Other benefits of increasing vegetables and fruits is the impact on serum levels of antioxidants. High plasma levels of ascorbic acid, selenium, and carotenoids have been noted to protect against cancer. High plasma concentrations of carotene are associated both with lower mortality from all causes and with lower rates of cancer in the elderly (Buijsse and colleagues, 2005). A focus on dark-green leafy vegetables will provide vitamins A and C, folate, and magnesium. Retinoids (vitamin A) as found in dark-green leafy and orange vegetables and fruits have cancer preventative and treatment properties. Magnesium is now known to reduce inflammation, which is now being connected with cancer. Legumes and dark-green leafy vegetables are very high in magnesium content. Researchers looking at cancer risk and prevention are increasingly recognizing a multitude of factors that allow complex cellular actions. Therefore the fact that eating a variety of unprocessed foods reduces cancer risk is likely related to the complexity of nutrients found in such foods. Review of various antioxidant supplements, including **glutathione** (a polypeptide), melatonin, vitamin A, vitamin C, and vitamin E, found no significant evidence in outcomes of cancer treatment (Block and colleagues, 2007).

Flavonoids are partially responsible for the cancer prevention effect of common vegetables and fruits (Cherng and colleagues, 2007). The much lower risk of colon, prostate, and breast cancers in Asians may be due to the polyphenol (flavonoid)

components and the higher intake of vegetables, fruits, and tea than typical Western diets provide (Kandaswami and colleagues, 2005).

MAINTAIN A HEALTHY WEIGHT AND BE PHYSICALLY ACTIVE

Stay physically active to help prevent obesity and promote insulin sensitivity. This allows reduced production of insulin-like growth factor and may be one of the reasons that normal-weight, physically active individuals have lower rates of cancer. Maintaining a normal body weight helps prevent an inflammatory state. Reducing inflammation helps prevent cancer risk.

DRINK ALCOHOL IN MODERATION, IF AT ALL

Avoid excess alcohol intake. A product of alcohol metabolism, acetaldehyde, causes DNA to become fragile through its destruction of the folate molecule and appears to promote tumor formation. Smoking compounds the risk. Poor diet associated with alcohol abuse can lead to deficiencies of riboflavin, folate, and zinc, which further promote a high risk of throat, colon, liver, and breast cancer (Poschl and colleagues, 2004). For women with risk of breast cancer, avoidance of all alcohol is generally advocated. Some newer research suggests a diet containing adequate folate may allow such women to safely include moderate amounts of alcohol (see section on breast cancer) as advised by the American Heart Association to lower risk of cardiovascular disease.

SELECT FOODS LOW IN FAT AND SALT

Limit saturated fat intake because it is related to increased incidence of cancer. Most polyunsaturated fats also are now felt to increase cancer risk because of their tendency to oxidize and form free radicals. The exception is the form of polyunsaturated fat known as omega-3 fatty acids, especially the long-chain polyunsaturated fatty acids eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), present in fatty fish and fish oils, which appear to be protective against various forms of cancer (see section on types of cancers below). Several mechanisms whereby omega-3 fatty acids reduce cancer risk have been proposed. These include reduced production of the fatty acid arachidonic acid (see Chapter 2), altered gene expression, alteration of estrogen metabolism, changes in production of free radicals and reactive oxygen species, and mechanisms involving insulin sensitivity and membrane fluidity (Larsson and colleagues, 2004). Reduction in inflammation levels from the inclusion of fatty fish with EPA and DHA omega-3 fatty acids also may explain the association with reduced cancer risk (Babcock, Dekoj, and Espat, 2005).

Monounsaturated fats, as found in olive oil, appear to have at least a neutral effect on cancer risk. The traditional diet of Greece, still followed in Crete, suggests a lower risk of cancer. There is a high intake of olive oil, fiber from a variety of plant-based foods, and fish providing omega-3 fats (Simopoulos, 2004).

One way to decrease the intake of saturated and polyunsaturated fats is to limit the total fat intake. However, because the monounsaturated fats found in olive oil and the omega-3 fatty acids found in cold-water fish appear at least neutral if not protective against cancer, the Mediterranean-style diet (similar to the TLC diet; see Chapter 7) is an alternative to low-fat diets in the battle against cancer and other chronic illnesses such as heart disease and diabetes.

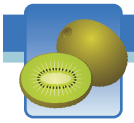
Minimize salt intake to lower cancer risk, especially gastric cancer (Tsugane, 2005). Chinese-style salted fish increases the risk for nasopharyngeal cancer, particularly if eaten during childhood, and should be eaten only in moderation (Key and colleagues, 2004). The impact of salt on risk of cancer may have to do with its ability to erode the protective mucous lining of the stomach. A similar irritant effect on the pharyngeal region may also occur.

PREPARE AND STORE FOODS SAFELY

Practice safe food-handling practices, including avoidance of food pathogens that occur with spoiled foods. **Aflatoxins** that occur with moldy foods are known carcinogens. Avoiding excess intake of foods cooked at high temperatures, such as barbecued meats, reduces intake of harmful **nitrosamines.** Using tin foil on a barbecue grill reduces the exposure of foods to smoke from meat drippings on hot coals.

DO NOT USE TOBACCO IN ANY FORM

Chewing tobacco is a known risk factor for cancer of the oral cavity. Cigarette, cigar, and pipe smoking allows carcinogens to enter systemically and is related to a variety of cancers. The combination of excess alcohol intake and tobacco further increases the risk of oral and throat cancer.



Cultural Considerations

Low socioeconomic status has been linked with increased risk of cancer such as bladder, colon, and rectal cancers. Although it may be presumed this is due to lifestyle, the connection appears more complex and is not understood (Goy, Rosenberg, and King, 2008). ■

Fact & Fallacy

FALLACY Drinking orange juice reduces the risk of cancer.

FACT This is an overly simplistic statement that, when put into practice, can actually increase cancer risk in persons with insulin resistance. To help prevent the development of hyperinsulinemia, fresh fruits and vegetables are advisable. Eating an orange is preferable to drinking juice because juice is often consumed in excess amounts. One orange equates to 4 oz of juice (see Figure 1-1). A person who drinks a 12-oz serving of juice is consuming the equivalent of ¼ cup of sugar. Even though this is fructose, not sucrose, excess may promote hyperinsulinemia and cancer risk. Vegetable juices are lower in sugar content and likely will reduce cancer risk, such as with tomato juice and its lycopene content. ■

HOW DOES NUTRITION INCREASE OR REDUCE RISK OF SPECIFIC CANCERS?

BLADDER CANCER

The fourth leading type of cancer in men in the United States is bladder cancer, which ranks ninth in worldwide cancer incidence. Men have a greater incidence of bladder cancer than women. Cigarette smoking and chronic urinary tract infections (UTIs)

are associated with an increased risk of this cancer (Murta-Nascimento and colleagues, 2007). Cranberry juice has been shown to reduce risk of UTIs. Other potential risk factors include drinking tap water with chlorination by-products or arsenic. Heavy consumption of phenacetin-containing analgesics has been shown to cause bladder cancer in humans (Janković and Radosavljević, 2007). Obesity contributes modest adverse risk for bladder cancer (Koebnick and colleagues, 2008).

Factors that reduce risk of bladder cancer include intake of fruits and vegetables. Intake of B vitamins (B_2, B_6, B_{12}, and folate—see Chapter 3 for food sources) and retinol as found in deep orange and dark-green leafy vegetables are associated with a reduced risk. In particular vitamin B_6 and retinol showed the strongest evidence of risk reduction (García-Closas and colleagues, 2007). Compounds in cruciferous vegetables (broccoli, cauliflower, Brussels sprouts, and cabbage) have an anticarcinogenic effect on bladder cancer (Zhao and colleagues, 2007). Two mushroom extracts, when combined with moderate amounts of vitamin C, became highly cytotoxic, resulting in greater than 90% cell death related to bladder cancer (Konno, 2007).

BREAST CANCER

Breast cancer is the second leading cause of cancer death among U.S. women. Breast cancer can also occur in men, although rarely, and generally there is a worse prognosis because of a delay in diagnosis. Excess weight appears to contribute to risk. Postmenopausal overweight women have an increased risk, as do premenopausal women who have a high waist-to-hip ratio (greater than 0.87) (Tehard and Clavel-Chapelon, 2006). Because estrogen levels increase as a result of obesity, this is one factor behind the increased risk of breast cancer found with obesity (Suzuki and colleagues, 2006).

Evidence supports a moderate association between type 2 diabetes and the risk of breast cancer, particularly among postmenopausal women (Xue and Michels, 2007). A low level of high-density lipoprotein (HDL) cholesterol, as found with the metabolic syndrome, has recently been related to increased breast cancer risk in overweight and obese women (Furberg and colleagues, 2005). The common link with obesity, type 2 diabetes, and breast cancer appears to be insulin resistance with high insulin levels. Hyperinsulinemia has been associated with poor outcomes in breast cancer. Medical nutrition therapy that helps normalize hyperinsulinemia is important in early-stage breast cancer and for the long-term management of breast cancer survivors (Goodwin and colleagues, 2009). See Chapters 5 and 8 on managing hyperinsulinemia via low–glycemic load meals.

Traditional dietary goals have been aimed at low-fat diets to prevent breast cancer. However, in one study among postmenopausal women, a low-fat diet did not reduce breast cancer risk (Prentice and colleagues, 2006). This finding was supported by another study over a 7-year period that found a low-fat diet high in fiber did not reduce reoccurrence of breast cancer (Pierce and colleagues, 2007). On the other hand, a large prospective study found dietary fat intake was directly associated with the risk of postmenopausal breast cancer regardless of type (Thiébaut and colleagues, 2007).

The different outcomes of research related to dietary fat intake likely are due to the type of fat. A low incidence of breast cancer has been noted in the Mediterranean region, where there is a high intake of olive oil. It has been suggested that the benefi-

cial effect of olive oil on lowering risk of breast cancer is due to the many phenolic compounds found in olive oil (Menendez and colleagues, 2007). Intake of oily fish suppresses at least one form of breast cancer. The research suggested there was suppressed tumor incidence and reduced mammary gland abnormality (Sun, Berquin, and Edwards, 2005; Yee and colleagues, 2005). This positive impact of fish oil may result, in part, from decreased inflammation as associated with cancer. See Chapters 5 and 7 on reducing inflammation with diet.

For women with the metabolic syndrome, lowering carbohydrate intake can be presumed beneficial. In fact, a high glycemic index has been associated with increased breast cancer risk, especially among those who were physically inactive or those of normal weight who had used hormone replacement therapy (Silvera and colleagues, 2005). In premenopausal women, increased risk with high glycemic load was related only to overweight and obese women, not women of normal weight (McCann and colleagues, 2007). This is likely due to women of normal weight being insulin sensitive, not insulin resistant. Among women of Italian heritage a high–glycemic load diet increases risk of breast cancer particularly in premenopausal women and those of normal weight (Sieri and colleagues, 2007). Following the Therapeutic Lifestyle Changes (TLC) diet (see Chapter 7) as advised for management of the metabolic syndrome should help reduce risk of breast cancer for women with insulin resistance. Increasing physical activity levels also is linked with lower risk of breast cancer (Bardia and colleagues, 2006). Physical activity improves insulin sensitivity.

A high intake of fruits and vegetables has been shown to significantly decrease risk of breast cancer (Fung and colleagues, 2005). It may be the dietary fiber from fruit and cereal that helps reduce breast cancer risk (Suzuki and colleagues, 2008). A high folate intake, as found in high amounts in legumes and greens, from diet or supplements is associated with a lower incidence of postmenopausal breast cancer (Ericson and colleagues, 2007).

Alcohol consumption, even in moderation, is associated with breast cancer risk, and the risk was found to be greatest in women with lower total folate intake (Stolzenberg-Solomon and colleagues, 2006). The usual recommendation is for women at risk of breast cancer to avoid all alcohol. However, among women with folate intake higher than 350 mcg no association between the alcohol intake and the breast cancer incidence rate was found (Tjonneland and colleagues, 2006). Thus women who want to and can keep alcohol intake within moderate amounts should increase folate intake, especially if known to have a high risk for breast cancer. Folate is found in dark-green leafy vegetables, legumes, whole grains, milk, and fish.

A traditional Asian type of diet of vegetable and soybean products is found with lower breast cancer among Chinese women, whereas a Western type of diet increases breast cancer risk among those who are menopausal (Cui and colleagues, 2007). Phytoestrogens, as found in soy, are a group of plant-derived substances that are similar to estradiol. Because a decreased risk of breast cancer has been recognized in women from Asian countries, phytoestrogens have been implicated as the beneficial factor. Early exposure to soy products in childhood or early adolescence is suggested to be protective. This same benefit has not been shown among breast cancer survivors. The phytoestrogen genistein as may be found in supplemental form interferes with the effects of tamoxifen to reduce breast cancer cell growth (Duffy, Perez, and Partridge, 2007). Soy supplements containing the active ingredients found in soy

are generally discouraged. Green tea polyphenols have been linked with reduced cancer risk, including breast cancer (Thangapazham and colleagues, 2007).

Teaching Pearl

In one study only about one third of women with breast cancer received dietary advice from their physicians. However, over one half stated they would like more information. Diet changes made by the women included less sugar intake, less saturated and trans fats, and reduced alcohol while increasing monounsaturated fats, high-fiber foods, and low-fat dairy products (Landers and colleagues, 2008). Higher intakes of total calcium and vitamin D reduce risk for premenopausal women. However, the benefit was not seen among postmenopausal women (Lin and colleagues, 2007). The health care professional can ask if advice on diet is desired, and at least general guidelines can be promoted. For specific medical nutrition therapy, a referral to a registered dietitian is advised. ■

COLORECTAL CANCER

The incidence of colon cancer in industrialized countries has increased since the early 1970s and has followed the increased rate of obesity and diabetes. Cancer of the colon and rectum continues to be a major cause of death and illness in persons over 50 years of age and is related to the metabolic syndrome.

High waist circumference is an independent risk factor for colorectal adenoma (Kim and colleagues, 2007). Hyperinsulinemia found with excess weight and kcalorie intake with low physical activity also has been associated with colorectal cancer. Other factors include excess alcohol intake, smoking, and low consumption of folate and the amino acid methionine—see Chapter 2 (Campos and colleagues, 2005).

Women with low levels of insulin-like growth hormone and C-peptide (see Chapter 5) were found to have low risk of colon cancer, whereas elevation of either was associated with increased risk (Wei and colleagues, 2005). In persons with type 2 diabetes mellitus, epidemiologic studies show an increased risk for colorectal cancer and an even higher risk if patients are treated with sulfonylureas (see Chapter 8) or insulin. Individuals with type 2 diabetes who are on chronic insulin therapy were found to have three times the risk of colon cancer compared with those without insulin therapy (Chung and colleagues, 2008). It is advised that all patients with type 2 diabetes mellitus undergo colonoscopy before starting insulin therapy and have regular screening at least every 5 years (Berster and Göke, 2008).

Diet and alcohol have an impact. Alcohol is associated with colon cancer. Men who consume greater than or equal to 5 oz of alcohol weekly have twice the risk of colorectal cancer of those who drink less alcohol. Low intake of vitamin B_6 (see Chapter 3) is related to colon cancer, especially when combined with higher alcohol intake (Ishihara and colleagues, 2007).

A number of dietary factors are linked with lower risk of colon cancer. Salt and other substances as found in smoked or salted fish increase risk (Marques-Vidal, Ravasco, and Ermelinda Camilo, 2006). Sweets, refined white flour products, and red meat products are linked with increased risk, whereas a variety of high-fiber foods, low-fat dairy products, white meat, and fish are recommended to lower risk (Ströhle, Maike, and Hahn, 2007). This type of dietary pattern helps increase intake of folate

and vitamin B_6 (see Chapter 3), which are associated with reduced colorectal cancer risk. The use of multivitamin supplements is not related to colorectal cancer risk (Zhang and colleagues, 2006). Vitamin B_6 may further play a role in the prevention of colorectal cancer among those who drink alcohol, especially women (Larsson and colleagues, 2005). A dose of 1000 International Units of vitamin D per day is associated with a 50% reduction in colorectal cancer incidence (Grant, Garland, and Gorham, 2007).

The association of the metabolic syndrome with colon cancer suggests dietary advice should be aimed at reducing carbohydrate intake, rather than focusing on total fat intake. It was found a low-fat dietary pattern did not reduce the risk of colorectal cancer in postmenopausal women during an 8-year period (Beresford and colleagues, 2006). Increasing omega-3 fatty acids is related to reduced risk (Theodoratou and colleagues, 2007).

High–glycemic load meals, fructose, and sucrose have been linked with increased colorectal cancer risk among men (Michaud and colleagues, 2005). Research on fiber intake is less conclusive, but it may be related to other aspects of diet and lifestyle (Michels and colleagues, 2005). A Mediterranean diet, which has a low glycemic index and with traditional small quantities of food, a low glycemic load as well, is associated with reduced risk. This type of diet is similar to public health initiatives such as the 2005 U.S. Dietary Guidelines, MyPyramid Food Guidance System, and the Dietary Approaches to Stop Hypertension (DASH) diet—see Chapters 1 and 7 (Dixon and colleagues, 2007).

There is conflicting evidence regarding intake of calcium and vitamin D from dairy intake or supplements. Some research links intake with lower rates of colon cancer (Larsson and colleagues, 2006a; Park and colleagues, 2007). Other research, such as the large, prospective, female cohort from the U.S. Women's Health Study found no association with reduced risk (Lin and colleagues, 2005).

ENDOMETRIAL AND OVARIAN CANCER

The endometrial lining of the uterus is a common site of cancer in women. Conditions found with the metabolic syndrome are linked with both endometrial and ovarian cancers. This includes the link between inflammation and gynecologic cancers (Goswami and colleagues, 2008). Obesity and hyperinsulinemia are linked. High estrogen levels, as found with obesity, appear to be a major risk factor for endometrial cancer (Gunter and colleagues, 2008). Women with polycystic ovary syndrome, found with the metabolic syndrome and obesity, have increased risk of endometrial cancer (Costello, 2005). Altered lipid levels also are linked. Ovarian cancer is associated with significantly lowered HDL and total cholesterol levels (see Table 10-1).

Folate plays an important role in cancer prevention. Dietary folate intake was linked with reduced endometrial cancer risk among Chinese women (Xu and colleagues, 2007). Leafy greens, rich in folate, also are high in retinoids and carotenoids that are related to low risk of ovarian cancer. It further appears that carotenoids have a role in treatment of ovarian cancer (Czeczuga-Semeniuk and Wolczynski, 2005).

Research on the role of carbohydrates with diet and cancer is limited. There is some evidence that plasma insulin levels from a high–glycemic load diet may influence ovarian cancer risk (Silvera and colleagues, 2007a). Limited evidence has

Table 10-1 Relationship of Plasma Lipid Levels With Gynecologic Cancer

CANCER TYPE	TOTAL CHOLESTEROL	TRIGLYCERIDES	LOW-DENSITY LIPOPROTEIN	HIGH-DENSITY LIPOPROTEIN
Breast	Up 21%	Up 18%	Up 43%	Down 30%
Ovarian	Down 28%	Down 31%	Down 11%	Down 39%
Other gynecologic cancers	Down 21%	Down 25%	Down 6.2%	Down 27%

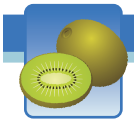
Data from Qadir MI, Malik SA: Plasma lipid profile in gynecologic cancers, *Eur J Gynaecol Oncol* 29(2):158-161, 2008.

indicated high intakes of lactose might increase the risk for ovarian cancer (Key and Spencer, 2007). However, a meta-analysis did not find any association between milk and dairy products and ovarian cancer except for a nonsignificant increased risk from whole milk and butter (Qin and colleagues, 2005).

A 20% low-fat, high-fiber approach has not been shown to be effective at reducing endometrial or ovarian cancer in the short-term, but over an 8-year-period there was a lower rate for ovarian cancer (Prentice and colleagues, 2007).

Ovarian cancer risk was minimally linked among women who drank more than four cups coffee daily compared with women who did not drink coffee. No association was found among tea drinkers (Silvera and colleagues, 2007b).

A relatively new compound, called **acrylamide**, was found in starchy foods prepared at high temperatures, such as with fried foods. This substance has been associated with increased risk of postmenopausal endometrial and ovarian cancer (Hogervorst and colleagues, 2007).



Cultural Considerations

Women with gynecologic cancer and survivors often use complementary and alternative medicine (CAM). One study found about one third of women reported using three or more forms of CAM. The most commonly used were mind-body therapies and supplements. Older, more educated women were most likely to use CAM, especially if worried about ovarian cancer risk or if they had a previous cancer diagnosis. It is advised that providers inquire about and discuss the pros and cons of CAM with their patients—see Chapter 3 on herbal preparations (Mueller and colleagues, 2008). ■

ESOPHAGEAL CANCER

The incidence of esophageal adenocarcinoma is on the rise in the United States. Its precursor condition, **Barrett's esophagus** (a premalignant lesion related to ulceration of the lower esophageal section that can lead to strictures inhibiting the movement of food into the stomach), also is on the rise. Zinc deficiency may contribute to Barrett's esophagus (Guy and colleagues, 2007).

Studies suggest a reduced risk of esophageal cancer in populations with a high intake of fish. One study found supplementation with the omega-3 fatty acid EPA significantly reduced inflammation related to Barrett's esophagus (Mehta and colleagues, 2008).

There is a strong correlation with an increased intake of carbohydrate, especially related to intake of corn syrup as found in sweetened beverages. This may be due to the rise in obesity rates as linked with higher intake of kcalories from sugar-based beverages (Thompson and colleagues, 2008).

Esophageal cancer is related to smoking and use of alcohol. There is an increased risk with the combination of excess alcohol intake and smoking (La Vecchia, Zhang, and Altieri, 2008).

Eating food rapidly and frequent intake of pickled vegetables also have been implicated in increased risk of esophageal cancer (Yang and colleagues, 2005). How increased pace of eating is associated with esophageal cancer is unknown. The reduced saliva release with reduced chewing may play a role. Saliva helps to neutralize acidity of the oral cavity, which may play a role in esophageal cancer.

Increased consumption of fruits (including oranges/tangerines), seafood, and milk were found to be protective against the development of esophageal cancer (Fan and colleagues, 2008). This may be due to the intake of vitamin C, with research of supplements showing a beneficial impact. It was found that those who took a multivitamin, 250 mg of vitamin C, or 180 mg of vitamin E had lower risk of esophageal cancer (Dong and colleagues, 2008).

GASTROINTESTINAL CANCER

Gastrointestinal cancers account for 20% of all cancer incidences worldwide. A variety of factors appears to increase risk of gastric cancer. The risk factors most strongly associated with gastric cancer are diet and the gastric bacterial infection caused by *Helicobacter pylori.* Lower risk was found with increasing intake of several micronutrients and vegetables, especially cruciferous vegetables (Epplein and colleagues, 2008). A positive family history of gastric cancer is a risk factor. Low serum pepsinogen levels reflect gastric atrophy, and screening may help to identify populations at high risk for gastric cancer. *H. pylori* screening and treatment is recommended for those with high risk of gastric cancer (Fock and colleagues, 2008).

Glycemic load and hyperinsulinemia have been connected with gastric cancer risk. Observational studies support a protective effect of citrus fruit intake in the risk of stomach cancer (Bae, Lee, and Guyatt, 2008).

Gastric cancer is a major health burden in the Asia-Pacific region, and a high intake of salt appears to be the cause. Data also suggest that high intake of nitrosamines, processed meat products, and overweight and obesity are associated with increased risk for gastric cancer around the world (Liu and Russell, 2008).

LEUKEMIA

Risk of leukemia has been linked with oxidative stress. This may be precipitated by environmental factors, but poor nutritional intake adds to the risk. A low level of the antioxidant minerals selenium and zinc have been noted, along with a high copper status, in leukemia patients. It is not known if this is the cause or the consequence of leukemia (Zuo and colleagues, 2006). Children with Down syndrome have shown decreased levels of zinc and a fiftyfold increased risk of developing acute leukemia during their first few years of life. Use of a multivitamin supplement was not found to reduce risk of leukemia (Blair and colleagues, 2008).

Other evidence suggests treatment with zinc and magnesium is beneficial with acute lymphocytic leukemia (ALL). It is now advised to provide zinc and magnesium at 3.18 mg/kg and 8.0 mg/kg of body weight per day, respectively. Along with chemotherapy, this approach may be curative (Eby, 2005). There also appears to be an increased need for vitamin C in children with ALL (Neyestani and colleagues, 2007). An isoflavone, genistein, as found in soy has been shown to have cancer-preventing activity in animal models. A soy-enriched diet has the potential to reduce leukemic activity (Raynal and colleagues, 2008).

LIVER CANCER

Liver cancer, more formally known as hepatocellular carcinoma, is often a result of metastasis, because this organ is involved in multiple metabolic processes. Many toxic substances are processed by the liver, including alcohol, a well-known risk factor for the development of liver cancer when consumed in excess.

Hepatitis C virus infection acquired two to four decades ago explains at least half of the recently observed increase in liver cancer rates. This appears related to inflammation causing oxidative damage to DNA. It is suggested that markers of oxidative stress may help predict risk of liver cancer among persons with hepatitis C (Maki and colleagues, 2007).

Diabetes is associated with a twofold to threefold increase in the risk of liver cancer, regardless of the presence of other risk factors (Davila and colleagues, 2005). Hemochromatosis is related to the development of diabetes, liver disease, and cirrhosis, as well as liver cancer. Hyperpigmentation can be observed with this condition. Hepatocellular cancer occurs in 30% of individuals with liver cirrhosis related to hemochromatosis—see Chapter 3 (Horvath and David, 2004).

LUNG CANCER

A variety of causes are related to lung cancer, including smoking, secondhand smoke, and environmental toxins such as pollution or natural sources such as radon. Low dietary magnesium intake has been linked with increased risk and appears to be due to impaired DNA repair capacity (Mahabir and colleagues, 2008b).

Reduced risk of lung cancer has been associated with higher intake of cruciferous vegetables (broccoli, cabbage, cauliflower, Brussels sprouts). This may be due to the phytochemical content of cruciferous vegetables (Wang and colleagues, 2004). Broccoli and Brussels sprouts are both high in magnesium content.

Results demonstrate that a lower intake of n-6 fatty acids with higher n-3 fatty acid intake can help prevent and treat lung cancer (Xia, Wang, and Kang, 2005). This can be explained by another study that showed exposure of lung cancer cells to the omega-3 fatty acid EPA altered levels of prostaglandin, resulting in inhibition of tumor cell proliferation (Yang and colleagues, 2004).

Among women, wine and increased exercise is related to lower risk of lung cancer. For both genders intake of fruits lowered risk (Kubik and colleagues, 2008). Dietary boron intake was inversely associated with lung cancer in women (Mahabir and colleagues, 2008a). There is preliminary evidence that dietary intake of copper, zinc, and iron is associated with reduced lung cancer. This is believed to be due to DNA stability (Mahabir and colleagues, 2007).

PANCREATIC CANCER

In the United States this form of cancer is rare, but there is nearly a 100% mortality rate from pancreatic cancer within 1 to 2 years. Because of this, pancreatic cancer now ranks fourth as a cause of mortality from cancer. Smoking is the major known risk factor for this cancer.

The metabolic syndrome, with hyperinsulinemia and insulin resistance, is associated with pancreatic cancer. This is supported by evidence of elevated nonfasting C-peptide levels (see Chapter 5) among persons with pancreatic cancer (Michaud and colleagues, 2007). Obesity in general and central obesity are linked (Patel and colleagues, 2005). Individuals with a body mass index (BMI) of 35 or higher were found to have a 45% greater risk, whereas waist circumference itself was found to be linked only in women (Stolzenberg-Solomon and colleagues, 2008). Pancreatitis that tends to occur with high triglyceride levels as found with dyslipidemia and the metabolic syndrome and diabetes have been linked. There is a high rate of pancreatic cancer among African Americans, who are known to have high rates of diabetes (Lowenfels and Maisonneuve, 2005).

Research suggests that higher intake of the amino acid methionine may reduce the risk of pancreatic cancer (Larsson and colleagues, 2007). One study suggests that a diet rich in tomatoes and tomato-based products with high lycopene content may help reduce pancreatic cancer risk (Nkondjock and colleagues, 2005). Other evidence suggests increased intake of folate from food sources, but not from supplements, may be associated with a reduced risk of pancreatic cancer (Larsson and colleagues, 2006b). A focus on high-fiber foods in general should help lower the risk of pancreatic cancer by lowering insulin resistance.

PROSTATE CANCER

Prostate cancer is the most common form and leading cause of death from cancer among men in the United States. It is screened with serum prostate-specific antigen (PSA) levels. The greatest factors linked with overall incidence of prostate cancer include African heritage, family history of prostate cancer, and low intake of tomato products. For fatal prostate cancer, recent smoking history, taller height, higher BMI, family history, and high intakes of kcalories, calcium, and alpha-linolenic acid have been found associated. Low level of physical activity is associated with higher risk (Giovannucci and colleagues, 2007). Men who have breast cancer have a higher incidence of prostate cancer than the general population (Lee and Jones, 2008).

The role of hyperinsulinemia in the development of cancer risk is now being recognized. Obesity may promote the development of a more aggressive form of prostate cancer (Amling, 2005). This would be expected for men who have the metabolic syndrome, because high intake of carbohydrate will increase production of insulin. A study with a low-fat diet and exercise resulted in hormonal changes that reduced growth of androgen-dependent prostate cancer cells (Barnard and Aronson, 2005).

As described previously, in managing the metabolic syndrome a reduced intake of saturated fat is a major goal, with substitution of monounsaturated fats for some carbohydrates in the diet. A diet high in refined carbohydrates has been associated

with increased prostate tumor growth in a mouse study (Venkateswaran and colleagues, 2007). This is in contrast to lower cancer rates with high intake of fruits and vegetables (Chong and Rashid, 2005).

Various vitamins and minerals are linked with reduced risk of prostate cancer. In general, food sources are supported by research as the optimal goal, but in some situations supplements can play a positive role. There is weak evidence that multivitamin supplementation reduces risk among men for prostate cancer. Beta-carotene supplementation for men with low dietary intake is helpful (Kirsh and colleagues, 2006). Evidence suggests vitamin E from food sources, rather than supplementation, is needed to have an impact (Wright and colleagues, 2007). Brazil nuts, high in selenium and vitamin E, have been shown to decrease the risk of prostate cancer in some men. Intake of Brazil nuts should be in moderate amounts, however, due to the high saturated fat content. This is particularly true for men with the metabolic syndrome. Vitamin D appears to reduce growth of prostate cancer cells. This may help explain the positive impact of fish intake, which is associated with reduced prostate cancer risk. Consuming whole fish, including the liver (e.g., with sardines), is a natural source of vitamin D. Green tea may reduce risk of prostate cancer (Sonn, Aronson, and Litwin, 2005).

In a large prospective study of prostate cancer, greater dietary intake of calcium and dairy products, particularly low-fat forms, was associated with a slight increased risk for nonaggressive prostate cancer, but was unrelated to aggressive disease. Supplementary calcium intake was not associated with the risk (Ahn and colleagues, 2007).

Adequate intake of lycopene (a phytochemical that is red) from cooked tomatoes is believed to reduce risk for prostate cancer. However, it may not just be the lycopene content of tomatoes that is helpful. Whole tomatoes, which contain a variety of phytochemicals, reduce the risk of prostate cancer.

Although cadmium exposure appears to be a risk factor for prostate cancer, consuming in excess of the Dietary Reference Intake (DRI) for zinc at over 13 mg/day (40 mg/day is the Tolerable Upper Intake Level [UL] for zinc among adult men) appears to offset this risk (van Wijngaarden, Singer, and Palapattu, 2007).

RENAL CANCER

The incidence of kidney or renal cancer has increased in the United States over the past three decades. Weight gain in early adulthood and middle age is strongly associated with kidney cancer, whereas there is no evidence of a connection with weight gain after midlife (over age 50 years). In particular, a high waist-to-hip ratio, as found with the metabolic syndrome, is positively associated with renal cancer in women and for both genders with height (Adams and colleagues, 2008).

Aside from overweight or obesity, exercise was shown to reduce the risk, whereas a Western-style diet and smoking increased the risk (Murai and Oya, 2004). Acrylamide found with heat-treated carbohydrates, as discussed above as a risk factor for endometrial and ovarian cancer, also is implicated with risk of renal cancer (Hogervorst and colleagues, 2008). Women who consume five or more servings of fruit and vegetables daily have been found to have a relative risk of about half that of women who consumed vegetables and fruits less than once daily. Specifically, bananas, cabbage, and root and salad vegetables decreased the risk, but increased

intake of fruit juice increased the risk of renal cancer (Rashidkhani, Lindblad, and Wolk, 2005). Because cranberry juice can be helpful to reduce urinary tract infections, which is important to reduce bladder cancer, limiting cranberry juice to 4 oz of juice per serving can help maintain a low–glycemic load meal. An alternative is cranberry extract tablets.

SKIN CANCER

Malignant melanoma has been one of the most rapidly increasing cancers within the United States. This is the basis for the advice to use sun lotion with sun protection factor (SPF) of at least 15 in order to reduce the adverse effect of ultraviolet (UV) light. Self-monitoring is important, with assessment for changes in shape or appearance of moles. A dermatologist should be consulted for suspicious indicators of skin cancer.

The role of nutritional prevention is being researched. Generally it appears beneficial to include plenty of fruits and vegetables in the diet. In regard to skin cancer, leafy greens seem to have the most impact in lowering risk of melanoma. This was shown in one study comparing intake of a vegetable and fruit dietary pattern to one of meat and fat. The decrease in squamous cell carcinoma risk of over 50% was particularly related to intake of green leafy vegetables (Ibiebele and colleagues, 2007). Recent evidence suggests that low 25(OH)D serum levels (see Chapter 3) may promote the development and progression of malignant melanoma (Nürnberg and colleagues, 2008).

The evidence of the benefits of fruit in prevention of skin cancer is less convincing (McNaughton, Marks, and Green, 2005). There is even evidence that excess intake increases risk of one form of skin cancer. In a large study of nurses, orange juice appeared to increase risk of cutaneous melanoma. This may be due to some naturally occurring substances found in citrus fruits (Sayre and Dowdy, 2008). It is known that vitamin C in excess can lead to oxidative damage, and this process is associated with cancer development. This is the likely explanation of the findings of another study linking basal cell carcinoma with intake of foods high in vitamins C and E plus supplements (Heinen and colleagues, 2007). Moderate intakes of vitamins and minerals from food sources are likely to be safe with benefits outweighing any risk.

Reduced rates of skin cancer are further associated with intake of the omega-3 fatty acids DHA and EPA, as found in cold-water fish. One impact of omega-3 fatty acids is reduced sunburn, an acute inflammatory response (Shahbakhti and colleagues, 2004).

THYROID CANCER

There are various causes of thyroid cancer. One relatively well-known one is due to the April 26, 1986, Chernobyl power plant accident in the Belarus, Russia, and Ukraine region. Those most affected were the cleanup workers and children. Individuals treated or exposed to high levels of radioactive iodine, especially the children who had lived near Chernobyl at the time of the nuclear power plant accident, should be carefully followed up throughout their lifetime because of concerns of secondary cancer such as leukemia (Balonov, 2007; Kumagai and colleagues, 2007).

Avoiding iodine deficiency with regular iodine supplementation can reduce risk from radioactive iodine exposure. This may help to lessen further incidence of thyroid cancer, leukemia, and breast cancer in areas that received lesser contamination from the Chernobyl accident such as in Europe (Kesminiene and Cardis, 2007). Twenty years after the Chernobyl accident, excess thyroid cancers are still occurring among persons exposed as children or adolescents and is likely to continue for several more decades (Ron, 2007).

OTHER CANCERS

Lymphoma has been associated with celiac disease (Smedby and colleagues, 2005). Risk of non-Hodgkin's lymphoma has been related to increased intakes of the B vitamins, folate, and B_6, and the amino acid methionine (Koutros and colleagues, 2008).

HOW DOES CANCER AFFECT THE NUTRITIONAL STATUS OF THE HOST?

ALTERED METABOLISM

Cancer cells use a lot of energy, primarily glucose. This can lead to loss of energy to healthy cells and lower blood glucose levels. There is generally a hypermetabolic state associated with cancer that can lead to weight loss and various health implications with unintended weight loss.

CANCER CACHEXIA

As cancer progresses, appetite and food consumption are likely to decrease, resulting in a form of malnutrition and emaciation commonly called **cancer cachexia.** Cachexia includes weakness, metabolic and hormonal abnormalities, and a progressive loss of vital functions. Cachexia is a common progressive wasting syndrome characterized by extensive loss of adipose tissue and skeletal muscle. Loss of skeletal muscle is caused by reduced protein synthesis and increased protein breakdown.

An altered sense of taste **(dysgeusia),** a feeling of fullness, nausea and vomiting, and food aversions may occur even before therapy begins. Among the most common taste changes are a lowered threshold for bitterness and an elevated threshold for sweetness. This may account for the common aversion to meat and the difficulty in tasting sweet foods. Extra sugar on fruits and cereals is a frequent request. Thresholds for tasting sour and salty foods tend to increase as well.

Cachexia may develop for several reasons. Metabolites, which are chemical substances produced by the tumor, may have an anorexia-inducing effect on the hypothalamus, the portion of the brain believed to regulate hunger and satiety. Figure 10-1 shows the pathways that contribute to cancer cachexia. The same systemic inflammation implicated in cancer development appears related to the hypermetabolism, weight loss, and fatigue associated with cachexia. Decreased inflammation from the omega-3 fatty acids may be of benefit in treating cancer cachexia (MacDonald, 2007). One study found that several individuals with advanced malignancy and significant weight loss who took high-dose omega-3 fatty acid capsules (7.5 g EPA plus DHA for a 70-kg individual) achieved either weight stabilization or weight gain (Burns and colleagues, 2004). Some individuals have found that keeping capsules in

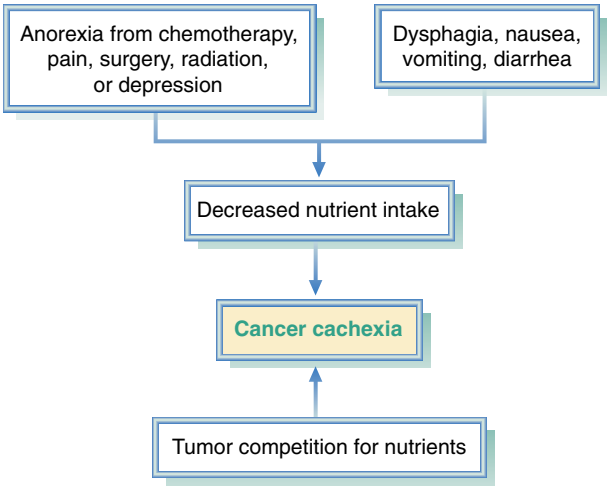
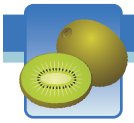


FIGURE 10-1 Cancer cachexia.

the freezer, or using enteric-coated tablets, helps prevent aftertaste. The quantity indicated is not likely to be consumed by diet, with approximately 250 to 300 mg EPA/DHA daily equating to 6 oz of fatty fish.



Cultural Considerations

There are many believers in alternative methods of prevention or treatment of cancer. Some of these are benign and may have potential therapeutic impact. However, "snake oil" medicine still exists because there are people who are gullible. Use of colonic enemas, essential oils to induce frequent bowel movements, or potentially toxic herbs should be discouraged as much as possible. ■

WHAT ARE THE NUTRITIONAL PROBLEMS AND GOALS OF THE CANCER PATIENT?

Excess weight loss contributes to loss of muscle and body proteins. Depletion of lean arm tissue is related to short survival (Fouladiun and colleagues, 2005). Because immune factors are protein based, excess weight loss encourages opportunistic infections. Thus maintenance of body weight during the treatment of cancer can best increase chance of survival.

The diet of the person with cancer must supply enough proteins, fats, carbohydrates, vitamins, minerals, and fluids to meet the increased energy demands of a high metabolic rate to prevent weight loss, to rebuild body tissues, and to promote a sense of well-being during treatment. Individual assessment of caloric intake and weight stabilization will give insight into a particular individual's needs. Nutritionally complete liquid supplements in addition to meals are often needed to ensure adequate nutritional intake.

Retarding tumor growth is clearly a goal in cancer treatment. In a study of mice, an omega-3 fatty acid–enriched diet proved to be a safe means for retarding tumor growth and vascularization (Hardman and colleagues, 2005). In another mice study, either a no-carbohydrate ketogenic diet or low-fat diet decreased prostate tumor size, and the tumors were about one-third smaller than those in mice receiving a Western-style diet. The ketogenic diet allowed for the longest survival of the mice (Freedland and colleagues, 2008). The rationale for a ketogenic diet is that cancer cells use glucose as a fuel source. The combined use of a ketogenic diet with the fat content coming from omega-3 fatty acids and medium-chain triglyceride (MCT) oil (see Chapters 2 and 12) inhibited tumor growth in a third mouse study (Otto and colleagues, 2008). These dietary approaches may have impact on human cancer survival as well.

Maintaining nutritional status of the normal body cells is important as the cancer therapy works to destroy the cancerous cells. Because protein status is related to serum albumin levels, it is important to maintain a normal albumin level. Albumin level and caloric intake were found to predict mortality. However, adequate kcalorie intake is essential for dietary protein to be used as a building source. Daily intake of fats and carbohydrates was found to be more important for predicting survival than protein intake. Because of a preference for sweets with cancer, promotion of dessert intake can be beneficial to meet the goal for kcalories. Liquid supplements, milkshakes, or commercial pasteurized eggnog may be accepted and can help meet the need for protein intake.

The intake of all vitamins and minerals should meet the DRIs (see the back of the book). A multivitamin and mineral supplement may be needed to meet these goals. Individual needs must be assessed carefully because radiation, chemotherapy, and surgery impose nutritional risks (see common dietary problems and solutions later in the chapter). Because of increased cancer survival rates, long-term health goals need to be considered (see section below on cancer survivors).

Fluids are especially important to replace losses from fever, diarrhea, and vomiting and to aid the kidneys in the removal of waste products that result from cancer treatment. The following are nutritional goals during cancer treatment:

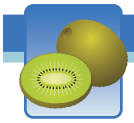
- Maintaining weight (a short-term goal)
- Achieving and maintaining normal weight (a long-term goal)
- Replacing nutritional losses from side effects of treatment (e.g., fluid and electrolyte losses from vomiting, diarrhea, and malabsorption)
- Providing adequate amounts of kcalories, protein, carbohydrates, fat, vitamins, and minerals

Fact & Fallacy

FALLACY The high-fiber, low-fat macrobiotic diet will cure cancer.

FACT The macrobiotic diet is primarily a vegan diet with fish. Those who follow a macrobiotic diet may view it as a philosophy of living, including eating in moderation. It is generally low in kcalories, being primarily based on plant-based foods, and may not be able to support the high energy and nutrient needs of the cancer patient. Weight loss leading to cachexia can result; therefore this diet is not recommended during cancer treatment. ■

Cancer is usually treated by surgery, radiation, and chemotherapy, used alone or in combination. Each form of treatment imposes nutritional risks. Depending on the site of radiation treatment or surgical removal of cancerous areas, there will be different effects on nutritional status. If radiation treatment is near the oral cavity, for example, inflammation can occur that makes eating painful. Dry mouth can occur from damage to the salivary glands. Inadequate saliva production inhibits consumption of dry foods and can therefore allow rapid development of dental decay (see Chapter 12 for more on dental health). If radiation treatment occurs near the abdominal area, digestion and absorption of food nutrients will be adversely affected. Nausea, vomiting, and diarrhea are common side effects of this treatment. Such a person may benefit from a low-lactose diet or more aggressive nutritional support (see Chapter 15).



Cultural Considerations

Complementary and alternative medicine (CAM) among persons with cancer in the United States has been estimated to be about 30% (± 25%). Most cancer patients use CAM to boost the immune system, relieve pain, and control other side effects rather than for curative intent. Because adverse reactions can occur with herbal therapy (see Chapter 3), persons undergoing cancer treatment need to use caution and use CAM only under the guidance of knowledgeable practitioners in both oncology and CAM (Mansky and Wallerstedt, 2006). ■

SURGERY

Surgery is used in the treatment of cancer in an attempt to remove tumors or alleviate symptoms (e.g., obstruction of the intestinal tract). The nutritional problems that may develop depend on the type of procedure performed. Providing optimal nutrition may require dietary modifications based on the person's ability or inability to consume, digest, and absorb nutrients. See Table 10-2 for a summary of surgical procedures requiring dietary modification. One study found that oral administration of a supplement rich in omega-3 fatty acids for 5 days before surgery improved preoperative nutritional status and improved inflammatory and immune responses both preoperatively and postoperatively (Nakamura and colleagues, 2005).

Table 10-2 Surgical Procedures Requiring Postoperative Dietary Modifications

PROCEDURE	NUTRITIONAL PROBLEMS	DIETARY MODIFICATIONS
Radical neck resection	Inability to chew or swallow	Nasogastric tube feeding
Gastrectomy	"Dumping syndrome"	Small frequent meals, liquids between meals, restriction of concentrated carbohydrates
Small bowel resection	Diarrhea, malabsorption	Elemental diet
Ileostomy, colostomy	Fluid and electrolyte imbalances	Replacement of fluids and electrolytes

RADIATION

Radiation therapy (application of radioactive material) to the head, neck, thorax, esophagus, and abdomen can cause acute eating problems. Side effects of treatment often add to the person's discomfort. Chewing and swallowing problems (dysphagia), **stomatitis** (sore mouth), **esophagitis** (inflammation of the esophagus), and decreased saliva production leading to dry mouth may occur. Without adequate saliva production to neutralize the acid in the mouth, severe dental decay and gum destruction can develop in a very short period of time. Attention to oral hygiene and maintaining hydration status can help maintain oral health (see Chapter 12).

When the abdomen is irradiated, malabsorption of many nutrients occurs if the damage to the gastrointestinal tract is severe. If damage is less severe, gastritis, nausea, vomiting, and diarrhea may result.

Increased beta-carotene intake can reduce adverse effects of radiation therapy (Meyer and colleagues, 2007). However, antioxidant supplements should be avoided during radiation therapy because they appear to reduce the effectiveness of treatment (Meyer and colleagues, 2008).

Teaching Pearl

Intensive nutrition intervention following the American Dietetic Association medical nutrition therapy protocol resulted in higher protein intake of 1.1 to 1.3 g/kg/day and higher kcalories at ±30 kcal/kg/day during radiation treatment than a standard nutritional talk and educational pamphlet (Isenring, Bauer, and Capra, 2007). Health care providers should make referrals to a registered dietitian when nutritional needs are not being met. ■

CHEMOTHERAPY

Chemotherapy is the use of drugs to cure or control cancer. It is **systemic**, meaning that it can affect the entire body rather than just a part of it. The drugs interfere with cells as they divide. Normal cells and cancer cells are affected, and when cells in the gastrointestinal tract are affected, diarrhea, constipation, or poor absorption of nutrients may occur. These side effects can be only temporary because the gastrointestinal tract cells replace themselves every 3 days. However, the course of chemotherapy may be for a prolonged period. Thus the adverse effects may occur for some time and result in poor nutritional status. Chemotherapy drugs cause nausea and vomiting. Steroids that cause water retention and bloating are sometimes used. After treatment these conditions disappear, and the person's nutritional status improves. Steroids used in chemotherapy may require the use of dietary sodium and carbohydrate restrictions because of fluid retention and high serum glucose levels. The side effects experienced during chemotherapy treatments may make it difficult for the person to consume the optimal amounts of nutrients.

There is some evidence that omega-3 fatty acids may help reduce toxicity of chemotherapy, at least for persons being treated for esophageal cancer (Minami and colleagues, 2008). Nausea is common with chemotherapy. Nausea that develops during the period that begins 24 hours after the administration of chemotherapy is

called delayed nausea. Meals high in protein decrease nausea and along with ginger, which has similar properties, has shown benefit in reducing delayed nausea (Levine and colleagues, 2008).

Weight gain is a common problem among women with breast cancer who receive chemotherapy. The weight gain may be the result of reduced physical activity. Exercise is advised to prevent weight gain in these women.

WEIGHT LOSS

Decreased caloric intake, increased caloric expenditure (from energy demands of the tumor and the stress of chemotherapy and radiation treatments), or a combination of the two, as well as decreased glucose tolerance and altered protein metabolism, all play a role in weight loss. As much as 3000 kcal and 100 g of protein or more may be necessary to prevent tissue breakdown and weight loss (see Chapter 15 for more information on nutritional support). It should be noted, however, that there is debate about which individuals with cancer will benefit from total parenteral nutrition (TPN). Reduced gastrointestinal function with diminished movement of food from the stomach causes the individual to feel full too soon and further diminishes the appetite.

Advanced cancer is the fastest growing indication for use of home parenteral nutrition (see Chapter 15). It is most commonly used for intestinal failure in the setting of bowel obstruction. Initiation of home parenteral nutrition at a higher functioning level is preferred; studies are needed to validate the use of parenteral nutrition in end-stage cancer patients (Soo and Gramlich, 2008).

In conditions of stress (see Chapter 15), increased amounts of counterregulatory hormones that inhibit the action of insulin are produced. This results in gluconeogenesis (production of blood glucose from protein). Increased breakdown of proteins in the muscle causes a loss of amino acids, resulting in muscle weakness and wasting. The ability to preserve muscle mass during periods of reduced food consumption is diminished in persons with cancer. Thus loss of muscle and protein stores is common for them.

COMMON DIETARY PROBLEMS AND SOLUTIONS

Fatigue

Prepare easy meals such as scrambled eggs, toast, and canned fruit.
Eat a good breakfast; patients usually have more energy in the morning.
Use frozen or canned foods to minimize food preparation time.
Drink commercial liquid supplements, milkshakes, or pasteurized eggnog.

Altered Taste

Try lemon juice or vinegar on vegetables.
Emphasize cold foods such as ice cream and pudding; keep cans of fruit in the refrigerator.
Experiment with spices and marinades for meat.
Add bacon bits for flavor.

No Appetite

Include snacks; emphasize small, frequent meals.
Include high-calorie drinks such as sherbet blended with juice or milkshakes.

Keep high-kcalorie sugar-based candy by bedside (brush teeth first; rinse mouth with water regularly).

Nausea and Vomiting

Use antiemetic medications before meals (at least ½ hour before eating).
Include low-fat protein sources.
Incorporate ginger into meals and/or beverages.
Avoid fatty foods.
Avoid concentrated sweets; salty foods may be better tolerated.
Sip liquids slowly.
Avoid reclining directly after meals; use propped pillows in bed.
Avoid foods with a strong odor.

Stomatitis or Esophagitis

Eat soft foods.
Add gravy, butter, or sauces to dry foods.
Avoid very salty, spiced, or acidic foods.
Use a straw for beverages.
Have a health care provider prescribe artificial saliva.

Diarrhea

Avoid lactose-containing beverages and foods.
Use commercial drinks that are lactose-free.
Avoid roughage; emphasize soluble-fiber foods, such as oatmeal and bananas.

Constipation

Increase water and fiber intake.
Include walking if possible, or leg lifts if bedridden.

CANCER SURVIVORS

There are millions of cancer survivors today. Secondary health concerns are increasingly being recognized. Cancer survivors are at increased risk for cardiovascular disease, diabetes, osteoporosis, and second primary tumors. Areas of concern include a focus on survivor lifestyle, but there are medical conditions that health care professionals should be alert to in order to intervene in a timely manner.

With gastric surgery, pellagra is one condition that can develop over time. One case study came to light when an older adult developed gait disturbance, delirium, and myoclonus (shocklike muscle movements similar to movements found with epilepsy) along with dermatitis and diarrhea within 2 years after surgery for gastric cancer. Treatment with intravenous vitamin B_3 resolved the symptoms (Nagaishi and colleagues, 2008).

Surgery involving the intestinal tract, such as with pancreatic or gastric cancer, can have multiple nutritional deficiencies involved. One is low levels of vitamin E when the duodenum is bypassed. Low levels of vitamin E are associated with low total cholesterol levels and with neuropathy. Health care professionals should be alert to neurologic symptoms in postgastrectomy patients in which the intestinal tract is bypassed to rule out hypovitaminosis E (Rino and colleagues, 2007).

One form of surgery related to pancreatic cancer involves the removal of the duodenum and upper jejunum, where the pancreas is attached. Severe malnutrition can develop similar to what is found with bariatric weight loss surgery (see Chapter 6). Zinc deficiency has been noted with this surgery. Symptoms include skin eruptions,

hair loss, **glossitis** (inflammation of the tongue), and nail changes. Treatment with at least zinc supplementation is required (Yu, Shan, and Lin, 2007). In some cases, such as with esophageal or gastric surgery, feeding tubes or other artificial nutrition may be required long-term to maintain nutritional status (see Chapter 15).

There is an increased rate of bone loss in women who have premature menopause before the age of 45 as a result of ovarian cancer or are receiving estrogen suppression therapy for certain forms of breast cancer. This is especially true when medications called aromatase inhibitors are used. A baseline dual-energy x-ray absorptiometry (DXA) scan assessment of bone mineral density is advised along with rigorous prevention strategies, including use of bisphosphonates and adequate intake of calcium and vitamin D (Reid and colleagues, 2008).

A study of long-term breast cancer survivors found over 50% reported improvements in diet or exercise; 25% reported both lifestyle improvements. Those with increased exercise and/or more fruits and vegetables in their diet noted increased levels of energy (Alfano and colleagues, 2008). Health care professionals can be instrumental in encouraging exercise to help develop endurance.

Obesity is common among survivors of endometrial cancer, which increases risk for premature death. A lifestyle intervention promoting weight loss, improved eating habits, and increased physical activity can be effective in achieving sustainable weight loss (von Gruenigen and colleagues, 2008).

One treatment used for prostate cancer is androgen deprivation therapy (ADT), which is associated with significant bone loss and fractures. All men should receive preventive measures with 1200 mg of calcium and at least 800 International Units of vitamin D daily along with weight-bearing exercise (Greenspan, 2008). Studies of men undergoing long-term ADT for treatment of prostate cancer of 1 year or more also are at increased risk of the metabolic syndrome, diabetes, and cardiovascular disease. It is recommended that regular screening for diabetes, lipids, and other cardiovascular risk factors in such men be undertaken (Shahani and colleagues, 2008).

In regard to skin cancer, including green leafy vegetables in the diet may help prevent development of subsequent squamous cell carcinomas of the skin. This may be due to the phytochemical content such as lutein and zeaxanthin. Low-fat dairy products should be advised (Hughes and colleagues, 2006).

Many of the children exposed to the contamination of the Chernobyl accident in 1986 were treated with surgical removal of the thyroid gland followed by radioactive iodine ablation of residual thyroid tissue. This same process is used to treat adults with hyperthyroidism and is considered low risk for breast cancer. However, because of the high dose of radioactive iodine with subsequent radioactive treatment it is advised that breast screening surveillance be undertaken with survivors (Travis and Stabin, 2006).

Teaching Pearl

Nutrition education can occur in many ways. In an intervention study there was an increased intake of high-fiber foods among breast cancer survivors who received individualized telephone counseling and among those who attended cooking classes (Newman and colleagues, 2005). ■

There is a very high concern about maintaining long-term health in children and adolescent cancer survivors. It was found proportionately more childhood cancer survivors reported barriers to exercise and following a low-fat diet than to including more high-fiber and calcium-rich foods. The main barriers to exercise included fatigue, lack of time, and not belonging to a gym. Barriers to limiting intake of high-fat foods were food commercials that increased appeal, having friends who ate high-fat foods, and restaurant offerings (Arroyave and colleagues, 2008).

Treatment of cancer goes beyond cure. Treatment includes promotion of health behaviors that will help prevent reoccurrence of cancer and maintain other positive health outcomes such as prevention of osteoporosis and cardiovascular disease.

WHAT IS THE ROLE OF THE NURSE AND OTHER HEALTH CARE PROFESSIONALS IN NUTRITIONAL COUNSELING FOR CANCER PREVENTION AND TREATMENT?

All health care professionals can promote the guidelines to reduce the risk of developing cancer. This entails speaking with individuals about their personal habits. Many changes can be made in the nutritional environment. Restaurants might be encouraged to use olive oil for dipping bread rather than serving only butter or solid margarines. Advising schools to offer an array of vegetables and fruits will help children develop a taste for high-fiber foods. Helping to provide high-fiber foods and low-sugar beverages at social functions will encourage individuals to make better choices.

The nurse plays an important role in helping the person with cancer to cope with difficulty eating. For those with nausea and vomiting, nurses can assess the need for antiemetic medications. Suggestions for eating the largest amount in the morning can be helpful, because this is typically when appetite is greatest.

Nurses should establish a good relationship and be sensitive when giving advice on how to promote optimum nutrition at a time when individuals with cancer may be feeling poor physically, emotionally, and psychologically. Nurses need to have a total health care team approach to identify the problems leading to poor nutritional status and to implement a plan of action to overcome barriers to good nutritional intake. This might include arranging favorite foods in a hospital setting or coordinating home-delivered meals.

Individuals coping with cancer in the home need encouragement to take advantage of the good days, when favorite and well-tolerated nutritious foods can be prepared in advance, frozen or refrigerated, and heated and served later at mealtime. An effort should then be made to provide a pleasant meal environment. The use of colorful place settings can help to improve appetite. For a visiting nurse, conversation should be focused on positive topics.

Nurses have the primary responsibility for caring for individuals in the home setting. They must learn about a person's true nutritional needs and know when to consult a dietitian or to personally counsel to provide comfort for as long as possible. Good nutritional status in cancer treatment is of utmost importance because it greatly influences the effectiveness of therapy and overall comfort for the person contending with cancer. Visiting nurses, health care providers, dietitians, and volunteers often are active in hospice care (a program for the terminally ill, including individuals with cancer) and assist in dealing with the last stages of life in the home setting, as discussed in Chapter 15.

Chapter Challenge Questions & Classroom Activities

1. Describe a diet that reduces the risk of developing cancer.
2. Name some of the factors contributing to cancer cachexia.
3. What are some of the nutritional problems imposed by cancer treatments? What dietary modifications are necessary?
4. Why is it important to individualize the diet of the cancer patient?

Case Study

Maria still worried that her breast cancer would return, but she had passed many milestones and was still healthy. She continued to battle her weight, but at least it was stable, and her BMI was 24. Now the doctor was having her undergo a DXA scan because of some of her earlier treatments. She also knew that she had never been a good milk drinker. She looked up in the waiting room and recognized her daughter's friend Oksana. After greeting each other with a big hug, they started talking about their experiences. Oksana had lived in the Ukraine in the 1980s before coming to the United States. Her family had been concerned about their children's health. Oksana had regular screening for thyroid cancer but so far was still healthy.

Critical Thinking Applications

1. How can Maria's weight be described in relation to her BMI?
2. How can Maria get the nutrients she needs for bone health if she doesn't drink milk, and what does the DXA scan determine?
3. What guidance would you provide to Maria to meet the goal of reduced risk of breast cancer recurrence and prevention of osteoporosis?
4. Why is Oksana being screened for thyroid cancer, and what is important for her to do with her diet?

REFERENCES

Adams KF, Leitzmann MF, Albanes D, Kipnis V, Moore SC, Schatzkin A, Chow WH: Body size and renal cell cancer incidence in a large US cohort study, *Am J Epidemiol* 168(3):268-277, 2008.

Ahn J, Albanes D, Peters U, Schatzkin A, Lim U, Freedman M, Chatterjee N, Andriole GL, Leitzmann MF, Hayes RB; Prostate, Lung, Colorectal, and Ovarian Trial Project Team: Dairy products, calcium intake, and risk of prostate cancer in the Prostate, Lung, Colorectal, and Ovarian Cancer Screening Trial, *Cancer Epidemiol Biomarkers Prev* 16(12):2623-2630, 2007.

Alfano CM, Day JM, Katz ML, Herndon JE 2nd, Bittoni MA, Oliveri JM, Donohue K, Paskett ED: Exercise and dietary change after diagnosis and cancer-related symptoms in long-term survivors of breast cancer: CALGB 79804, *Psychooncology*, June 5, 2008 (Epub in advance of print).

Amling CL: Relationship between obesity and prostate cancer, *Curr Opin Urol* 15(3):167-171, 2005.

Anetor JI, Wanibuchi H, Fukushima S: Arsenic exposure and its health effects and risk of cancer in developing countries: micronutrients as host defence, *Asian Pac J Cancer Prev* 8(1):13-23, 2007.

Arroyave WD, Clipp EC, Miller PE, Jones LW, Ward DS, Bonner MJ, Rosoff PM, Snyder DC, Demark-Wahnefried W: Childhood cancer survivors' perceived barriers to improving exercise and dietary behaviors, *Oncol Nurs Forum* 35(1):121-130, 2008.

Babcock TA, Dekoj T, Espat NJ: Experimental studies defining omega-3 fatty acid antiinflammatory mechanisms and abrogation of tumor-related syndromes, *Nutr Clin Pract* 20(1):62-74, 2005.

Bae JM, Lee EJ, Guyatt G: Citrus fruit intake and stomach cancer risk: a quantitative systematic review, *Gastric Cancer* 11(1):23-32, 2008.

Balonov MI: The Chernobyl Forum: major findings and recommendations, *J Environ Radioact* 96(1-3):6-12, 2007.

Bardia A, Hartmann LC, Vachon CM, Vierkant RA, Wang AH, Olson JE, Sellers TA, Cerhan JR: Recreational physical activity and risk of postmenopausal breast cancer based on hormone receptor status, *Arch Intern Med* 166(22):2478-2483, 2006.

Barnard RJ, Aronson WJ: Preclinical models relevant to diet, exercise, and cancer risk, *Recent Results Cancer Res* 166:47-61, 2005.

Beale AL, Penney MD, Allison MC: The prevalence of iron deficiency among patients presenting with colorectal cancer, *Colorectal Dis* 7(4):398-402, 2005.

Beresford SA, Johnson KC, Ritenbaugh C, Lasser NL, Snetselaar LG, Black HR, Anderson GL, Assaf AR, Bassford T, Bowen D, Brunner RL, Brzyski RG, Caan B, Chlebowski RT, Gass M, Harrigan RC, Hays J, Heber D, Heiss G, Hendrix SL, Howard BV, Hsia J, Hubbell FA, Jackson RD, Kotchen JM, Kuller LH, LaCroix AZ, Lane DS, Langer RD, Lewis CE, Manson JE, Margolis KL, Mossavar-Rahmani Y, Ockene JK, Parker LM, Perri MG, Phillips L, Prentice RL, Robbins J, Rossouw JE, Sarto GE, Stefanick ML, Van Horn L, Vitolins MZ, Wactawski-Wende J, Wallace RB, Whitlock E: Low-fat dietary pattern and risk of colorectal cancer: the Women's Health Initiative Randomized Controlled Dietary Modification Trial, *JAMA* 295(6):643-654, 2006.

Berster JM, Göke B: Type 2 diabetes mellitus as risk factor for colorectal cancer, *Arch Physiol Biochem* 114(1):84-98, 2008.

Blair CK, Roesler M, Xie Y, Gamis AS, Olshan AF, Heerema NA, Robison LL, Ross JA; Children's Oncology Group (COG): Vitamin supplement use among children with Down's syndrome and risk of leukaemia: a Children's Oncology Group (COG) study, *Paediatr Perinat Epidemiol* 22(3):288-295, 2008.

Block KI, Koch AC, Mead MN, Tothy PK, Newman RA, Gyllenhaal C: Impact of antioxidant supplementation on chemotherapeutic efficacy: a systematic review of the evidence from randomized controlled trials, *Cancer Treat Rev* 33(5):407-418, 2007.

Buijsse B, Feskens EJ, Schlettwein-Gsell D, Ferry M, Kok FJ, Kromhout D, de Groot LC: Plasma carotene and alpha-tocopherol in relation to 10-y all-cause and cause-specific mortality in European elderly: the Survey in Europe on Nutrition and the Elderly, a Concerted Action (SENECA), *Am J Clin Nutr* 82(4):879-886, 2005.

Burns CP, Halabi S, Clamon G, Kaplan E, Hohl RJ, Atkins JN, Schwartz MA, Wagner BA, Paskett E: Phase II study of high-dose fish oil capsules for patients with cancer-related cachexia, *Cancer* 101(2):370-378, 2004.

Campos FG, Logullo Waitzberg AG, Kiss DR, Waitzberg DL, Habr-Gama A, Gama-Rodrigues J: Diet and colorectal cancer: current evidence for etiology and prevention, *Nutr Hosp* 20(1):18-25, 2005.

Chan AT, Ma J, Tranah GJ, Giovannucci EL, Rifai N, Hunter DJ, Fuchs CS: Hemochromatosis gene mutations, body iron stores, dietary iron, and risk of colorectal adenoma in women, *J Natl Cancer Inst* 97(12):917-926, 2005.

Cherng JM, Shieh DE, Chiang W, Chang MY, Chiang LC: Chemopreventive effects of minor dietary constituents in common foods on human cancer cells, *Biosci Biotechnol Biochem* 71(6):1500-1504, 2007.

Chong P, Rashid P: Can we prevent prostate cancer? *Aust Fam Physician* 34(4):265-267, 2005.

Chung YW, Han DS, Park KH, Eun CS, Yoo KS, Park CK: Insulin therapy and colorectal adenoma risk among patients with type 2 diabetes mellitus: a case-control study in Korea, *Dis Colon Rectum* 51(5):593-597, 2008.

Costello MF: Polycystic ovary syndrome—a management update, *Aust Fam Physician* 34(3):127-133, 2005.

Cui X, Dai Q, Tseng M, Shu XO, Gao YT, Zheng W: Dietary patterns and breast cancer risk in the Shanghai Breast Cancer study, *Cancer Epidemiol Biomarkers Prev* 16(7):1443-1448, 2007.

Czeczuga-Semeniuk E, Wolczynski S: Identification of carotenoids in ovarian tissue in women, *Oncol Rep* 14(5):1385-1392, 2005.

Davila JA, Morgan RO, Shaib Y, McGlynn KA, El-Serag HB: Diabetes increases the risk of hepatocellular carcinoma in the United States: a population based case control study, *Gut* 54(4):533-539, 2005.

Dixon LB, Subar AF, Peters U, Weissfeld JL, Bresalier RS, Risch A, Schatzkin A, Hayes RB: Adherence to the USDA Food Guide, DASH Eating Plan, and Mediterranean dietary pattern reduces risk of colorectal adenoma, *J Nutr* 137(11):2443-2450, 2007.

Dobrovolskaia MA, Kozlov SV: Inflammation and cancer: when NF-kappaB amalgamates the perilous partnership, *Curr Cancer Drug Targets* 5(5):325-344, 2005.

Dong LM, Kristal AR, Peters U, Schenk JM, Sanchez CA, Rabinovitch PS, Blount PL, Odze RD, Ayub K, Reid BJ, Vaughan TL: Dietary supplement use and risk of neoplastic progression in esophageal adenocarcinoma: a prospective study, *Nutr Cancer* 60(1):39-48, 2008.

Duffy C, Perez K, Partridge A: Implications of phytoestrogen intake for breast cancer, *CA Cancer J Clin* 57(5):260-277, 2007.

Eby GA: Treatment of acute lymphocytic leukemia using zinc adjuvant with chemotherapy and radiation—a case history and hypothesis, *Med Hypotheses* 64(6):1124-1126, 2005.

Epplein M, Nomura AM, Hankin JH, Blaser MJ, Perez-Perez G, Stemmermann GN, Wilkens LR, Kolonel LN: Association of *Helicobacter pylori* infection and diet on the risk of gastric cancer: a case-control study in Hawaii, *Cancer Causes Control* 19(8):869-877, 2008.

Ericson U, Sonestedt E, Gullberg B, Olsson H, Wirfält E: High folate intake is associated with lower breast cancer incidence in postmenopausal women in the Malmö Diet and Cancer cohort, *Am J Clin Nutr* 86(2):434-443, 2007.

Fan Y, Yuan JM, Wang R, Gao YT, Yu MC: Alcohol, tobacco, and diet in relation to esophageal cancer: the Shanghai Cohort study, *Nutr Cancer* 60(3):354-363, 2008.

Fock KM, Talley N, Moayyedi P, Hunt R, Azuma T, Sugano K, Xiao SD, Lam SK, Goh KL, Chiba T, Uemura N, Kim JG, Kim N, Ang TL, Mahachai V, Mitchell H, Rani AA, Liou JM, Vilaichone RK, Sollano J: Asia-Pacific Gastric Cancer Consensus Conference: Asia-Pacific consensus guidelines on gastric cancer prevention, *J Gastroenterol Hepatol* 23(3):351-365, 2008.

Fontana L, Klein S, Holloszy JO: Long-term low-protein, low-calorie diet and endurance exercise modulate metabolic factors associated with cancer risk, *Am J Clin Nutr* 84(6):1456-1462, 2006.

Fouladiun M, Korner U, Bosaeus I, Daneryd P, Hyltander A, Lundholm KG: Body composition and time course changes in regional distribution of fat and lean tissue in unselected cancer patients on palliative care—correlations with food intake, metabolism, exercise capacity, and hormones, *Cancer* 103(10):2189-2198, 2005.

Frasca F, Pandini G, Sciacca L, Pezzino V, Squatrito S, Belfiore A, Vigneri R: The role of insulin receptors and IGF-I receptors in cancer and other diseases, *Arch Physiol Biochem* 114(1):23-37, 2008.

Freedland SJ, Mavropoulos J, Wang A, Darshan M, Demark-Wahnefried W, Aronson WJ, Cohen P, Hwang D, Peterson B, Fields T, Pizzo SV, Isaacs WB: Carbohydrate restriction, prostate cancer growth, and the insulin-like growth factor axis, *Prostate* 68(1):11-19, 2008.

Fung TT, Hu FB, Holmes MD, Rosner BA, Hunter DJ, Colditz GA, Willett WC: Dietary patterns and the risk of postmenopausal breast cancer, *Int J Cancer* 116(1):116-121, 2005.

Furberg AS, Jasienska G, Bjurstam N, Torjesen PA, Emaus A, Lipson SF, Ellison PT, Thune I: Metabolic and hormonal profiles: HDL cholesterol as a plausible biomarker of breast cancer risk. The Norwegian EBBA Study, *Cancer Epidemiol Biomarkers Prev* 14(1):33-40, 2005.

García-Closas R, García-Closas M, Kogevinas M, Malats N, Silverman D, Serra C, Tardón A, Carrato A, Castaño-Vinyals G, Dosemeci M, Moore L, Rothman N, Sinha R: Food, nutrient and heterocyclic amine intake and the risk of bladder cancer, *Eur J Cancer* 43(11):1731-1740, 2007.

Giovannucci E: Vitamin D and cancer incidence in the Harvard Cohorts, *Ann Epidemiol* 19(2):84-88, 2009.

Giovannucci E, Liu Y, Platz EA, Stampfer MJ, Willett WC: Risk factors for prostate cancer incidence and progression in the health professionals follow-up study, *Int J Cancer* 121(7):1571-1578, 2007.

Goodwin PJ, Ennis M, Bahl M, Fantus IG, Pritchard KI, Trudeau ME, Koo J, Hood N: High insulin levels in newly diagnosed breast cancer patients reflect underlying insulin resistance and are associated with components of the insulin resistance syndrome, *Breast Cancer Res Treat* 114(3):517-525, 2009.

Goswami B, Rajappa M, Sharma M, Sharma A: Inflammation: its role and interplay in the development of cancer, with special focus on gynecological malignancies, *Int J Gynecol Cancer* 18(4):591-599, 2008.

Goy J, Rosenberg MW, King WD: Health risk behaviors: examining social inequalities in bladder and colorectal cancers, *Ann Epidemiol* 18(2):156-162, 2008.

Grant WB, Garland CF, Gorham ED: An estimate of cancer mortality rate reductions in Europe and the US with 1,000 IU of oral vitamin D per day, *Recent Results Cancer Res* 174:225-234, 2007.

Greenspan SL: Approach to the prostate cancer patient with bone disease, *J Clin Endocrinol Metab* 93(1):2-7, 2008.

Gunter MJ, Hoover DR, Yu H, Wassertheil-Smoller S, Manson JE, Li J, Harris TG, Rohan TE, Xue X, Ho GY, Einstein MH, Kaplan RC, Burk RD, Wylie-Rosett J, Pollak MN, Anderson G, Howard BV, Strickler HD: A prospective evaluation of insulin and insulin-like growth factor-I as risk actors for endometrial cancer, *Cancer Epidemiol Biomarkers Prev* 17(4):921-929, 2008.

Guy NC, Garewal H, Holubec H, Bernstein H, Payne CM, Bernstein C, Bhattacharyya AK, Dvorak K: A novel dietary-related model of esophagitis and Barrett's esophagus, a premalignant lesion, *Nutr Cancer* 59(2):217-227, 2007.

Hardman WE, Sun L, Short N, Cameron IL: Dietary omega-3 fatty acids and ionizing irradiation on human breast cancer xenograft growth and angiogenesis, *Cancer Cell Int* 5(1):12, 2005.

Heinen MM, Hughes MC, Ibiebele TI, Marks GC, Green AC, van der Pols JC: Intake of antioxidant nutrients and the risk of skin cancer, *Eur J Cancer* 43(18):2707-2716, 2007.

Hogervorst JG, Schouten LJ, Konings EJ, Goldbohm RA, van den Brandt PA: A prospective study of dietary acrylamide intake and the risk of endometrial, ovarian, and breast cancer, *Cancer Epidemiol Biomarkers Prev* 16(11):2304-2313, 2007.

Hogervorst JG, Schouten LJ, Konings EJ, Goldbohm RA, van den Brandt PA: Dietary acrylamide intake and the risk of renal cell, bladder, and prostate cancer, *Am J Clin Nutr* 87(5):1428-1438, 2008.

Holick MF: Vitamin D and sunlight: strategies for cancer prevention and other health benefits, *Clin J Am Soc Nephrol* 3(5):1548-1554, 2008.

Horvath G, David K: Iron storage disease, *Orv Hetil* 145(39):1979-1984, 2004.

Hu J, La Vecchia C, Desmeules M, Negri E, Mery L, Group CC: Meat and fish consumption and cancer in Canada, *Nutr Cancer* 60(3):313-324, 2008.

Hughes MC, van der Pols JC, Marks GC, Green AC: Food intake and risk of squamous cell carcinoma of the skin in a community: the Nambour Skin Cancer Cohort study, *Int J Cancer* 119(8):1953-1960, 2006.

Ibiebele TI, van der Pols JC, Hughes MC, Marks GC, Williams GM, Green AC: Dietary pattern in association with squamous cell carcinoma of the skin: a prospective study, *Am J Clin Nutr* 85(5):1401-1408, 2007.

Irigaray P, Newby JA, Clapp R, Hardell L, Howard V, Montagnier L, Epstein S, Belpomme D: Lifestyle-related

factors and environmental agents causing cancer: an overview, *Biomed Pharmacother* 61(10):640-658, 2007.

Isenring EA, Bauer JD, Capra S: Nutrition support using the American Dietetic Association medical nutrition therapy protocol for radiation oncology patients improves dietary intake compared with standard practice, *J Am Diet Assoc* 107(3):404-412, 2007.

Ishihara J, Otani T, Inoue M, Iwasaki M, Sasazuki S, Tsugane S; Japan Public Health Center-Based Prospective Study Group: Low intake of vitamin B-6 is associated with increased risk of colorectal cancer in Japanese men, *J Nutr* 137(7):1808-1814, 2007.

Janković S, Radosavljević V: Risk factors for bladder cancer, *Tumori* 93(1):4-12, 2007.

Kandaswami C, Lee LT, Lee PP, Hwang JJ, Ke FC, Huang YT, Lee MT: The antitumor activities of flavonoids, *In Vivo* 19(5):895-909, 2005.

Kesminiene A, Cardis E: [Cancer epidemiology after the Chernobyl accident], *Bull Cancer* 94(5):423-430, 2007.

Key TJ, Schatzkin A, Willett WC, Allen NE, Spencer EA, Travis RC: Diet, nutrition and the prevention of cancer, *Public Health Nutr* 7(1A):187-200, 2004.

Key TJ, Spencer EA: Carbohydrates and cancer: an overview of the epidemiological evidence, *Eur J Clin Nutr* 61(Suppl 1):S112-S121, 2007.

Kim JH, Lim YJ, Kim YH, Sung IK, Shim SG, Oh SO, Park SS, Yang S, Son HJ, Rhee PL, Kim JJ, Rhee JC, Choi YH: Is metabolic syndrome a risk factor for colorectal adenoma? *Cancer Epidemiol Biomarkers Prev* 16(8):1543-1546, 2007.

Kirsh VA, Hayes RB, Mayne ST, Chatterjee N, Subar AF, Dixon LB, Albanes D, Andriole GL, Urban DA, Peters U; PLCO Trial: Supplemental and dietary vitamin E, beta-carotene, and vitamin C intakes and prostate cancer risk, *J Natl Cancer Inst* 15;98(4):245-254, 2006.

Koebnick C, Michaud D, Moore SC, Park Y, Hollenbeck A, Ballard-Barbash R, Schatzkin A, Leitzmann MF: Body mass index, physical activity, and bladder cancer in a large prospective study, *Cancer Epidemiol Biomarkers Prev* 17(5):1214-1221, 2008.

Konno S: Effect of various natural products on growth of bladder cancer cells: two promising mushroom extracts, *Altern Med Rev* 12(1):63-68, 2007.

Koutros S, Zhang Y, Zhu Y, Mayne ST, Zahm SH, Holford TR, Leaderer BP, Boyle P, Zheng T: Nutrients contributing to one-carbon metabolism and risk of non-Hodgkin lymphoma subtypes, *Am J Epidemiol* 167(3):287-294, 2008.

Kubik A, Zatloukal P, Tomasek L, Dolezal J, Syllabova L, Kara J, Kopecky P, Plesko I: A case-control study of lifestyle and lung cancer associations by histological types, *Neoplasma* 55(3):192-199, 2008.

Kumagai A, Reiners C, Drozd V, Yamashita S: Childhood thyroid cancers and radioactive iodine therapy: necessity of precautious radiation health risk management, *Endocr J* 54(6):839-847, 2007.

Landers P, Tkacheva-Jameson O, Anderson S, Tolma E, Skaggs V: An update on breast cancer in Oklahoma and the dietary changes women make after diagnosis, *J Okla State Med Assoc* 101(1):15-19, 2008.

Larsson SC, Bergkvist L, Rutegård J, Giovannucci E, Wolk A: Calcium and dairy food intakes are inversely associated with colorectal cancer risk in the Cohort of Swedish Men, *Am J Clin Nutr* 83(3):667-673, 2006a.

Larsson SC, Giovannucci E, Wolk A: Vitamin B_6 intake, alcohol consumption, and colorectal cancer: a longitudinal population-based cohort of women, *Gastroenterology* 128(7):1830-1837, 2005.

Larsson SC, Giovannucci E, Wolk A: Methionine and vitamin B_6 intake and risk of pancreatic cancer: a prospective study of Swedish women and men, *Gastroenterology* 132(1):113-118, 2007.

Larsson SC, Håkansson N, Giovannucci E, Wolk A: Folate intake and pancreatic cancer incidence: a prospective study of Swedish women and men, *J Natl Cancer Inst* 98(6):407-413, 2006b.

Larsson SC, Kumlin M, Ingelman-Sundberg M, Wolk A: Dietary long-chain n-3 fatty acids for the prevention of cancer: a review of potential mechanisms, *Am J Clin Nutr* 79(6):935-945, 2004.

La Vecchia C, Zhang ZF, Altieri A: Alcohol and laryngeal cancer: an update, *Eur J Cancer Prev* 17(2):116-124, 2008.

Lee UJ, Jones JS: Incidence of prostate cancer in male breast cancer patients: a risk factor for prostate cancer screening, *Prostate Cancer Prostatic Dis* 12(1):52-56, 2008.

Levine ME, Gillis MG, Koch SY, Voss AC, Stern RM, Koch KL: Protein and ginger for the treatment of chemotherapy-induced delayed nausea, *J Altern Complement Med* 14(5): 545-551, 2008.

Lin J, Manson JE, Lee IM, Cook NR, Buring JE, Zhang SM: Intakes of calcium and vitamin D and breast cancer risk in women, *Arch Intern Med* 167(10):1050-1059, 2007.

Lin J, Zhang SM, Cook NR, Manson JE, Lee IM, Buring JE: Intakes of calcium and vitamin D and risk of colorectal cancer in women, *Am J Epidemiol* 161(8):755-764, 2005.

Liu C, Russell RM: Nutrition and gastric cancer risk: an update, *Nutr Rev* 66(5):237-249, 2008.

Lowenfels AB, Maisonneuve P: Risk factors for pancreatic cancer, *J Cell Biochem* 20(2):197-209, 2005.

MacDonald N: Cancer cachexia and targeting chronic inflammation: a unified approach to cancer treatment and palliative/supportive care, *J Support Oncol* 5(4):157-162, 2007.

Mahabir S, Forman MR, Barerra SL, Dong YQ, Spitz MR, Wei Q: Joint effects of dietary trace metals and DNA repair capacity in lung cancer risk, *Cancer Epidemiol Biomarkers Prev* 16(12):2756-2762, 2007.

Mahabir S, Spitz MR, Barrera SL, Dong YQ, Eastham C, Forman MR: Dietary boron and hormone replacement therapy as risk factors for lung cancer in women, *Am J Epidemiol* 167(9):1070-1080, 2008a.

Mahabir S, Wei Q, Barrera SL, Dong YQ, Etzel C, Spitz MR, Forman MR: Dietary magnesium and DNA repair capacity as risk factors for lung cancer, *Carcinogenesis* 29(5):949-956, 2008b.

Maki A, Kono H, Gupta M, Asakawa M, Suzuki T, Matsuda M, Fujii H, Rusyn I: Predictive power of biomarkers of oxidative stress and inflammation in patients with hepatitis C virus–associated hepatocellular carcinoma, *Ann Surg Oncol* 14(3):1182-1190, 2007.

Mansky PJ, Wallerstedt DB: Complementary medicine in palliative care and cancer symptom management, *Cancer J* 12(5):425-431, 2006.

Marques-Vidal P, Ravasco P, Ermelinda Camilo M: Foodstuffs and colorectal cancer risk: a review, *Clin Nutr* 25(1):14-36, 2006.

McCann SE, McCann WE, Hong CC, Marshall JR, Edge SB, Trevisan M, Muti P, Freudenheim JL: Dietary patterns related to glycemic index and load and risk of premenopausal and postmenopausal breast cancer in the Western New York Exposure and Breast Cancer Study, *Am J Clin Nutr* 86(2):465-471, 2007.

McNaughton SA, Marks GC, Green AC: Role of dietary factors in the development of basal cell cancer and squamous cell cancer of the skin, *Cancer Epidemiol Biomarkers Prev* 14(7):1596-1607, 2005.

Mehta SP, Boddy AP, Cook J, Sams V, Lund EK, Johnson IT, Rhodes M: Effect of n-3 polyunsaturated fatty acids on Barrett's epithelium in the human lower esophagus, *Am J Clin Nutr* 87(4):949-956, 2008.

Menendez JA, Vazquez-Martin A, Colomer R, Brunet J, Carrasco-Pancorbo A, Garcia-Villalba R, Fernandez-Gutierrez A, Segura-Carretero A: Olive oil's bitter principle reverses acquired autoresistance to trastuzumab (Herceptin) in HER2-overexpressing breast cancer cells, *BMC Cancer* 7:80, 2007.

Meyer F, Bairati I, Fortin A, Gélinas M, Nabid A, Brochet F, Têtu B: Interaction between antioxidant vitamin supplementation and cigarette smoking during radiation therapy in relation to long-term effects on recurrence and mortality: a randomized trial among head and neck cancer patients, *Int J Cancer* 122(7):1679-1683, 2008.

Meyer F, Bairati I, Jobin E, Gélinas M, Fortin A, Nabid A, Têtu B: Acute adverse effects of radiation therapy and local recurrence in relation to dietary and plasma beta carotene and alpha tocopherol in head and neck cancer patients, *Nutr Cancer* 59(1):29-35, 2007.

Michaud DS, Fuchs CS, Liu S, Willett WC, Colditz GA, Giovannucci E: Dietary glycemic load, carbohydrate, sugar, and colorectal cancer risk in men and women, *Cancer Epidemiol Biomarkers Prev* 14(1):138-147, 2005.

Michaud DS, Wolpin B, Giovannucci E, Liu S, Cochrane B, Manson JE, Pollak MN, Ma J, Fuchs CS: Prediagnostic plasma C-peptide and pancreatic cancer risk in men and women, *Cancer Epidemiol Biomarkers Prev* 16(10):2101-2109, 2007.

Michels KB, Fuchs CS, Giovannucci E, Colditz GA, Hunter DJ, Stampfer MJ, Willett WC: Fiber intake and incidence of colorectal cancer among 76,947 women and 47,279 men, *Cancer Epidemiol Biomarkers Prev* 14(4):842-849, 2005.

Minami Y, Miyata H, Doki Y, Yano M, Yamasaki M, Takiguchi S, Fujiwara Y, Yasuda T, Monden M: Omega-3 fatty acid–containing diet (Racol) reduces toxicity of chemoradiation therapy for patients with esophageal cancer, *Gan To Kagaku Ryoho* 35(3):437-440, 2008.

Mueller CM, Mai PL, Bucher J, Peters JA, Loud JT, Greene MH: Complementary and alternative medicine use among women at increased genetic risk of breast and ovarian cancer, *BMC Complement Altern Med* 8:17, 2008.

Murai M, Oya M: Renal cell carcinoma: etiology, incidence and epidemiology, *Curr Opin Urol* 14(4):229-233, 2004.

Murta-Nascimento C, Schmitz-Dräger BJ, Zeegers MP, Steineck G, Kogevinas M, Real FX, Malats N: Epidemiology of urinary bladder cancer: from tumor development to patient's death, *World J Urol* 25(3):285-295, 2007.

Nagaishi A, Tanabe H, Ueno M, Matsui M, Matsui M: [Case of non-alcoholic pellagra following gastrectomy], *Rinsho Shinkeigaku* 48(3):202-204, 2008.

Nakamura K, Kariyazono H, Komokata T, Hamada N, Sakata R, Yamada K: Influence of preoperative administration of omega-3 fatty acid–enriched supplement on inflammatory and immune responses in patients undergoing major surgery for cancer, *Nutrition* 21(6):639-649, 2005.

Newman VA, Thomson CA, Rock CL, Flatt SW, Kealey S, Bardwell WA, Caan BJ, Pierce JP; Women's Healthy Eating and Living (WHEL) Study Group: Achieving substantial changes in eating behavior among women previously treated for breast cancer—an overview of the intervention, *J Am Diet Assoc* 105(3):382-391, 2005.

Neyestani TR, Fereydouni Z, Hejazi S, Salehi-Nasab F, Nateghifard F, Maddah M, Karandish M: Vitamin C status in Iranian children with acute lymphoblastic leukemia: evidence for increased utilization, *J Pediatr Gastroenterol Nutr* 45(1):141-144, 2007.

Nkondjock A, Ghadirian P, Johnson KC, Krewski D; Canadian Cancer Registries Epidemiology Research Group: Dietary intake of lycopene is associated with reduced pancreatic cancer risk, *J Nutr* 135(3):592-597, 2005.

Nürnberg B, Schadendorf D, Gärtner B, Pföhler C, Herrmann W, Tilgen W, Reichrath J: Progression of malignant melanoma is associated with reduced 25-hydroxyvitamin D serum levels, *Exp Dermatol* 17(7):627, 2008.

Otto C, Kaemmerer U, Illert B, Muehling B, Pfetzer N, Wittig R, Voelker HU, Thiede A, Coy JF: Growth of human gastric cancer cells in nude mice is delayed by a ketogenic diet supplemented with omega-3 fatty acids and medium-chain triglycerides, *BMC Cancer* 8:122, 2008.

Park SY, Murphy SP, Wilkens LR, Nomura AM, Henderson BE, Kolonel LN: Calcium and vitamin D intake and risk of colorectal cancer: the Multiethnic Cohort Study, *Am J Epidemiol* 165(7):784-793, 2007.

Patel AV, Rodriguez C, Bernstein L, Chao A, Thun MJ, Calle EE: Obesity, recreational physical activity, and risk of pancreatic cancer in a large U.S. cohort, *Cancer Epidemiol Biomarkers Prev* 14(2):459-466, 2005.

Pierce JP, Natarajan L, Caan BJ, Parker BA, Greenberg ER, Flatt SW, Rock CL, Kealey S, Al-Delaimy WK, Bardwell WA, Carlson RW, Emond JA, Faerber S, Gold EB, Hajek RA, Hollenbach K, Jones LA, Karanja N, Madlensky L, Marshall J, Newman VA, Ritenbaugh C, Thomson CA, Wasserman L, Stefanick ML: Influence of a diet very high in vegetables, fruit, and fiber and low in fat on prognosis following treatment for breast cancer: the Women's Healthy Eating and Living (WHEL) randomized trial, *JAMA* 298(3):289-298, 2007.

Pisani P: Hyperinsulinaemia and cancer, meta-analyses of epidemiological studies, *Arch Physiol Biochem* 114(1):63-70, 2008.

Pischon T, Nöthlings U, Boeing H: Obesity and cancer, *Proc Nutr Soc* 67(2):128-145, 2008.

Poschl G, Stickel F, Wang XD, Seitz HK: Alcohol and cancer: genetic and nutritional aspects, *Proc Nutr Soc* 63(1):65-71, 2004.

Prentice RL, Caan B, Chlebowski RT, Patterson R, Kuller LH, Ockene JK, Margolis KL, Limacher MC, Manson JE, Parker LM, Paskett E, Phillips L, Robbins J, Rossouw JE, Sarto GE, Shikany JM, Stefanick ML, Thomson CA, Van Horn L, Vitolins MZ, Wactawski-Wende J, Wallace RB, Wassertheil-Smoller S, Whitlock E, Yano K, Adams-Campbell L, Anderson GL, Assaf AR, Beresford SA, Black HR, Brunner RL, Brzyski RG, Ford L, Gass M, Hays J, Heber D, Heiss G, Hendrix SL, Hsia J, Hubbell FA, Jackson RD, Johnson KC, Kotchen JM, LaCroix AZ, Lane DS, Langer RD, Lasser NL, Henderson MM: Low-fat dietary pattern and risk of invasive breast cancer: the Women's Health Initiative Randomized Controlled Dietary Modification Trial, *JAMA* 295(6):629-642, 2006.

Prentice RL, Thomson CA, Caan B, Hubbell FA, Anderson GL, Beresford SA, Pettinger M, Lane DS, Lessin L, Yasmeen S, Singh B, Khandekar J, Shikany JM, Satterfield S, Chlebowski RT: Low-fat dietary pattern and cancer incidence in the Women's Health Initiative Dietary Modification Randomized Controlled Trial, *J Natl Cancer Inst* 99(20):1534-1543, 2007.

Qadir MI, Malik SA: Plasma lipid profile in gynecologic cancers, *Eur J Gynaecol Oncol* 29(2):158-161, 2008.

Qin LQ, Xu JY, Wang PY, Hashi A, Hoshi K, Sato A: Milk/dairy products consumption, galactose metabolism and ovarian cancer: meta-analysis of epidemiological studies, *Eur J Cancer Prev* 14(1):13-19, 2005.

Rashidkhani B, Lindblad P, Wolk A: Fruits, vegetables and risk of renal cell carcinoma: a prospective study of Swedish women, *Int J Cancer* 113(3):451-455, 2005.

Raynal NJ, Momparler L, Charbonneau M, Momparler RL: Antileukemic activity of genistein, a major isoflavone present in soy products, *J Nat Prod* 71(1):3-7, 2008.

Reid DM, Doughty J, Eastell R, Heys SD, Howell A, McCloskey EV, Powles T, Selby P, Coleman RE: Guidance for the management of breast cancer treatment–induced bone loss: a consensus position statement from a UK Expert Group, *Cancer Treat Rev* 34(Suppl 1)S3-18, 2008.

Renehan AG, Roberts DL, Dive C: Obesity and cancer: pathophysiological and biological mechanisms, *Arch Physiol Biochem* 114(1):71-83, 2008.

Rino Y, Suzuki Y, Kuroiwa Y, Yukawa N, Saeki H, Kanari M, Wada H, Ino H, Takanashi Y, Imada T: Vitamin E malabsorption and neurological consequences after gastrectomy for gastric cancer, *Hepatogastroenterology* 54(78):1858-1861, 2007.

Ron E: Thyroid cancer incidence among people living in areas contaminated by radiation from the Chernobyl accident, *Health Phys* 93(5):502-511, 2007.

Sayre RM, Dowdy JC: The increase in melanoma: are dietary furocoumarins responsible? *Med Hypotheses* 70(4):855-859, 2008.

Shahani S, Braga-Basaria M, Basaria S: Androgen deprivation therapy in prostate cancer and metabolic risk for atherosclerosis, *J Clin Endocrinol Metab* 93(6):2042-2049, 2008.

Shahbakhti H, Watson RE, Azurdia RM, Ferreira CZ, Garmyn M, Rhodes LE: Influence of eicosapentaenoic acid, an omega-3 fatty acid, on ultraviolet-B generation of prostaglandin-E2 and proinflammatory cytokines interleukin-1 beta, tumor necrosis factor-alpha, interleukin-6 and interleukin-8 in human skin in vivo, *Photochem Photobiol* 80(2):231-235, 2004.

Sieri S, Pala V, Brighenti F, Pellegrini N, Muti P, Micheli A, Evangelista A, Grioni S, Contiero P, Berrino F, Krogh V: Dietary glycemic index, glycemic load, and the risk of breast cancer in an Italian prospective cohort study, *Am J Clin Nutr* 86(4):1160-1166, 2007.

Silvera SA, Jain M, Howe GR, Miller AB, Rohan TE: Dietary carbohydrates and breast cancer risk: a prospective study of the roles of overall glycemic index and glycemic load, *Int J Cancer* 114(4):653-658, 2005.

Silvera SA, Jain M, Howe GR, Miller AB, Rohan TE: Glycaemic index, glycaemic load and ovarian cancer risk: a prospective cohort study, *Public Health Nutr* 10(10):1076-1081, 2007a.

Silvera SA, Jain M, Howe GR, Miller AB, Rohan TE: Intake of coffee and tea and risk of ovarian cancer: a prospective cohort study, *Nutr Cancer* 58(1):22-27, 2007b.

Simopoulos AP: The traditional diet of Greece and cancer, *Eur J Cancer Prev* 13(3):219-230, 2004.

Smedby KE, Akerman M, Hildebrand H, Glimelius B, Ekbom A, Askling J: Malignant lymphomas in coeliac disease: evidence of increased risks for lymphoma types other than enteropathy-type T cell lymphoma, *Gut* 54(1):54-59, 2005.

Sonn GA, Aronson W, Litwin MS: Impact of diet on prostate cancer: a review, *Prostate Cancer Prostatic Dis* 8(4):304-310, 2005.

Soo I, Gramlich L: Use of parenteral nutrition in patients with advanced cancer, *Appl Physiol Nutr Metab* 33(1):102-106, 2008.

Stolzenberg-Solomon RZ, Adams K, Leitzmann M, Schairer C, Michaud DS, Hollenbeck A, Schatzkin A, Silverman DT: Adiposity, physical activity, and pancreatic cancer in

the National Institutes of Health-AARP Diet and Health Cohort study, *Am J Epidemiol* 167(5):586-597, 2008.

Stolzenberg-Solomon RZ, Chang SC, Leitzmann MF, Johnson KA, Johnson C, Buys SS, Hoover RN, Ziegler RG: Folate intake, alcohol use, and postmenopausal breast cancer risk in the Prostate, Lung, Colorectal, and Ovarian Cancer Screening Trial, *Am J Clin Nutr* 83(4):895-904, 2006.

Ströhle A, Maike W, Hahn A: Nutrition and colorectal cancer, *Med Monatsschr Pharm* 30(1):25-32, 2007.

Suba Z, Ujpál M: Correlations of insulin resistance and neoplasms, *Magy Onkol* 50(2):127-135, 2006.

Sun H, Berquin IM, Edwards IJ: Omega-3 polyunsaturated fatty acids regulate syndecan-1 expression in human breast cancer cells, *Cancer Res* 65(10):4442-4447, 2005.

Suzuki R, Rylander-Rudqvist T, Ye W, Saji S, Adlercreutz H, Wolk A: Dietary fiber intake and risk of postmenopausal breast cancer defined by estrogen and progesterone receptor status–a prospective cohort study among Swedish women, *Int J Cancer* 122(2):403-412, 2008.

Suzuki R, Rylander-Rudqvist T, Ye W, Saji S, Wolk A: Body weight and postmenopausal breast cancer risk defined by estrogen and progesterone receptor status among Swedish women: a prospective cohort study, *Int J Cancer* 119(7):1683-1689, 2006.

Tappel A: Heme of consumed red meat can act as a catalyst of oxidative damage and could initiate colon, breast and prostate cancers, heart disease and other diseases, *Med Hypotheses* 68(3):562-564, 2007.

Tehard B, Clavel-Chapelon F: Several anthropometric measurements and breast cancer risk: results of the E3N cohort study, *Int J Obes (Lond)* 30(1):156-163, 2006.

Thangapazham RL, Singh AK, Sharma A, Warren J, Gaddipati JP, Maheshwari RK: Green tea polyphenols and its constituent epigallocatechin gallate inhibits proliferation of human breast cancer cells in vitro and in vivo, *Cancer Lett* 245(1-2):232-241, 2007.

Theodoratou E, McNeill G, Cetnarskyj R, Farrington SM, Tenesa A, Barnetson R, Porteous M, Dunlop M, Campbell H: Dietary fatty acids and colorectal cancer: a case-control study, *Am J Epidemiol* 166(2):181-195, 2007.

Thiébaut AC, Kipnis V, Chang SC, Subar AF, Thompson FE, Rosenberg PS, Hollenbeck AR, Leitzmann M, Schatzkin A: Dietary fat and postmenopausal invasive breast cancer in the National Institutes of Health-AARP Diet and Health Cohort study, *J Natl Cancer Inst* 99(6):451-462, 2007.

Thompson CL, Khiani V, Chak A, Berger NA, Li L: Carbohydrate consumption and esophageal cancer: an ecological assessment, *Am J Gastroenterol* 103(3):555-561, 2008.

Tjonneland A, Christensen J, Olsen A, Stripp C, Nissen SB, Overvad K, Thomsen BL: Folate intake, alcohol and risk of breast cancer among postmenopausal women in Denmark, *Eur J Clin Nutr* 60(2):280-286, 2006.

Travis CC, Stabin MG: 131I ablation treatment in young females after the Chernobyl accident, *J Nucl Med* 47(10): 1723-1727, 2006.

Tsugane S: Salt, salted food intake, and risk of gastric cancer: epidemiologic evidence, *Cancer Sci* 96(1):1-6, 2005.

van Wijngaarden E, Singer EA, Palapattu GS: Prostate-specific antigen levels in relation to cadmium exposure and zinc intake: results from the 2001-2002 National Health and Nutrition Examination Survey, *Prostate* 68(2): 122-128, 2007.

Venkateswaran V, Haddad AQ, Fleshner NE, Fan R, Sugar LM, Nam R, Klotz LH, Pollak M: Association of diet-induced hyperinsulinemia with accelerated growth of prostate cancer (LNCaP) xenografts, *J Natl Cancer Inst* 99(23):1793-1800, 2007.

von Gruenigen VE, Courneya KS, Gibbons HE, Kavanagh MB, Waggoner SE, Lerner E: Feasibility and effectiveness of a lifestyle intervention program in obese endometrial cancer patients: a randomized trial, *Gynecol Oncol* 109(1): 19-26, 2008.

Wang LI, Giovannucci EL, Hunter D, Neuberg D, Su L, Christiani DC: Dietary intake of cruciferous vegetables, glutathione S-transferase (GST) polymorphisms and lung cancer risk in a Caucasian population, *Cancer Causes Control* 15(10):977-985, 2004.

Wei EK, Ma J, Pollak MN, Rifai N, Fuchs CS, Hankinson SE, Giovannucci E: A prospective study of C-peptide, insulin-like growth factor-I, insulin-like growth factor binding protein-1, and the risk of colorectal cancer in women, *Cancer Epidemiol Biomarkers Prev* 14(4):850-855, 2005.

Wright ME, Weinstein SJ, Lawson KA, Albanes D, Subar AF, Dixon LB, Mouw T, Schatzkin A, Leitzmann MF: Supplemental and dietary vitamin E intakes and risk of prostate cancer in a large prospective study, *Cancer Epidemiol Biomarkers Prev* 16(6):1128-1135, 2007.

Xia SH, Wang J, Kang JX: Decreased n-6/n-3 fatty acid ratio reduces the invasive potential of human lung cancer cells by downregulation of cell adhesion/invasion-related genes, *Carcinogenesis* 26(4):779-784, 2005.

Xu WH, Shrubsole MJ, Xiang YB, Cai Q, Zhao GM, Ruan ZX, Cheng JR, Zheng W, Shu XO: Dietary folate intake, MTHFR genetic polymorphisms, and the risk of endometrial cancer among Chinese women, *Cancer Epidemiol Biomarkers Prev* 16(2):281-287, 2007.

Xue F, Michels KB: Diabetes, metabolic syndrome, and breast cancer: a review of the current evidence, *Am J Clin Nutr* 86(3):s823-s835, 2007.

Yang CX, Wang HY, Wang ZM, Du HZ, Tao DM, Mu XY, Chen HG, Lei Y, Matsuo K, Tajima K: Risk factors for esophageal cancer: a case-control study in South-western China, *Asian Pac J Cancer Prev* 6(1):48-53, 2005.

Yang P, Chan D, Felix E, Cartwright C, Menter DG, Madden T, Klein RD, Fischer SM, Newman RA: Formation and antiproliferative effect of prostaglandin E(3) from eicosapentaenoic acid in human lung cancer cells, *J Lipid Res* 45(6):1030-1039, 2004.

Yee LD, Young DC, Rosol TJ, Vanbuskirk AM, Clinton SK: Dietary (n-3) polyunsaturated fatty acids inhibit HER-2/neu-induced breast cancer in mice independently of the

PPARgamma ligand rosiglitazone, *J Nutr* 135(5):983-988, 2005.

Yu HH, Shan YS, Lin PW: Zinc deficiency with acrodermatitis enteropathica–like eruption after pancreaticoduodenectomy, *J Formos Med Assoc* 106(10):864-868, 2007.

Zhang SM, Moore SC, Lin J, Cook NR, Manson JE, Lee IM, Buring JE: Folate, vitamin B_6, multivitamin supplements, and colorectal cancer risk in women, *Am J Epidemiol* 163(2):108-115, 2006.

Zhao H, Lin J, Grossman HB, Hernandez LM, Dinney CP, Wu X: Dietary isothiocyanates, GSTM1, GSTT1, NAT2 polymorphisms and bladder cancer risk, *Int J Cancer* 120(10):2208-2213, 2007.

Zuo XL, Chen JM, Zhou X, Li XZ, Mei GY: Levels of selenium, zinc, copper, and antioxidant enzyme activity in patients with leukemia, *Biol Trace Elem Res* 114(1-3):41-53, 2006.

chapter 11

Maternal and Infant Nutrition in Health and Disease

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Chapter Topics

General Nutrition Advice During Pregnancy
The Influence of Nutrition on the Outcome of Pregnancy
Common Problems Through the Trimesters
Lactation Goals and Management
Bottle-Feeding Concerns
Infant Growth and Development
Clinical Problems in Infancy
Postpartum Depression
The Role of the Nurse and Other Health Care Professionals in Maternal and Infant Nutrition

Objectives

After completing this chapter, you should be able to:

- Identify nutritional needs during pregnancy, lactation, and infancy.
- Discuss lactation management techniques.
- Discuss infant feeding strategies.
- Identify risk factors and prevention of postpartum depression.

Terms to Identify

Ankyloglossia
Antidiuretic hormone
Baby-led weaning
Bipolar disorder
Colostrum
Congenital diaphragmatic hernia
Craniotabes
Critical period
Diuresis
Eclampsia
Embryo
Encephalopathies
Esophageal sphincter
Failure to thrive (FTT)
Fetal alcohol syndrome (FAS)
Fetus
Galactorrhea
Galactocele
Gavage feeding
Gestational hypertension-preeclampsia
HELLP syndrome
Hind milk
Hyperbilirubinemia
Hyperemesis gravidarum

Immunoglobulin A (IgA)
Inborn errors of metabolism
International Board-Certified Lactation Consultant (IBCLC)
Intrauterine growth retardation (IUGR)
Jaundice
Lactation
La Leche League
Let-down reflex
Low birth weight (LBW)
Macrosomia
Methylation
Morning sickness
Necrotizing enterocolitis
Neonatal hypoglycemia
Neural tube defects (NTDs)
Nursing-bottle mouth
Obstetrician
Oligohydramnios
Oxytocin
Physiologic anemia
Pica
Placenta
Postpartum blues
Postpartum psychosis
Preeclampsia
Pregnancy-induced hypertension (PIH)
Preterm milk
Products of conception
Proteinuria
Raynaud's phenomenon
Restless leg syndrome (RLS)
Shoulder dystocia
Small for gestational age (SGA)
Spina bifida
Supply and demand
Tongue-tie
Very low birth weight (VLBW)

INTRODUCTION

The human species is very resilient, having survived over the centuries with wide variation in nutritional intake. Many adults are healthy today, even though they were fed under less-than-ideal circumstances as infants. Only in the latter half of the twentieth century have nutritional health, reproduction, and ways to raise healthier babies been thoroughly understood. It is now widely accepted that nutrition plays a vital role in a healthy pregnancy and baby.

Growth of the **fetus** (the unborn baby; Box 11-1) may be affected by various maternal factors, for example, the ingestion, digestion, absorption, and metabolism of nutrients. The fetus is dependent on these processes and transfer of nutrients

Box 11-1 Fetal Development

FIRST TRIMESTER (EMBRYO; CRITICAL STAGE)
Organs develop (4 to 12 weeks)
Central nervous system develops (4 to 12 weeks)
Skeletal structure hardens from cartilage to bone (4 weeks)

SECOND TRIMESTER (FETUS)
Growth and development continue (13 to 40 weeks)
Teeth calcify (20 weeks)
Fetus can survive outside womb (24 weeks)

THIRD TRIMESTER TO BIRTH
Growth and development continue
Storage of iron and other nutrients (36 to 40 weeks; premature babies often deficient in iron)
Development of necessary fat tissue (36 to 40 weeks)

through the **placenta** (the organ that allows the transfer of maternal nutrients to the fetus via the umbilical cord—referred to as the afterbirth at the time of delivery). An intact placenta of good size is critical for ideal growth of the fetus.

The impact of maternal nutrition does not stop at birth. Breastfeeding, preparation for a future successful pregnancy, and even the infant's feeding environment are all influenced by the mother's nutrition. A well-nourished mother is better able to cope with the demands of infant care, and a well-nourished infant displays a pleasant disposition, facilitating the return of the mother's strength and vitality. The relationship between maternal and infant nutrition is very much reciprocal.

To promote healthy outcomes during pregnancy the American Dietetic Association advises optimal weight gain; physical activity as appropriate; a varied diet that follows the 2005 Dietary Guidelines for Americans; vitamin and mineral supplementation appropriate to needs; avoidance of alcohol, tobacco, and drugs; and safe food handling. Women who are not meeting these goals or have chronic health problems can benefit from a referral to a registered dietitian (Kaiser and colleagues, 2008).

A well-balanced diet will help the fetus grow well and allow the mother to stay healthy for future pregnancies. Table 11-1 shows a sample menu to promote a healthy pregnancy.

WHAT GENERAL NUTRITIONAL ADVICE IS RECOMMENDED DURING PREGNANCY?

WEIGHT GAIN

A major determinant of fetal outcome during pregnancy is maternal weight gain. Adequate weight gain improves fetal growth. A woman who is underweight before pregnancy may benefit with more weight gain than is typically recommended to best promote development of the placenta and vasculature needed to deliver nutrients to the fetus. However, excess weight gain needs to be avoided for the health of the mother and the growing fetus. The weight gain advised for overweight women is for the **products of conception** (Figure 11-1).

Debate continues on optimal weight gain. During the 1960s limits were set at 20 lb or less. In recent years the following amounts were felt to be the ideal weight gain:

- 25 to 35 lb for normal-weight women (body mass index [BMI] 20 to 26)
- 28 to 40 lb for an underweight woman (BMI < 20)
- 15 to 20 lb for an overweight woman (BMI > 26)

Average weight gain of about 1 lb per week in the second and third trimesters of pregnancy is expected. A grid can be used to plot weight gain throughout the pregnancy (Figure 11-2).

However, current evidence is once again suggesting lower levels of weight gain during pregnancy are optimal. Evidence supports the Institute of Medicine (IOM) weight gain recommendation that will help to achieve better pregnancy outcomes in obese and overweight women (Jain and colleagues, 2007). Some distinctions with the new 2009 IOM guidelines are as follows:

Table 11-1 Sample Meal Plans for Pregnancy

	PREGNANT WOMAN	PREGNANT ADOLESCENT
Breakfast*	Orange juice,† 1 c Shredded wheat Scrambled egg Toast, 1 slice Milk, 1 c Decaffeinated coffee	Orange juice,† 1 c Shredded wheat Scrambled egg Toast, 2 slices Butter or margarine Marmalade† Milk, 1 c
Lunch	Tuna sandwich on whole-grain bread Carrot and green pepper sticks Oatmeal cookies† Milk, 1 c	Tuna sandwich on whole-grain bread Carrot and green pepper sticks Cheese cube Oatmeal cookies† Fresh fruit Milk, 1 c
Midafternoon snack	Milk, 1 c	Chicken sandwich Milk, 1 c
Dinner	Broiled steak Steamed broccoli Baked potato Tomato salad with French dressing Apple slices	Broiled steak Steamed broccoli with melted cheese Baked potato with sour cream Vegetable salad with French dressing Apple with peanut butter Milk, 1 c
Bedtime	Hot milk or cocoa,† 1 c	Milk or cocoa,† 1 c

*Needs more kcalories, protein, and calcium.
†For women with gestational diabetes, juice may be deemed inappropriate for control of blood glucose; oranges or other vitamin C–containing fruit may be advised later in the day rather than at breakfast, and desserts should be restricted based on values obtained from the woman's self-monitoring of blood glucose levels (SMBG).

- 28 to 40 lb for underweight women (BMI < 18.5)
- 25 to 35 lb gain for normal-weight women (BMI 18.5–24.9)
- 15 to 25 lb for overweight women (BMI 25–29.9)
- 11 to 20 lb for women with obesity (BMI ≥ 30)

Only about one third of U.S. women gain within IOM recommendations, with most far exceeding the goals (Olson, 2008). A large proportion of adolescents gain more than is recommended by the IOM. However, the use of adult BMI categories for determining weight gain in adolescent pregnancies may not be appropriate (Groth, 2007).

For multiple births increased weight gain is expected. One study of twins found the optimal rates of fetal growth and birth weights were associated with the maternal weight gains listed in Table 11-2 (Luke and colleagues, 2003).

For triplet gestations a higher weight gain would be expected. A normal prepregnancy BMI and a total gestational weight gain of at least 35 to 45 lb are associated with fewer pregnancy complications (Eddib and colleagues, 2007).

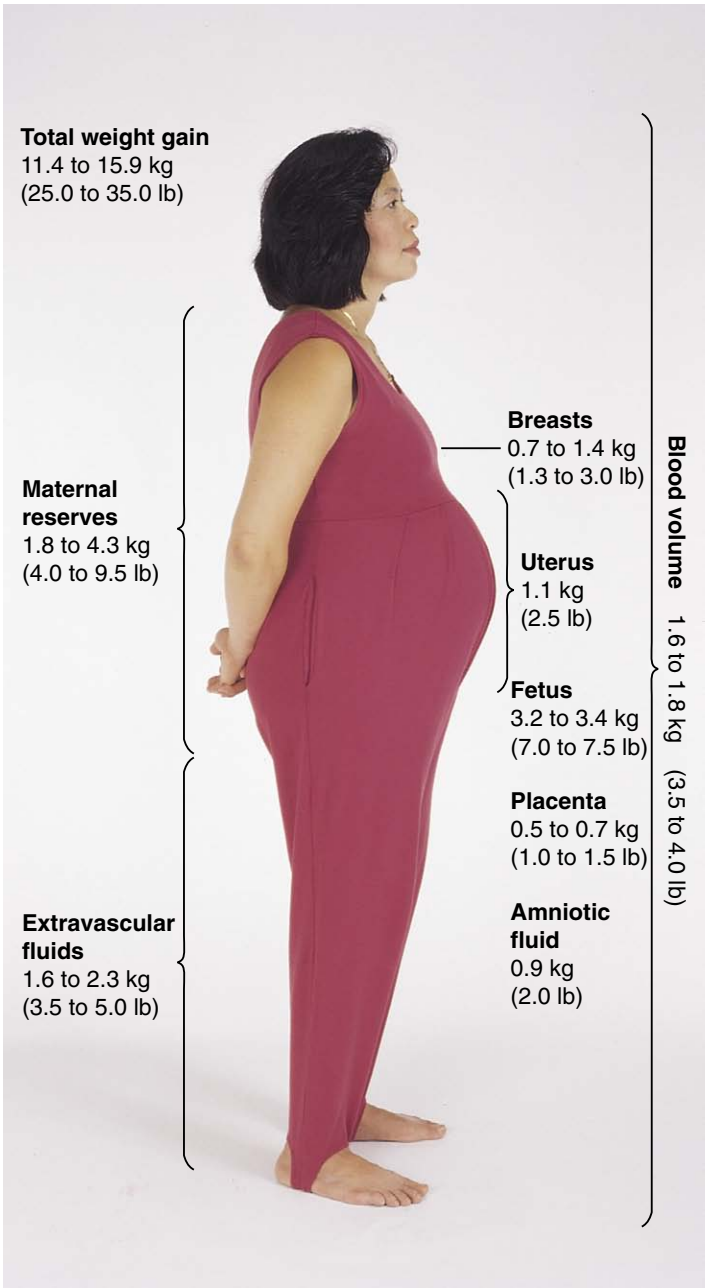


FIGURE 11-1 Components of weight gain during pregnancy. (From Murray SS, McKinney ES: *Foundations of maternal-newborn & women's health nursing,* ed 5, St. Louis, 2010, Saunders.)

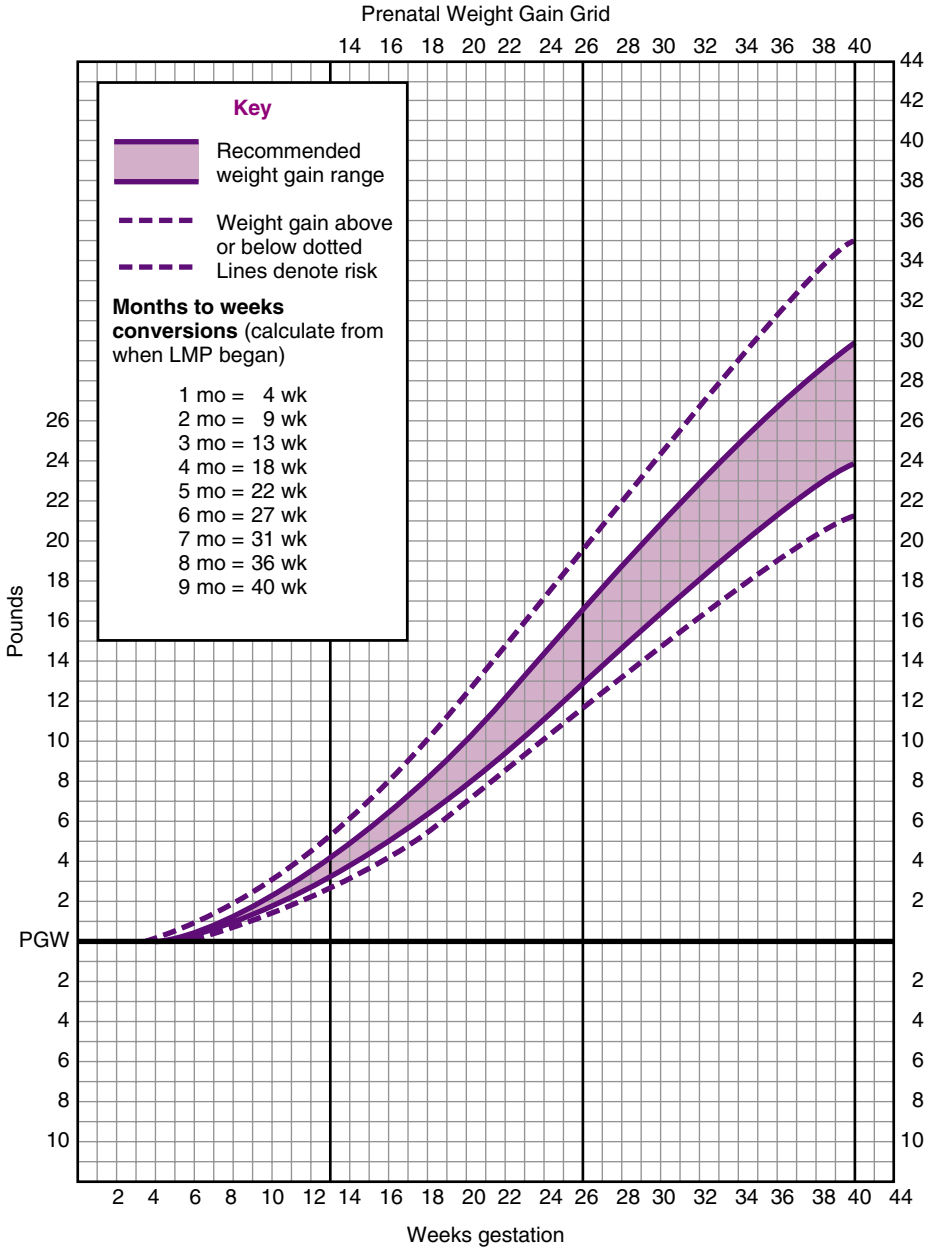


FIGURE 11-2 Recommended prenatal weight gain. Chart to monitor weight gain throughout pregnancy. *LMP,* Last menstrual period; *PGW,* pregestational weight (weight before conception). (From the New York State Health Department, WIC Program.)

Table 11-2 Prenatal Weight Gain Recommendations for Multiple Birth

WEIGHT CATEGORY	0-20 WEEKS (lb/wk)	20-28 WEEKS (lb/wk)	28-40 WEEKS (lb/wk)
Underweight	1¼ - 1¾	1½ - 1¾	1¼
Normal weight	1 - 1½	1¼ - 1¾	1
Overweight	1 - 1¼	1 - 1½	1
Obesity	¾ - 1	¾ - 1¼	¾

Fact & Fallacy

FALLACY Because a pregnant woman is "eating for two," she should eat twice as much.

FACT It should be remembered that the second person is very small—about 7 lb at birth. Although some nutrient requirements increase dramatically during pregnancy, the overall caloric need increases by only about 15%, amounting to about an extra 150 kcal/day during the first trimester and an additional 350 kcal/day for the remainder of the pregnancy, for a total of about 2200 to 2900 kcal. The additional kilocalories can easily come from extra milk, meat, and fruit (see Table 1-4). Individual guidance for kcalorie needs should be based on pregnancy weight gain and other parameters such as levels of blood glucose and ketones. Therefore it is important that a pregnant woman consume mainly nutrient-dense foods. ■

To promote a healthy diet, a pregnant woman should be encouraged to consume at least the minimum number of servings recommended by the 2005 Dietary Guidelines and the MyPyramid Food Guidance System (Table 11-3), with a focus on the use of whole grains and unprocessed or minimally processed foods. This equates to about 1500 kcal daily depending on choices. This is likely too few kcalories, but if weight goals are being met and there are no ketones (see section on diabetes), this level may be appropriate.

MACROSOMIA

Revised weight gain goals are being developed, in part, because of the increased numbers of large-size babies. **Macrosomia** (birth weight more than 4 kg or 8.8 lb) is associated with problems for both mother and infant. Achieving appropriate weight gain appears to be the most important factor in preventing macrosomia rather than the woman's initial BMI (Kabali and Werler, 2007). One study found women who gain more than recommended by the IOM are three times more likely to have an infant with macrosomia (Hedderson and colleagues, 2006).

At increased risk of having an infant with macrosomia are women who have conditions related to the metabolic syndrome, such as high BMI, excess pregnancy weight gain, and type 2 or gestational diabetes mellitus (GDM) (Henriksen, 2008). Low level of pregestational physical activity also increases risk of macrosomia (Voldner and colleagues, 2008). Among a population of white women the strongest single predictors for macrosomia were history of having a baby with macrosomia, BMI greater than 23, and prior GDM (Ogonowski and colleagues, 2008).

Table 11-3 Changes in Foods From the MyPyramid Food Groups During Pregnancy and Lactation

MYPYRAMID GROUPS*	NONPREGNANT WOMEN	PREGNANT WOMEN (SECOND HALF OF PREGNANCY)	LACTATING WOMEN
Milk			
Adult	3 c or more	3 c or more	4 c or more
Adolescent	4 c or more	5 c or more	5 c or more
Vegetable and fruit			
Citrus and other vitamin C foods	1 serving	2 servings	2-3 servings
Dark green, leafy or deep orange vegetable	1 serving at least every other day	1 serving daily	1-2 servings daily
Other fruits or vegetables, including potatoes†	3-4 servings	2 servings	2 servings
Meat or alternate	2 servings or more	3 servings or more (6 oz cooked or more)	3 servings or more (6 oz cooked or more)
Cereal and bread, whole grains	6 servings or more	6 servings or more	6 servings or more

*Additional servings of these or any other food may be added as needed to provide the necessary calories and palatability.
†Total vegetable and fruit intake advised to be at least 4½ c daily.

If fortified milk is not used, obtain physician's instructions for vitamin D supplementation.
Use iodized salt.
Use water or other beverages—at least 6 to 8 c daily.

Uncontrolled diabetes results in increased availability of glucose, which promotes fetal insulin secretion and fetal growth. However, it has been found that even with good blood glucose management, macrosomia can still occur. This may be due to increased amounts of amino acids that are delivered to the fetus. In uncontrolled diabetes during the first trimester even short intervals of poor control can adversely affect placental growth and transport function for the remainder of pregnancy, thereby contributing to macrosomia (Jansson and colleagues, 2006).

Vaginal delivery of a macrosomic fetus requires an experienced obstetrician because of concerns of **shoulder dystocia** (a condition in which the newborn's head is normal size, but with large shoulders) making vaginal delivery extremely difficult, and that can lead to newborn asphyxia. A macrosomic infant greater than 4 kg is the borderline birth weight at which there is increased frequency of birth canal injuries (Hirnle and colleagues, 2007).

Complications of macrosomia include **neonatal hypoglycemia** (plasma glucose level less than 40 mg/dL; less than 70 mg/dL is suboptimal, and glucose should be maintained above this level), and **hyperbilirubinemia** (serum bilirubin greater than or equal to 20 mg/dL)

The impact of macrosomia can lead to adult health problems for the child. One study found older children who had been large for gestational age at birth and exposed in utero to the mother's diabetes or maternal obesity had evidence of metabolic syndrome as measured by a fasting glucose/insulin ratio less than 7 (Boney and colleagues, 2005).

LOW BIRTH WEIGHT

There has been an upsurge in recent years of prematurity and **low birth weight (LBW)** (less than 5.5 lb) of unknown etiology. One possible cause is reduced milk intake. Women who consume less than three glasses of milk per day have been noted to have increased risk of having infants who are born **small for gestational age (SGA)** (less than 10th percentile height or weight based on gestational age) (Olsen and colleagues, 2007). Iron supplementation in pregnant women even without anemia is associated with reduced risk of having LBW infants (Palma and colleagues, 2008). One goal in the prevention of SGA infants is related to cholesterol levels later in childhood. Infants who were born SGA had increased cholesterol levels at age 5 years (Ogden and colleagues, 2008). There also is some evidence that **intrauterine growth retardation (IUGR)** or low birth weight is significantly associated with low-normal kidney function in adulthood, and more so in men (Hallan and colleagues, 2008).

MACRONUTRIENTS

Protein intake needs to be adequate; the minimum intake should be 60 g, which is met by the inclusion of the minimum number of servings recommended in the Dietary Guidelines. An intake of up to 100 g of protein daily has been advocated to ensure a healthy pregnancy.

The kcalories needed to provide appropriate weight gain are supplied from additional carbohydrates and fat. Carbohydrates need to be consumed in adequate but appropriate amounts. The time of pregnancy is not a license to eat all and everything, such as the stereotypical ice cream. A ½-cup scoop of ice cream is on average 170 kcal. The Dietary Reference Intake (DRI) should be met at 130 g carbohydrates, with additional quantities to prevent ketone formation and to promote weight gain needs. Carbohydrate intake should be spread over the day with a maximum of 10 hours between meals. This means a bedtime snack and breakfast containing carbohydrate is important, along with the main mealtimes of lunch and supper.

A minimum of 30 g of fat is required to provide all of the essential fatty acids required for fetal growth and development. There is a wide range in the need for kcalories during pregnancy and lactation because of variation in activity levels and possibly increased or decreased metabolic efficiency, among other factors.

The type of fat in the diet has increasingly been examined in relation to neurologic development of the fetus. It has been advised that pregnant and lactating women include a source of omega-3 fatty acids that can positively affect fetal status. Vegetarians can be advised to consume walnuts, canola oil, flax, or seaweed, such as in Japanese dishes, for alternative plant sources of omega-3 fatty acids. Prenatal vitamins that contain omega-3 fats are now available and may be safer to ingest than fish during pregnancy because of concerns about mercury (see below).

Hydrogenated, or trans fatty acids, should be limited in general, but especially during pregnancy. In a rat study it was found hydrogenated vegetable fat consumed during gestation and lactation alters the blood lipid profiles and promotes inflammation in the offspring (Pisani and colleagues, 2008). In another study, rats exposed to trans fats via hydrogenated soybean oil were shown to have altered appetite regulation and insulin receptors, suggesting intrauterine programming for risk of later development of obesity and hyperglycemia (Albuquerque and colleagues, 2006).

Monounsaturated and omega-3 fats are the preferred source of dietary fat during pregnancy. The plant-based sources of omega-3 fats, specifically canola oil, appear to be of benefit for the growing fetus.

MICRONUTRIENT NEEDS

Fortunately, there are biologic mechanisms that help promote adequate nutrient availability to the fetus if the mother's diet is inadequate. For example, there is increased absorption in the intestinal tract of some nutrients during pregnancy. Other nutrients are maintained at a high level because of reduced excretion through the mother's kidneys. The negative aspect is to the mother whose nutritional status will become impaired if she does not take in sufficient nutrients for the needs of her unborn child as well as her own needs. This can have an adverse impact on future pregnancies if the mother's nutritional status is not maintained or restored.

Although a woman's ability to absorb minerals is enhanced during pregnancy, an adequate dietary intake is still best. Vitamin supplements should be used only as added insurance, not as a replacement for nutrients found in foods. In fact, common prenatal multivitamins do not have choline and are low in magnesium and zinc content. Supplements should not exceed the DRIs (see the back of the book). Minerals such as zinc, copper, and magnesium are found in whole grains and legumes. Adequate consumption of dark green, leafy vegetables (folic acid) and deep orange vegetables and fruits should be encouraged for a source of beta-carotene (vitamin A). Vitamin C foods, such as citrus fruits and dark green, leafy vegetables, should be increased during pregnancy and lactation. Milk is also an important contributor to a healthy pregnancy. It is a source of calcium, vitamin D, and even magnesium and potassium. It has been found that the intake of magnesium, potassium, and folate during pregnancy is related to total body bone mineral content of the children at 9 years of age (Tobias and colleagues, 2005).

Pregnant women following a vegan diet need to ensure adequate intake of vitamin B_{12} through fortified foods or supplements. Vitamin D also is difficult to obtain in a vegan diet; the pregnant woman's diet should therefore be supplemented. Good nutritional intake should be maintained after delivery for healthy lactation and in preparation for a future pregnancy.

FOOD SAFETY CONCERNS

Another concern during pregnancy is food poisoning. Safe food-handling practices should be followed (see Chapter 14). It is recommended that deli meats be heated, especially during pregnancy.

HOW DOES NUTRITION INFLUENCE THE OUTCOME OF PREGNANCY?

PREGNANCY PLANNING

Good nutritional status for an optimal pregnancy outcome begins long before conception. Adequate growth and development (see Chapter 12) of the female child

helps support reproductive health. Having adequate nutrient stores to allow for fetal growth and development is critical.

PREVENTION OF NEURAL TUBE DEFECTS

Neural tube defects (NTDs) are severe congenital malformations due to failure of neural tube formation in the first few weeks of pregnancy. This has been linked with folic acid deficiency. Because conception generally occurs days and weeks before its recognition, all women of childbearing years are advised to consume folic acid (0.4 to 1.0 mg/day), optimally from supplements, but also from foods naturally high in folic acid and fortified foods. Adequate intake of folic acid is advised through pregnancy, the postpartum period of 4 to 6 weeks, and through the duration of breastfeeding.

Neural tube defects include the condition **spina bifida,** in which the spinal canal does not fully close, and other congenital anomalies such as altered brain development, oral facial cleft, structural heart disease, limb defect, urinary tract anomaly, and hydrocephalus. There has been a decrease in the prevalence of cleft lip and cleft palate in the United States that coincided with the 1998 mandatory folic acid fortification of enriched cereal grains.

There is an increased need for folic acid supplementation with several health risks. This includes epilepsy, type 1 diabetes, class II or III obesity (see Chapter 6), family history of neural tube defect, and belonging to a high-risk ethnic group, such as the Sikh population. A higher intake also is advised for women with a history of poor compliance, variable diet, no consistent birth control, and substance use. The recommended intake for high-risk women is a multivitamin with 5 mg folic acid, beginning at least 3 months before conception and through the first semester of pregnancy. During the second and third trimesters of pregnancy, the postpartum period, and throughout breastfeeding 0.4 to 1.0 mg is advised (Wilson and colleagues, 2007).

Folate intake by women of childbearing age in the United States has decreased by approximately 130 mcg/day, after an earlier rise from food fortification. This is believed to be due to lower-carbohydrate diets and consequently less intake of fortified grain products. There are concerns of an increased incidence of neural tube defects, and recommendations have been made to consider the optimal means to fortify the food supply (Quinlivan and Gregory, 2007).

There may be other factors required to reduce the incidence of neural tube defects that are related to homocysteine. Adequate intake of vitamins B_{12} and B_6 is advised for all women of reproductive age (Candito and colleagues, 2008). Without these B vitamins a number of biologic processes are affected as a result of suppressed **methylation** (addition of CH_3 to various body compounds). Due to its short half-life, vitamin B_6 is particularly important for undisturbed **embryo** (the term used for the fetus in the first trimester) development. It should be taken along with folic acid as a periconceptional supplement to prevent embryonic deformities (Weingärtner and colleagues, 2007). Vitamin B_{12} deficiency, such as found with a vegan diet or among women with previous bariatric weight loss surgery, should be considered for infants with **encephalopathies** (degenerative diseases of the brain) that may be reversible if caught early (Gutiérrez-Aguilar and colleagues, 2005).

OBESITY

Obesity is an epidemic worldwide, and its adverse effects on conception, the health of the fetus, and lactation are now being recognized. Maternal risks of obesity during pregnancy include gestational diabetes, hypertension and preeclampsia (see later section), and increased incidence of delivery complications, whereas risks to the fetus include miscarriage, macrosomia, and stillbirth (Catalano, 2007). The ability to successfully breastfeed also is impaired with obesity. Increased efforts are likely required to promote the production and flow of breast milk with an obese woman. Women should ideally be counseled to prevent obesity or lose weight before conception.

Bariatric weight loss surgery is increasingly being advocated for women of childbearing years. This can help in some regards, but other adverse effects can occur with these procedures. Extremely obese persons often have nutritional deficiencies, particularly in fat-soluble vitamins, folic acid, and zinc. Bariatric surgery can worsen these deficiencies because of the severely reduced food portions and malabsorption in bypass procedures. Protein deficiency can develop that may require enteral or parenteral nutritional support (see Chapter 15). Anemia can develop from deficiency of iron, folic acid, and/or vitamin B_{12}. Wernicke encephalopathy from thiamin deficiency can develop that causes neurologic damage. A thorough nutritional follow-up should be performed before conception and during pregnancy after obesity surgery (Folope, Coëffier, and Déchelotte, 2007).

PREEXISTING DIABETES MANAGEMENT

Type 1 diabetes was once considered an automatic cause for alarm if pregnancy occurred. Even with long-standing diabetes, it is now believed that the outcome for mother and child is likely to be favorable if the various health concerns are managed well. It is now known that if a pregnant woman with diabetes maintains near normal blood glucose levels before conception and throughout the pregnancy, she is just as likely as a woman without diabetes to bear a healthy, normal infant.

It is paramount, however, that tight control over blood sugar levels be achieved before conception to help prevent birth defects from developing during the critical first trimester. For women with preexisting type 2 diabetes, the same precautions need to be taken. With uncontrolled type 2 diabetes, rates of perinatal mortality (25 per 1000) and congenital malformation (99 per 1000) are at least as poor as those in uncontrolled type 1 diabetes. The rates of hypertension, preeclampsia, cesarean birth, and postpartum hemorrhage are increased with uncontrolled type 2 diabetes (Dunne, 2005).

An added concern of women who are taking insulin to manage their diabetes is nighttime hypoglycemia. Lantus has not yet been approved for the management of diabetes because of its altered protein structure. Lantus would be the optimal long-acting insulin to use because it is peakless with low likelihood of hypoglycemia. Until Lantus is found to be safe to use during pregnancy, the other long-acting insulin, NPH, is advised. However, NPH does increase the risk of hypoglycemia, especially during the time of peak action, which is about 6 hours, with a variable range of peak action between 4 and 8 hours. It is for this reason that evening doses of long-acting insulin should be given at bedtime to allow for the peak action to occur closer to the time of the dawn phenomenon after 4 AM (refer to Chapter 8). An evening snack that

includes carbohydrate is recommended for all women during pregnancy to decrease production of ketones, but such a snack will also help prevent nighttime hypoglycemia.

With the advent of insulin pump therapy increased numbers of women during pregnancy use this technology. With appropriate and educated use of insulin pumps, maintaining normal blood glucose levels is easier than provision of insulin by injection. However, risks still exist. In one study the rates of diabetic ketoacidosis (DKA) and neonatal hypoglycemia were significantly higher in the group using pump therapy (Chen and colleagues, 2007).

Neonatal hypoglycemia needs to be avoided as much as hyperglycemia. Maintaining normal glucose levels during fetal life depends entirely on continuous placental glucose transfer. If the maternal level of blood glucose is low, the placental transfer of glucose to the fetus will be low. A number of health concerns for the fetus can develop with exposure to hypoglycemia. One problem is seizures (Okanishi and colleagues, 2008). Hypoglycemia is linked with developmental delay and permanent brain damage. Intrauterine growth retardation and prematurity may also be a consequence of fetal hypoglycemia. Hyperglycemia during pregnancy causes the fetus to increase endogenous insulin production, which can lead to hypoglycemia when this high supply of glucose is stopped, such as at delivery, but also potentially in utero. The goal of treatment in infants with hyperinsulinemia is to prevent brain damage from hypoglycemia by maintaining plasma glucose at 70 mg/dL (Palladino, Bennett, and Stanley, 2008).

Control of pregnancy with diabetes is best handled with a medical team approach, so that the most appropriate plan and means of control are developed, including aspects such as insulin, diet, and home glucose monitoring. This includes the mother in making decisions regarding how to manage her blood glucose levels. Discussion should include the benefits of diabetes management during pregnancy. This has been shown to help compliance and outcomes with a group of educated women realizing good metabolic control (A_{1c} of 7.5%; see Chapter 8) as compared with a noneducated group (A_{1c} of 8.4%). Clinical outcomes noted in the group of educated women included control of retinopathy, milder cases of preeclampsia, and no perinatal deaths (Todorova, Mazneikova, and Ivanov, 2004). Although this study defined good control with an A_{1c} of 7.5%, most health care professionals advise an A_{1c} in the 5% range during pregnancy for optimal fetal outcomes.

There are different viewpoints on optimal maternal blood glucose levels. The American College of Obstetricians and Gynecologists (ACOG, 2005) goals are as follows:

- Less than or equal to 95 mg/dL fasting
- Less than or equal to 100 mg/dL preprandial
- Less than or equal to 140 mg/dL 1-hour postprandial
- Less than or equal to 120 mg/dL 2-hours postprandial

The American Diabetes Association (ADA, 2004) advises the following:

- 80 to 110 mg/dL preprandial
- Less than or equal to 155 mg/dL 2-hours postprandial

The higher values of the ADA reflect revised guidelines using the newer blood glucose meters that are calibrated to read the higher plasma levels in order to match laboratory values. High postprandial blood sugar levels may indicate a need for

further carbohydrate restriction (particularly needed at breakfast), a need for insulin, or both. Morning urine ketone levels must also be monitored for a woman with GDM who is restricting her carbohydrate intake. Too little carbohydrate intake, too little insulin production, or weight loss of any amount can cause the mother's body fat to break down excessively. The resulting ketone buildup is potentially detrimental to the growing fetus and needs to be corrected with increased carbohydrates especially at night, insulin, or both. On occasion, a middle-of-the-night carbohydrate snack may be necessary to stop the morning ketonuria; this is usually not a problem because ketonuria is most likely to occur in the third trimester when the mother is up in the night using the bathroom.

IMPACT OF SEASON

Development of certain conditions have been related to season of birth, including schizophrenia, multiple sclerosis, type 1 diabetes, and longevity. This may be influenced by seasonal variation in nutrient intake during pregnancy (Watson and McDonald, 2007). Significantly fewer adolescents living in Chicago who developed diabetes were born during October. This was especially true among males and those who apparently had developed type 2 diabetes (Grover, Lipton, and Sclove, 2004).

One nutrient that is influenced by season is vitamin D. This is certainly true in Northern climates, but there is evidence that subclinical vitamin D deficiency can occur, even in regions with a temperate climate at a latitude 39.5 degrees N (Cabezuelo and colleagues, 2007). Vitamin D deficiency in utero has been linked with **craniotabes** (soft bone tissue of the skull due to reduced mineralization) in otherwise normal neonates. The condition can persist at least until 1 month of age among breastfeeding infants (Yorifuji and colleagues, 2008).

ABILITY TO CONCEIVE

The mother's nutrition and health status influences the growth and development of the fetus, but it can even affect the ability to conceive a pregnancy. Polycystic ovary syndrome (PCOS) is associated with reproductive dysfunction. Reversing obesity and insulin resistance has been shown to increase fertility without the need for costly assisted reproduction. In fact, women who undergo bariatric weight loss surgery often have unplanned pregnancies because of the increased fertility associated with achieving a more normal body weight.

INFLUENCING CONCEPTION

The quality of male sperm is now recognized as being important in achieving a healthy pregnancy outcome. Even moderate increases in blood lead content were found to be related to an increase in immature sperm concentration, and altered size of sperm (Telisman and colleagues, 2007). Cigarette smoking increases levels of both lead and cadmium in semen and leads to increased oxidative damage to sperm (Kiziler and colleagues, 2007).

Vitamin C has been linked with healthier sperm. A low level of seminal ascorbic acid is associated with DNA damage of sperm. An adequate intake of vitamin C helps prevent oxidative damage of sperm quality (Song, Norkus, and Lewis, 2006). The plasma ascorbic acid content of semen was found decreased in smokers and in infertile men. Beyond DNA damage of sperm, low vitamin C levels and smoking are

related to low sperm count and motility (Mostafa and colleagues, 2006). As reviewed previously in the book, excess vitamin C is linked with increased oxidative damage. The conception of a healthy pregancy may be helped when men consume moderate amounts of a variety of vitamin C foods.

PREVENTION OF BIRTH DEFECTS

Good nutritional status begins before conception and can help prevent birth defects. Down syndrome may be influenced by maternal nutritional status. Children with Down syndrome have been noted to have abnormalities in the metabolism of vitamin B_6. Oxalate is a marker of pyridoxine deficiency and is elevated in the amniotic fluid of fetuses with Down syndrome (Baggot and colleagues, 2008).

Fact & Fallacy

FALLACY You can safely avoid gaining too much weight during pregnancy by taking calcium supplements instead of drinking milk.

FACT Milk provides more nutrients than just calcium. A calcium supplement will not give you the extra 30 g of protein found in the recommended 4 cups of milk. Vitamin B_2 and other nutrients, such as potassium, magnesium, phosphorus, vitamins A and D, and other trace elements, are found in milk as well. Low-fat or skim milk can be used by weight-conscious women. ■

WHAT ARE NUTRITIONAL CONCERNS THROUGHOUT THE TRIMESTERS OF PREGNANCY?

FIRST-TRIMESTER CONCERNS

Once a pregnancy has been successfully conceived, the first trimester is the **critical period** of pregnancy. This is the period during which the embryo develops (see Box 11-1). In this period all formation of organs occurs, such as that of the heart, brain, liver, and intestinal tract.

Anemia

Iron deficiency anemia may be evident at the start of pregnancy. This can be due to a variety of problems. For any woman during pregnancy, iron deficiency anemia may occur later during pregnancy when iron intake and stores do not meet increased demands. This is generally preventable and treatable by daily supplements of 30 to 60 mg of ferrous salts. For women who do not tolerate large doses of iron, 18 mg is the standard amount in multivitamin and mineral preparations. However, evidence suggests intolerance to iron supplements is due to tablet size, rather than the iron content (Nguyen and colleagues, 2008).

An increased intake of red meat and cereals fortified with iron (in combination with a vitamin C source) may be adequate to meet iron goals. Undertaking iron studies is advised if there is concern about iron deficiency anemia. This is, in part, due to potential for iron overload. Endometriosis, for example, appears to be adversely affected by iron overload (Defrère and colleagues, 2008).

A newer cause of anemia is related to bariatric weight loss surgery, which is increasingly being performed on women of childbearing years. Iron deficiency devel-

ops after gastric bypass for several reasons, including intolerance of red meat, diminished stomach secretions, and malabsorption with removal of portions of the small intestine. Oral iron supplementation and vitamin C in addition to a multivitamin should be prescribed for women of childbearing years who have had bariatric surgery. Monitoring is required because it may take years before anemia develops. Once iron deficiency has developed, parenteral iron or blood transfusions may be required (Love and Billett, 2008).

Other forms of anemia also may occur during pregnancy. Copper deficiency causes one form of anemia. Both iron and copper are essential micronutrients and are required for a wide variety of enzymatic and other processes within the developing fetus (McArdle and colleagues, 2008). Deficiency of vitamin B_{12} or folic acid, both forms of macrocytic anemia, may be a cause. If vitamin B_{12} deficiency is suspected during pregnancy, as with a woman following a vegan diet, urinary methylmalonic acid excretion and plasma homocysteine levels should be determined and vitamin B_{12} supplementation should be started during pregnancy as needed and with the young infant to avoid potentially irreversible damage of the fetus and infant. One case of severe vitamin B_{12} deficiency involved a 7-month-old infant who developed muscular weakness believed to be due to impaired myelination that was irreversible (Schlapbach and colleagues, 2007).

Morning Sickness

Nausea or **morning sickness** commonly occurs in the first trimester and for some women throughout the entire pregnancy. The cause of the nausea is not fully understood but is probably related to hormonal changes during pregnancy. Reduced motility throughout the gastrointestinal (GI) tract occurs, which is believed to allow for the increased absorption of nutrients. However, the reduced motility may also lead to feelings of fullness and nausea. Because high-fat foods further slow the movement of food through the GI tract, they should be avoided unless tolerated and appropriate for individual weight gain goals.

Preliminary evidence suggests ginger (*Zingiber officinale*) may be an effective and safe treatment for nausea and vomiting in pregnancy. Use of 650 mg of ginger or 25 mg of vitamin B_6 3 times per day were both found to be effective for treatment of nausea and vomiting in pregnancy. However, ginger was more effective than vitamin B_6 (Chittumma, Kaewkiattikun, and Wiriyasiriwach, 2007). Doses needed for control of nausea and vomiting have not been specifically determined. One study found the dose of 1 g of ginger or 40 mg of vitamin B_6 daily were equally effective in reducing vomiting, and once again ginger was found to be more effective in controlling nausea (Ensiyeh and Sakineh, 2008).

Applied in daily doses of up to 6 g, fresh ginger root generally has few side effects (Betz and colleagues, 2005). The level of vitamin B_6 in treating nausea and vomiting is much higher than the DRI. The average dose of vitamin B_6 in one study, approximately 130 mg/day for a period of about 5 to 13 weeks, was associated with one major malformation, and the average birth weight was approximately 3000 to 4000 g (Shrim and colleagues, 2006). Long-term ingestion of vitamin B_6 greater than 100 mg/day is associated with neuropathy. The DRI for vitamin B_6 is 2.6 mcg during pregnancy, and the upper tolerable intake level (UL) has not been determined. Caution is advised.

An assessment of common provider advice for moderate to severe nausea with occasional vomiting includes the following:

- Eat frequent, small meals (93% of providers)
- Snack on soda crackers (68.5%)
- Take vitamin B_6 along with medication (67.1%) (Power, Milligan, and Schulkin, 2007)

The nausea of pregnancy may be related to low blood glucose levels. It is well known that the hormone glucagon can cause severe nausea, and this hormone is produced in response to lowering of blood glucose levels. It may be for this reason that the standard advice for women to eat dry toast or crackers before getting out of bed has been found helpful.

For a woman with morning sickness, a gradual increase in food consumption during the late afternoon and evening can replace nutrients that were not consumed in the morning. Including a bedtime carbohydrate snack with a protein source may help to stabilize blood sugar levels during the night and help prevent morning sickness.

Hyperemesis Gravidarum

Hyperemesis gravidarum, commonly referred to as simply hyperemesis, is characterized by excessive and prolonged vomiting beyond the first trimester. The severity of vomiting leads to significant weight loss, and the diagnosis includes a weight loss of over 5% with electrolyte imbalance. It is probably more common than statistics show because treatment may be in a physician's office rather than in a hospital setting. The cause of hyperemesis is generally unknown, although various issues have been implicated, including hyperthyroidism, infection with *Helicobacter pylori,* and altered hormones. Hyperemesis can cause serious dehydration and vitamin deficiencies, such as thiamin deficiency, which causes signs and symptoms of beriberi and Wernicke's encephalopathy (Indraccolo and colleagues, 2005).

Altered taste perception and aversion to smells of cooking food have been noted. It is partially for this reason that all foods that are tolerated are considered acceptable when severe nausea and vomiting are adversely affecting weight gain. Nutrient density becomes a minor issue when weight gain is paramount to combat the effects of hyperemesis. If a woman with hyperemesis can tolerate jelly beans or potato chips, they may be warranted as a source of concentrated kcalories to prevent further weight loss. Once the hyperemesis is resolved, more nutrient-dense foods can be included such as vegetables.

It is advised to check for ketones (see section on gestational diabetes) in order to determine management need (Sheehan, 2007). Control of ketones requires hydration and insulin, but with hyperemesis of pregnancy provision of carbohydrates also will be required. An assessment of treatment of women who had suffered with hyperemesis for at least 27 weeks revealed the most effective treatments included intravenous (IV) hydration, serotonin inhibitors, and parenteral nutrition (Goodwin and colleagues, 2008). However, parenteral nutrition (provision of nutrients directly into large veins; see Chapter 15) is not without risk. One study found peripherally inserted central catheter (PICC; see Chapter 15) line has the potential for greater complications, such as infection and clot formation, while providing no advantage

over tube feeding (see Chapter 15) in the management of pregnancies with hyperemesis (Holmgren and colleagues, 2008).

Fact & Fallacy

FALLACY Hyperemesis is psychologic in origin.

FACT There is little evidence that hyperemesis is caused by psychologic problems; rather, it is more likely that it causes psychologic distress itself. Stronger evidence indicates that hormonal or other physical issues are the basis for the development of hyperemesis. Smells, odors, and motion have been known to precipitate nausea and vomiting. ■

Promoting Neurologic Development

On a positive note, the inclusion of omega-3 fatty acids is now recognized to promote the development of the neurologic system in utero and early infancy. The primary source of omega-3 fatty acids, fish, comes at the risk of mercury poisoning. Sources relatively low in mercury include salmon, followed by shrimp, as the prime sources of omega-3 fatty acids. The more popular tuna can be consumed for omega-3 fatty acids but poses a greater risk for mercury toxicity (Mahaffey, Clickner, and Jeffries, 2008). One debate is how much fish is enough to provide the benefits of the omega-3 fatty acids without being detrimental due to mercury content. Higher fish intake was found associated with better child cognitive test performance, but higher mercury levels with poorer test scores. Fish consumption of two servings or less per week was not associated with a benefit (Oken and colleagues, 2008).

The large ocean fish such as shark, swordfish, and marlin or lake fish often contain high amounts of mercury and should be avoided during pregnancy. The appropriate state health department can be contacted regarding advisories for specific lake fish that should be avoided. Generally, small fish such as sardines are less likely to have high levels of mercury or other toxic substances harmful to a growing fetus.

Certain nutrients have greater effects on brain development than do others. These include protein, energy, certain fats, iron, zinc, copper, iodine, selenium, vitamin A, choline, and folate. Deficiency of these nutrients during fetal development includes adverse effects on information processing, memory, autonomic nervous regulation, and motor coordination (Georgieff, 2007).

Adequate intake of the B vitamins during pregnancy is important to promote neurologic development of the fetus. A dietary deficiency of vitamin B_1 is a cause of nerve damage. Wernicke's encephalopathy can occur with severe hyperemesis. Thiamin supplementation should be provided to women with prolonged vomiting in pregnancy, especially at the first indication of neurologic signs and symptoms (see Chapter 3) (Chiossi and colleagues, 2006). Optimally thiamin should be provided intravenously in such a situation. Vitamin B_{12} deficiency in utero (and in infancy) causes growth retardation, impaired or regression of psychomotor development, muscular hypotonia, and brain atrophy (Lücke and colleagues, 2007).

During gestation there is a high demand for the B vitamin choline. Adult rats supplemented with choline during early gestation have improved memory performance throughout their life span, whereas prenatally choline-deficient rats have memory deficits (Kovacheva and colleagues, 2007). It has been demonstrated that choline has a lasting effect on brain and behavior of the rat offspring (Cheng and colleagues, 2008). In one case of depletion of plasma choline and a similar substance in a pregnant woman, low placental weight and low infant birth weight was noted. The cause of the choline depletion appeared related to medications used to treat her bipolar disorder (Gossell-Williams, Fletcher, and Zeisel, 2008). Another B vitamin, pyridoxine, affects development of the part of the brain related to the learning process and memory retention. Reduced intellect and altered behaviors may occur in children of women with pyridoxine deficiency during pregnancy. Deficiency of this vitamin is common among women who used anovulatory steroids before pregnancy (Krishna and Ramakrishna, 2004).

Neurologic development continues into the second trimester and throughout early infancy. For women with low intake of fish, a daily vitamin/mineral supplement containing 200 mg docosahexaenoic acid (DHA) appears appropriate. This level of DHA given beginning at the twenty-first week of gestation significantly raised maternal levels of DHA at both the thirty-seventh week and 3 weeks postpartum, with breast milk containing twice the level of DHA as for women without the supplement (Bergmann and colleagues, 2008).

SECOND-TRIMESTER CONCERNS

Physiologic Anemia

Physiologic anemia results from expanded blood volume (plasma increases without a concomitant increase in red blood cells). There is controversy in the medical field regarding whether this form of anemia needs to be treated. However, until further research indicates otherwise, increased iron intake, without excess, is advised. Iron studies can help determine the necessity of iron supplementation.

Screening for and Management of Gestational Diabetes Mellitus (GDM)

GDM occurs after the placenta has reached a large enough size to release significant amounts of placental hormones into the mother's circulatory system. These hormones worsen insulin resistance and lead to high blood glucose levels, especially for women who already have a predisposition toward insulin resistance. The first indication of metabolic syndrome may be the diagnosis of gestational diabetes (Kaaja, 2008). An estimated 4% of pregnancies are GDM pregnancies.

Because GDM develops in the second trimester of pregnancy, risk of birth defects is greatly lessened. Macrosomia and shoulder dystocia are concerns related to uncontrolled GDM that make labor and delivery difficult and can result in need for cesarean section. Hypoglycemia of the infant after delivery is another concern that can require IV dextrose treatment and medical monitoring in the intensive care unit. If normal blood glucose levels are maintained and excess weight gain is avoided, these conditions are less likely to occur.

Debate continues on how best to screen for GDM and when to treat. Routine screening for GDM is now generally done between the twenty-fourth and

twenty-eighth weeks of pregnancy. A 1-hour screening with a 50-g oral glucose challenge test is advised for high-risk women. This includes women who are obese or 32 years of age or older (Hackmon and colleagues, 2007). If the initial 1-hour screening level is greater than or equal to 140 mg/dL, a 3-hour oral glucose tolerance test (OGTT) is advised, using a 100-g glucose drink. Having two of the following values above normal is diagnostic of GDM:

- Fasting blood glucose: 95 mg/dL
- 1 hour: 180 mg/dL
- 2 hour: 155 mg/dL
- 3 hour: 140 mg/dL

Whether a woman with impaired glucose tolerance according to the results of an OGTT, but not diagnosed with GDM, should monitor her blood glucose levels during pregnancy is not agreed upon. One study found women with one elevated oral glucose tolerance test value did not benefit from medical nutritional therapy and self-monitoring of blood glucose (Fassett, Dhillon, and Williams, 2007). However, more than one third of mothers who have delivered at least one large baby have been found to have had impaired glucose tolerance, based on A_{1c} (see Chapter 8), after delivery. An elevated prevalence of preeclampsia with impaired glucose metabolism during pregnancy also has been noted. Prevention of excess weight gain is important among women who have an abnormal OGTT result but do not meet the diagnostic criteria for GDM because they are at increased risk of delivering macrosomic and large-for-gestational-age neonates (Segal and colleagues, 2008).

Controversy also continues on how best to treat GDM. The controversies in GDM management include how low kcalorie intake should be, dietary composition of carbohydrates versus fats, and optimal gestational weight gain. There is evidence that the omega-3 fatty acid DHA reduces insulin resistance. Indications that food restrictions have gone too far include weight loss or lack of weight gain, undereating to avoid insulin therapy, positive urinary ketones, and intentional restriction of healthy foods (Reader, 2007).

Ultimately, if the mother's blood glucose level meets goals, she has no evidence of ketone production, and she is not losing weight, she can continue with what works for her. In general, a moderately reduced kcalorie intake can be helpful, in the range of 2000 kcal or less, with moderately reduced carbohydrate intake between 40% and 50% of total kcalories. Low–glycemic load meals are of further benefit, and postprandial blood glucose testing will verify an individual woman's carbohydrate tolerance. Limited weight gain can be beneficial to reduce risk of macrosomia. One study found approximately ¼ lb per week weight gain was associated with reduced risk of macrosomia without adverse effects observed to the fetus (Artal and colleagues, 2007).

Some providers question the wisdom of testing for ketonuria in treating GDM. However, there is evidence that ketonuria is not a desirable state. Maternal ketonuria among women with postterm pregnancy greater than or equal to 41 weeks' gestation was associated with a greater than twofold increase in the occurrence of **oligohydramnios** (deficiency of amniotic fluid) and reduction in fetal heart rate (Onyeije and Divon, 2001). Although DKA typically occurs in type 1 diabetes and can induce both maternal and fetal mortality, it has been linked with type 2 diabetes as well. A 37-year-old Saudi patient who had been diagnosed with type 2 diabetes developed

DKA during pregnancy despite having a normal blood glucose level. She responded to IV dextrose and insulin and gradually improved. Euglycemic DKA should be considered in type 2 diabetes during pregnancy and treated promptly (Tarif and Al Badr, 2007). Testing for ketonuria is inexpensive and easy. It only requires the woman to urinate on a strip that is visually compared to a color chart. The potential benefits of having women with GDM test for ketonuria when they are restricting carbohydrate intake appears warranted.

A condition almost not seen nowadays, as a result of improved diabetes screening and management, is hyperosmolar hyperglycemic nonketotic syndrome (HHNKS). This is a serious complication of uncontrolled hyperglycemia that can lead to coma and death. This condition was identified in a 21-year-old who presented for care at 32 weeks' gestation with an intrauterine fetal demise. Management included an insulin drip, rehydration, and magnesium. This condition should be suspected in pregnant obese women who present with hyperglycemia (Gonzalez and colleagues, 2007).

Women who have had GDM are at high risk for carbohydrate intolerance and metabolic syndrome in the following year. Medical surveillance is advised to allow for early detection and treatment of any metabolic disturbances ((Wender-Ozegowskan and colleagues, 2007).

Prevention of Childhood Asthma

Research continues on how to best prevent the recent rise in childhood asthma. Maternal causes related to pregnancy are now being explored. Preliminary evidence suggests that supplementation of maternal diet with fish oil is associated with altered neonatal immune responses to allergens. Reduced maternal intake of zinc and vitamins D and E during pregnancy is associated with increased asthma and wheezing outcomes in children up to the age of 5 years (Devereux, 2007). Increased intake of vitamin E foods during pregnancy is linked with reducing asthma and other wheezing conditions in early childhood (Litonjua and colleagues, 2006).

Prevention of Other Birth Defects

Congenital diaphragmatic hernia is a severe birth defect in which there is an opening in the diaphragm through which a portion of the abdominal contents protrudes into the thoracic cavity. A lower incidence was found among women who took vitamin supplements, higher intakes of B vitamins (folate, vitamin B_1, B_2, B_6, and B_{12}), minerals (calcium, iron, magnesium, and zinc), and vitamin E. Moreover, among women who did not take vitamin supplements, lower dietary intakes of calcium, retinol, selenium, vitamin B_{12}, and vitamin E were linked with increased risk of congenital diaphragmatic hernia (Yang and colleagues, 2008).

Impact of Exercise

Evidence-based guidelines indicate that regular prenatal exercise is an important component of a healthy pregnancy. Women who are the most physically active have the lowest prevalence of gestational diabetes. Physically active women also are less likely to develop preeclampsia. These benefits may be due to enhanced placental growth and vascularity and/or reduced oxidative stress, inflammation, and endothelial dysfunction (Weissgerber and colleagues, 2006).

Teaching Pearl

Statistics on health behaviors can help develop goals of intervention. The Pregnancy Risk Assessment Monitoring System (PRAMS) is an ongoing, state- and population-based surveillance system designed to monitor selected maternal behaviors and experiences that occur before, during, and after pregnancy among women who deliver live-born infants. Table 11-4 shows 2003 data related to eight perinatal indicators of the Healthy People 2010 objectives of 19 states (Alabama, Alaska, Arkansas, Colorado, Florida, Hawaii, Illinois, Louisiana, Maine, Nebraska, New Mexico, New York, North Carolina, Ohio, Oklahoma, South Carolina, Utah, Washington, and West Virginia). Thus it would be most appropriate to target prenatal guidelines for planned pregnancy in Louisiana, whereas the importance of supplemental vitamin use to help prevent neural tube defects would be advised in Arkansas. Increased prenatal education on the benefits of breastfeeding would be well served in Louisiana and less important in Alaska. ■

THIRD-TRIMESTER ISSUES

Preeclampsia or Pregnancy-Induced Hypertension

Preeclampsia is defined as the association of pregnancy-induced hypertension and proteinuria of 300 mg/24 hours or more after 20 weeks' gestation. Preeclampsia occurs in up to 15% of pregnancies and is generally associated with edema and coagulation abnormalities. This condition also is referred to as **pregnancy-induced hypertension (PIH).** Women with a history of preeclampsia are characterized by vascular dysfunction and an increased risk of cardiovascular disease. There is some evidence of an association with insulin resistance (Lampinen and colleagues, 2008). Periodontal disease during pregnancy has been associated with an increased risk of preeclampsia (Vergnes, 2008). The commonality may be inflammation as is found with insulin resistance and vascular dysfunction. Higher free radical production from oxidation also is implicated (Krishna Mohan and Venkataramana, 2007).

The only treatment of preeclampsia is delivery. However, there is one case report of a woman who had preeclampsia treated with delivery, but had a recurrence of the classic signs of preeclampsia in the postpartum period. Ultimately she was treated with magnesium with a final diagnosis of recurrent preeclampsia (Andrus and Wolfson, 2008). Lowering of blood pressure and prevention of eclampsia with magnesium sulfate is indicated in severe preeclampsia (Irminger-Finger, Jastrow, and

Table 11-4 Pregnancy Risk Assessment Monitoring System (Data from Suellentrop and colleagues, 2006)

2003 STATE RANGES	HIGHEST	LOWEST
Intended pregnancy	66.5%, Maine	48.1%, Louisiana
Multivitamin use ≥ 4 times per week	45.2%, Maine	23.0%, Arkansas
Physical abuse by husband/partner	7.6%, New Mexico	2.2%, Maine
Cigarette smoking abstinence third trimester	96.1%, Utah	72.5%, West Virginia
Cigarette smoking cessation	65.8%, Utah	30.2%, West Virginia
Alcohol abstinence third trimester	98.0%, Utah	91.3%, Colorado
Breastfeeding initiation	90.3%, Alaska	51.2%, Louisiana
Infant sleep position	78.7%, Washington	50.0%, Arkansas

Irion, 2008). Consideration needs to be given to antihypertensive therapy for severely preeclamptic and eclamptic women when systolic blood pressure reaches or exceeds 155 to 160 mm Hg (Martin and colleagues, 2005). The syndrome of hemolysis, elevated liver enzymes, and low platelets **(HELLP syndrome)** is related to **gestational hypertension-preeclampsia** (Coppage and Sibai, 2005).

There is a major role for magnesium in the regulation of blood pressure. Women with adequate intakes of magnesium are less likely to be affected by preeclampsia than those with an inadequate intake (Champagne, 2008). Calcium supplementation for high-risk women and those with low calcium intake appears to almost halve the risk of preeclampsia (Hofmeyr, Atallah, and Duley, 2006).

Eclampsia (the severe condition that may follow preeclampsia) is associated with convulsions and coma. Some symptoms that can indicate development of eclampsia include a sudden rise in blood pressure, severe headache, blurred vision, and **proteinuria** (protein in the urine). The onset of eclamptic convulsions can be before, during, or after delivery. Magnesium sulfate is the drug of choice for reducing the rate of eclampsia and convulsions developing during delivery and immediately postpartum. Women with a history of eclampsia are at increased risk for reoccurrence in subsequent pregnancies (Sibai, 2005).

The former practice of restricting kcalories and sodium to reduce the risk of PIH complications is now considered obsolete. To the contrary, there is a greater incidence of PIH among underweight women who fail to gain weight normally during pregnancy. The evidence indicates that the total amount of weight gain per se is not the significant factor. Sodium restriction is no longer recommended and may actually be harmful, because sodium requirements increase during pregnancy. However, avoiding excessive salt intake is recommended for pregnant women and for the general population. Found on food labels, the guidelines advocating 2400 mg of sodium for the general public are appropriate for women who are pregnant, with or without hypertension. The 2005 Dietary Guidelines advise 2300 mg sodium.

Constipation

Constipation is related to decreased intestinal motility, which is believed to be a normal physiologic process that assists in nutrient absorption during pregnancy. Increased production of the hormone progesterone is believed to be the physiologic basis for decreased peristalsis. Also, by the end of pregnancy, the associated pressure from the growing fetus contributes to constipation. Adequate fiber and fluid intake and appropriate exercise can help control constipation. A fiber intake of 20 to 35 g is generally advocated, with a fluid intake of at least 2 L daily with the goal of pale yellow urine to indicate an appropriate level of hydration. Excess fluid intake can lead to electrolyte imbalance and reduced ability of the kidneys to reabsorb needed minerals to maintain homeostasis. Laxatives should be used only on the advice of an **obstetrician** (a physician specializing in pregnancy).

Heartburn

Heartburn in pregnancy is believed to be caused by the pressure of the growing fetus on the stomach and hormonal changes, resulting in hydrochloric acid being forced into the esophagus. Pregnant women may find it helpful to eat smaller, more frequent meals and to avoid a reclining position after eating. Excess fat intake can

contribute to heartburn by causing food to remain in the stomach for longer periods. Excess fat may relax the muscle tone of the **esophageal sphincter** (the muscle connecting the stomach and esophagus), which can further lead to the seeping of hydrochloric acid up into the esophagus. Pregnant women should not take over-the-counter medications for heartburn without consulting their obstetricians.

Pica

The practice of **pica** (eating nonfood items, especially clay or laundry starch) during pregnancy is a carryover from a tradition in Africa, where it is still practiced in some areas. The consumption of clay can provide a source of calcium, iron, and other minerals; however, it can also provide toxic contaminants. When clay is not available in this country, laundry starch is sometimes substituted. Consumption of these substances can interfere with absorption of adequate nutrients and should be discouraged.

Teaching Pearl

The practice of pica is not often revealed, especially if the health care professional appears to have a judgmental attitude. The health care professional must demonstrate great sensitivity to elicit an accurate assessment of the practice of pica. Because pica is generally related to cultural heritage and beliefs, changing the practice may be difficult. Using objective measures, such as informing patients about the danger of anemia or lead poisoning, may help them understand the negative consequences of pica. ■

Prevention of Prematurity and Low Birth Weight

Low maternal concentrations of individual n-3 fatty acids and 20:3n-6, the precursor of arachidonic acid (20:4n-6), but high concentrations of the other n-6 fatty acids and the main dietary trans fatty acid (18:1n-9t) have been associated with lower birth weight and infants who are born SGA (van Eijsden and colleagues, 2008).

Caffeine consumption during pregnancy is reported to increase the risk of in utero growth restriction and spontaneous abortion. In a study of pregnant mice length and body weight of embryos were reduced. This may be due to the observed decreased embryo carotid artery flow (Momoi and colleagues, 2008).

Fact & Fallacy

FALLACY A few cups of coffee per day pose no risk during pregnancy.

FACT There is conflicting evidence about how much caffeine is safe during pregnancy. Caffeine is known to cause blood vessels to constrict, potentially limiting blood flow through the placenta to the growing fetus. Until more is known, the prudent approach is to cut back on coffee and other caffeine sources gradually to no more than one cup (200 mg of caffeine) daily. ■

Restless Leg Syndrome

A cause of poor sleep during pregnancy is related to **restless leg syndrome (RLS)**. This is a sensorimotor neurologic disorder that involves unpleasant sensations in the

lower limbs during periods of inactivity, especially during the night. Activity calms the sensations, with resulting leg movements during sleep.

About 10% of all white populations have RLS, although it may be mild in the majority of cases. Women generally outnumber men by about 2:1. The actual central nervous system pathologic process of RLS demonstrates reduced iron stores (Satija and Ondo, 2008). The cause may be genetic, or the condition may result from medications, diabetes mellitus, renal failure, iron deficiency, neurologic disorders, or rheumatoid arthritis (Vergne-Salle and colleagues, 2006). There is a transient form of RLS during pregnancy, primarily limited to the third trimester. Up to one in four women may be affected, and it has been associated with lower hemoglobin and mean corpuscular volume (MCV) even with supplemental iron and folate therapy (Manconi and colleagues, 2004). Increasing parity has been associated with RLS (Berger and colleagues, 2004).

One case of RLS during pregnancy improved after IV magnesium sulfate administration. The symptoms completely resolved during treatment, beginning the first day of administration (Bartell and Zallek, 2006).

OTHER CONCERNS FOR PREGNANCY

Epilepsy

In the United States, epilepsy is the most common neurologic condition encountered in pregnancy. Due to antiepileptic medication interaction with folate, preconceptional and gestational folate supplementation is advised to prevent neural tube defect. Antiepileptic drugs further can induce vitamin K deficiency. This can lead to neonatal hemorrhage during the first 24 hours of life. Supplemental vitamin K therapy is needed at least during the last month of pregnancy (Montouris, 2007).

Women with epilepsy during pregnancy need adequate fluid intake, regular meals, and proper sleep to avoid behavioral alterations that can trigger seizures. Seizure medicines are increased during pregnancy, but need to be reduced after delivery. It is at this time that there is increased seizure risk due to sleep deprivation from care of the newborn and due to hormonal changes. Adequate care plans are required to ensure the welfare of the newborn (Krishnamurthy, 2008).

All women with epilepsy should be encouraged to breastfeed their babies. The total amount of drug transferred to the infant via breast milk is usually much smaller than the amount transferred via the placenta during pregnancy, although it does have the potential to build up in the infant's system (Crawford, 2005).

Other strategies to reduce seizure activity include promoting stable blood glucose levels; avoiding allergenic foods and triggers such as alcohol, aspartame, and monosodium glutamate; and following a ketogenic diet as needed. Nutrients that may reduce seizure frequency include vitamin B_6 and E, the minerals magnesium and manganese, the protein taurine, and omega-3 fatty acids. Anticonvulsant medications interfere with the body's use of the B vitamins, folic acid, B_6, and biotin, vitamin D, and L-carnitine (Gaby, 2007).

Phenylketonuria

An example of a high-risk pregnancy that can be addressed nutritionally is one in which phenylketonuria (PKU) is present. The effects of high phenylalanine levels prenatally on the fetus include facial abnormalities, reduced head size, intrauterine growth retardation, developmental delay, and congenital heart disease. These adverse

outcomes can be reduced if the woman follows a phenylalanine-restricted diet by the beginning of the second trimester of pregnancy, but optimally before conception (PJ Lee and colleagues, 2005). The maternal blood phenylalanine levels must be maintained between 120 and 250 mcmol/L and the tyrosine blood levels between 45 and 90 mcmol/L. Weekly blood analyses of phenylalanine levels are advised to ensure the safety of the growing baby.

Affected women's diets need to be assessed by a registered dietitian to ensure a nutritional intake sufficient to support a healthy pregnancy. Receiving adequate protein to support a healthy pregnancy can be accomplished by use of special low-phenylalanine liquid supplements. However, low intake of foods containing phenylalanine increases risk of inadequate intake of vitamins and minerals needed for fetal growth and development.

Alcohol Use

Fetal alcohol syndrome (FAS) results from excessive alcohol intake by the mother during pregnancy. It is characterized by wide-set eyes and mental retardation or other dysfunction of the central nervous system. Small head size has been noted, along with impaired development of brain cell mitochondria resulting from alcohol exposure in utero (Xu, Liu, and Li, 2005). Cognitive deficits such as impaired problem-solving skills can occur in alcohol-exposed children with or without the diagnosis of FAS and in the absence of mental retardation (McGee and colleagues, 2008). Choline has been shown to significantly reduce the number of alcohol-related problems. Hyperactivity can be a problem with FAS but is lessened with choline supplementation (Thomas, Garrison, and O'Neill, 2004).

Because the safe limit of alcohol intake is not known, the best advice for the pregnant woman is to abstain from alcohol. Professional counseling may be necessary.

Drug Addiction

The use of illegal drugs (and legal drugs, such as alcohol and those found in tobacco) impairs fetal growth and development. Women who are addicted before conception often deny their dependence, presenting a challenge to the health care professional. Good nutrition is vital so that complications associated with drug use are not exacerbated.

Teaching Pearl

The effect of tobacco use on the growing infant can be related to scuba diving. It can be explained to the pregnant woman that the fetus is essentially scuba diving in utero and is dependent on oxygen from the mother. Tobacco use decreases the amount of oxygen the fetus is able to receive, essentially suffocating it. She may, however, need assistance in smoking cessation. Secondhand smoke may also be a problem. ■

Adolescent Pregnancy

Depending on the age of the mother and other factors, an adolescent pregnancy may be perfectly normal or extremely high risk. Younger teenagers and those who become

pregnant near the time of menarche are at greatest risk. Pregnant teenagers may have dietary habits that include foods low in essential nutrients, resulting in an insufficient intake of nutrients especially important during pregnancy. A concern about body image may result in inadequate weight gain.

Programs for pregnant teenagers, common in most communities, offer social support, encouragement to seek good medical care, and assistance in completion of school. The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC program) is generally available to all low-income pregnant teenagers, and referral should be made by the health care professional (see Chapter 14). It provides the pregnant teenager with vouchers for purchasing specified foods that meet needs for calcium, vitamin C, and iron. Nutrition assessment and education are also provided by registered dietitians or nutritionists within the WIC program.

Breastfeeding is possible for the motivated teenager, although other life concerns may take precedence. Nevertheless, breastfeeding should be recommended for all women unless specifically deemed unadvisable by a doctor. Even a few days or weeks of breastfeeding can be beneficial to the newborn infant and the new mother (see later in this chapter).

Celiac Disease

Studies show that women with celiac disease are at increased risk for infertility, miscarriages, having children with low birth weight, and short duration of breastfeeding. Folic acid deficiency can occur because of poor intestinal absorption, which leads to neural tube defects and cleft palates. Minor symptoms may lead to misdiagnosis. Proper diagnosis of celiac disease followed by use of a gluten-free diet may improve fertility and pregnancy outcomes through improved nutritional status. Refer back to Chapter 4 for more on celiac disease.

WHAT ARE LACTATION MANAGEMENT GOALS AND CONCERNS?

GOALS OF LACTATION

Because of the many health benefits of **lactation** (production of milk for breastfeeding; also called nursing), the American Academy of Pediatrics recommends exclusive breastfeeding until the infant is approximately 6 months of age. Healthy People 2010's objectives are to increase the number of women who breastfeed to 75% (www.healthypeople.gov). Health care professionals can help increase the rate of breastfeeding. The Baby-Friendly Hospital Initiative (BFHI) is a worldwide program sponsored by the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) to encourage and recognize hospitals and birthing centers that provide high-quality care in the support of lactation. Ten steps have been identified for U.S. hospitals (Box 11-2).

Currently the rate for breastfeeding infants until age 6 months remains below the Healthy People 2010 goal. The greatest decrease in the breastfeeding rate occurs during the first month. The following reasons are cited for breastfeeding cessation:

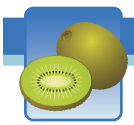
- Women's lack of confidence in their ability to breastfeed
- Problems with the infant latching or suckling
- Lack of individualized encouragement within 2 weeks after the birth

Box 11-2 The U.S. 10 Steps to Successful Breastfeeding for Hospitals.

1. Maintain a written breastfeeding policy that is routinely communicated to all health care staff.
2. Train all health care staff in skills necessary to implement this policy.
3. Inform all pregnant women about the benefits and management of breastfeeding.
4. Help mothers initiate breastfeeding with one hour of birth.
5. Show mothers how to breastfeed and how to maintain lactation even if they're separated from their infants.
6. Give infants no food or drink other than breastmilk, unless medically indicated.
7. Practice "rooming in"—allow mothers and infants to remain together 24 hours a day.
8. Encourage unrestricted breastfeeding.
9. Give no pacifiers or artificial nipples to breastfeeding infants.
10. Foster the establishment of breastfeeding support groups and refer mothers to them on discharge from the hospital or clinic.

Of women who stopped breastfeeding earlier than planned, the most common reason was insufficient milk supply. Other reasons in which medical practitioners can play a positive role included painful nipples and latch problems. Only about one half of women receive help with breastfeeding after hospital discharge (Lewallen and colleagues, 2006). Women who are supported by their physicians, who had themselves received 5 hours of lactation training, were more likely to report exclusive breastfeeding at 4 weeks and maintenance of breastfeeding through 18 weeks (Labarere and colleagues, 2005).

Of adolescent mothers, over one half were found to breastfeed for an average of about 3 months, but less than one fourth breastfed for 6 months or more, and over one third breastfed for 1 month or less. Many of the adolescent mothers felt they were not adequately informed of the advantages of breastfeeding and expressed a need for professional follow-up to contend with late-onset concerns (Spear, 2006). Programs such as WIC and the Cooperative Extension's Expanded Food and Nutrition Education Program (EFNEP) (see Chapter 14) currently provide breastfeeding encouragement and support, but more needs to be done.



Cultural Considerations

The vast majority of infants of immigrant mothers initiate breastfeeding, and infants who were breastfed had less hospitalization and better growth than infants who were not breastfed. This was found to be particularly true among the one third of immigrant households who reported household food insecurity (Neault and colleagues, 2007). Although immigrant mothers of all backgrounds are more likely to state intentions to breastfeed, the same holds true in low-income, inner-city African American women in relation to single white mothers with similar socioeconomic status and lower education (HJ Lee and colleagues, 2005). The success rate of African American women who initiate and maintain breastfeeding, however, is lower among those who are obese. ■

Although it is clearly documented that breastfeeding is optimal for the growing infant, the practical "how-to's" are not readily known. It was the efforts of a number

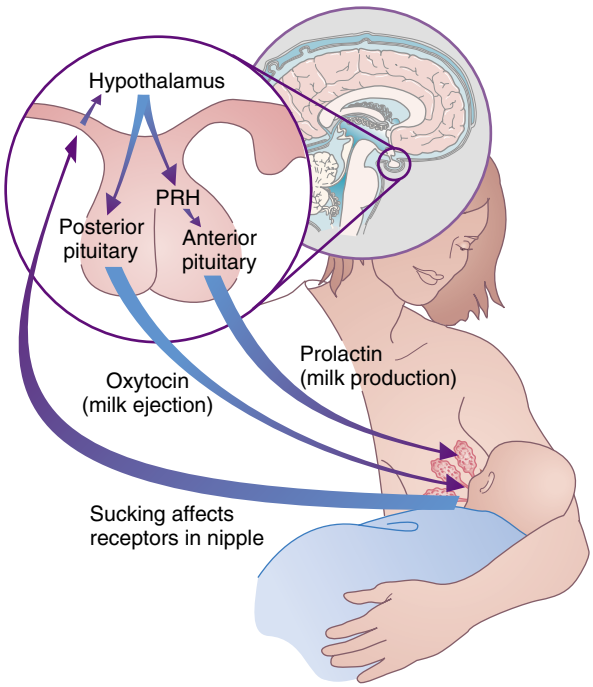


FIGURE 11-3 Milk release during breastfeeding. *PRH*, Prolactin-releasing hormone.

of women in the mid-twentieth century that led to the **La Leche League.** This grassroots level support group developed as a result of a growing concern that breastfeeding knowledge was becoming lost because many women had turned to bottle-feeding with the advances in technology. La Leche League remains a vital resource in the promotion of successful breastfeeding.

The health care field as a whole can do much more to support the goal of exclusive breastfeeding through the first 6 months of life. Studies show that textbooks on lactation management for pediatricians and nurses often are inadequate or inaccurate in some areas (Philipp and colleagues, 2007; Philipp and colleagues, 2004). It is especially important for the nurse working in obstetrics or pediatrics to know the physiology of successful breastfeeding and how to promote positive strategies to overcome potential problems (see sections below and Figure 11-3). It is advised that health care professionals working in this area read extensively, such as the American Academy of Pediatrics/American College of Obstetricians and Gynecologists' *Breastfeeding Handbook for Physicians* and La Leche League's *The Womanly Art of Breastfeeding*, review online resources as found through the American Academy of Pediatrics website (www.aap.org), and develop clinical skills related to handling various problems that may arise, such as through attending local La Leche League meetings and observing breastfeeding in the hospital setting. Local meetings of the La Leche League can be found through their website (www.llli.org).

The following review presents the basic know-how for successful breastfeeding that all health care professionals should be aware of. Health care professionals

working in settings with pregnant or breastfeeding women, such as family practices, obstetrics and pediatric offices, or hospital obstetrics, need far more information than is provided here. One strategy to promote breastfeeding is to inform pregnant women of the benefits of breastfeeding.

BENEFITS OF LACTATION

Benefits include increased immunity due to the transfer of immune factors of the mother through the **colostrum** (the substance that precedes breast milk) and the breast milk. In these fluids a substance called **immunoglobulin A (IgA)** helps guard against intestinal organisms and antigens, the latter of which are a cause of allergy development.

Nutrients in breast milk may have long-term positive effects on cognitive and intellectual development. A number of studies have indicated a link between breastfeeding and intelligence. One study found that duration of breastfeeding was associated with significantly higher scores on both the verbal and performance parts of a clinical intelligence test in young adulthood (Mortensen and colleagues, 2003). The improved learning ability of breastfed infants may be caused by the high level of essential fatty acids naturally found in breast milk but not in cow's milk. These fats are likely involved in improving neurologic development of the growing infant. Some infant formulas are now supplemented with an omega-3 fatty acid for this reason. Human milk contains both alpha linoleic acid (ALA) and DHA, unlike that of other mammals (Bourre, 2007).

Reduced incidence of **jaundice** (a condition that turns eyes and skin yellow from buildup of bile pigments and bilirubin that comes from the breakdown of hemoglobin and red blood cells) with breastfeeding is due to the frequent bowel movements associated with breastfeeding and increased excretion of bilirubin. If a breastfed infant develops hyperbilirubinemia, the advice should be to breastfeed more frequently and to withhold supplementary feedings (Semmekrot and colleagues, 2004).

One study found that babies who were breastfed had reduced systolic blood pressure during childhood (Lawlor and colleagues, 2005). This, in part, can be explained by weight outcomes. It is far more difficult to overfeed a breastfed infant as compared with a bottle-fed infant.

Another interesting aspect of breastfeeding has to do with exposure to food flavors. Breast milk varies in flavor depending on the mother's diet. This can help increase the infant's later acceptance of a variety of table foods.

Physically, the action of chewing that allows milk extraction from the breast helps to promote strong jaw muscles of the infant. If breastfeeding continues through later infancy, there are generally fewer problems of dental decay as compared with infants who are bottle-fed (see section below on nursing-bottle mouth).

For premature and low-birth-weight infants, breast milk, rather than cow's milk formula, reduces risk of developing **necrotizing enterocolitis** (a severe condition in which patches of necrotic areas occur in the GI tract that can interfere with digestion and absorption). The common practice of nutrient-fortified donor breast milk has not been adequately studied in relation to this condition (Quigley and colleagues, 2007). Counseling mothers of very low-birth-weight infants was found to increase the incidence of lactation initiation without increasing maternal stress and anxiety (Sisk and colleagues, 2006).

DIET INFLUENCE ON THE NURSING COUPLE

A variety of factors can influence the nutritional value and quantity of breast milk. Caloric intake can affect the quantity of milk produced; therefore it is important for a breastfeeding woman to lose any excess weight slowly. (An initial rapid loss will result from fluid loss after delivery, which is unrelated to caloric intake.) Generally, the kcalorie demands of lactation cause a natural slow weight loss. However, this is not always true. Once lactation is established, overweight women may restrict their energy intake by 500 kcal per day to promote a weight loss of 1 lb per week without affecting the growth of the infant. Increased exercise may also be necessary (Lovelady, 2004).

Other nutrients vary in their effect on the quality of breast milk. In general, most problems are limited to excessive intake of fat-soluble vitamins through the indiscriminate use of supplements in megadoses and insufficient intake of water-soluble vitamins and vitamin D. Levels of the B vitamins (except folate), vitamin A, selenium, and iodine in breast milk are affected by the mother's nutritional status and dietary intake (Allen, 2005).

Beriberi can occur in breastfed infants if their mothers have inadequate intake of vitamin B_1. Poor vitamin A status during the first month of life was found to significantly increase the risk of abnormal development of the respiratory system (Spears, Cheney, and Zerzan, 2004).

Drinking milk is not a prerequisite for the ability to lactate, contrary to what is often believed. However, without milk in the mother's diet her nutritional status and quality of breast milk can be marginalized. Women who restrict their milk intake to 1 cup or less daily were found to have their diets below the Estimated Average Requirement (see Chapter 3) for thiamin, riboflavin and zinc. Milk restriction can compromise intake of protein along with calcium and vitamin D. Milk restriction is not recommended during lactation, and where restriction is unavoidable, nutrients provided by milk should be compensated for by other foods or supplements (Mannion and colleagues, 2007). Other calcium-rich foods such as cheese, yogurt, pudding, or soybean products such as tofu (see Table 11-3 for recommended intakes during lactation) should be encouraged for the breastfeeding woman who cannot or will not drink milk.

Women who avoid drinking milk and live in cloudy or northern regions may have inadequate levels of vitamin D, which is reflected in breast milk. Vitamin D is needed by the growing infant to promote use of calcium and prevent rickets (refer back to Chapter 3). Vitamin D deficiency related to breastfeeding without supplementation can cause seizures due to hypocalcemia (Wallis, 2008). High risk of vitamin D deficiency includes lack of adequate sunlight such as with mothers who stay indoors or cover their skin.

Vitamin B_{12} deficiency among breastfed infants of vegetarian mothers has been observed. Symptoms include failure to thrive, anorexia, vomiting, psychomotor regression, hypotony, and diffuse cortical atrophy as shown with cerebral imaging. In a study conducted in France, about 100 cases of B_{12} deficiency among infants was found. Of these infants, almost 70% had been breastfed by vegetarian mothers, and the others were primarily born to mothers who had pernicious anemia. These infants exhibited failure to thrive as a result of loss of appetite, resistance to weaning, and

evidence of atrophy of the villi. Developmental delay in an infant may include vitamin B_{12} deficiency, even if there is no evidence from laboratory testing, especially if the breastfeeding mother follows a vegetarian diet (Mathey and colleagues, 2007). Women who have undergone bariatric weight loss surgery also are at risk of vitamin B_{12} deficiency (Jevitt and colleagues, 2007).

As long as the mother's nutritional intake is adequate, breast milk provides all the necessary vitamins for the infant, with the possible exception of vitamin D. During both pregnancy and lactation, vegans need vitamin D and vitamin B_{12} supplements, and their infants may need supplementation as well.

MANAGEMENT OF LACTATION

Nurses who see lactating mothers during the first days after delivery can play a vital role in the success (or failure) of breastfeeding. Bottles should be avoided initially to prevent infant confusion because the manner of milk extraction from a bottle is a sucking action and from the breast is a chewing action. Further, it is the stimulation of the mother's nipple that promotes prolactin and milk production. Positive verbal encouragement and support through any potential problems are of crucial importance during this highly vulnerable period in a woman's life.

Increasingly hospitals employ an **International Board-Certified Lactation Consultant (IBCLC)**, who can play a significant role in the success of breastfeeding women. They are of particular value when problems develop such as with prematurity. Within a neonatal intensive care unit (NICU) where an IBCLC was available, breastfeeding rates were nearly 50%, compared with about 35% among mothers who delivered at hospitals without an IBCLC (Castrucci and colleagues, 2007).

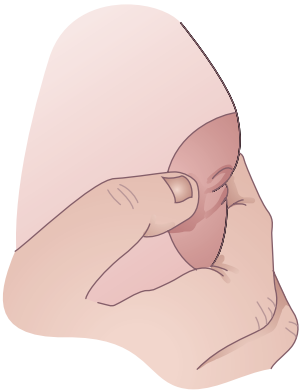
PHYSIOLOGY OF LACTATION

The decrease in levels of progesterone at time of delivery triggers the onset of prolactin production. The hormone prolactin is required for milk production, but the hormones insulin and cortisol must also be present. Being overweight or obese decreases the prolactin response to suckling in the first week postpartum and consequently can cause early lactation failure (Rasmussen and Kjolhede, 2004). Overweight women may require extra support to successfully breastfeed.

The general rule of thumb is that the more frequently a woman nurses, the more milk she will produce (Figure 11-3). This is referred to as **supply and demand.** This is due to promotion of prolactin production through nipple stimulation. The other primary physiology is the production of oxytocin, which causes contractions of the milk ducts and allows for milk flow. This is called the **let-down reflex.**

Because the quantity of breast milk production is difficult to ascertain, other guidelines are used to determine adequacy. For neonates and infants to 3 months of age, the guidelines are as follows: weight gain by the infant of 1 to 2 lb per month; 8 to 12 nursings per 24-hour period; and at least six wet diapers per 24-hour period (assuming the infant is not given any bottles of water).

Differences in milk output from the right and left breasts are common, with the right breast often having greater output of milk. The differences are not related to total milk output (Engstrom and colleagues, 2007). Women can successfully breastfeed from just the one breast. This may cause the breast to become larger than the



Inverted Nipple

An inverted nipple looks like a slit or a fold. A partially inverted nipple folds in on one side only.

A woman can tell if she has an inverted nipple by gently pinching the nipple at the base using the thumb and forefinger. If the nipple shrinks back, it is an "inverted" nipple.

Many women with inverted nipples have successfully breast-fed, but special preparation is very helpful. Using the Hoffman technique and wearing a plastic cup such as the Medela Soft Shells will encourage the nipples to stick out.

FIGURE 11-4 Inverted nipple. (From Health Education Associates, Sandwich, Mass.)

other breast, but this is temporary and will return to normal size at the end of lactation.

EARLY BREASTFEEDING CONCERNS

Inverted Nipples

A simple exercise can determine whether a woman has inverted nipples (Figure 11-4). Either the Hoffman technique or a milk cup (not a soft rubber shield) can be used to alleviate the problem (Figure 11-5).

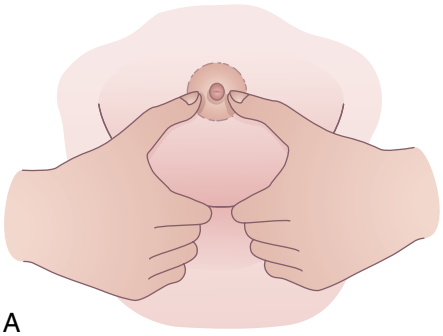
Poor Let-Down Reflex

Particularly for a first-time nursing mother, anxiety can be high and can inhibit the let-down reflex, which occurs when the milk descends from the upper parts of the breast **(hind milk)** and comes down to the areola (the darker skin around the nipple). **Oxytocin** (a hormone) promotes this reflex. A lactating woman can usually identify when the let-down reflex is occurring because there is a momentary "pins-and-needles" feeling in the breast area.

The hind milk is richer and higher in fat content than milk from other parts of the breasts. Because of the high caloric value of fat found in the hind milk, the let-down reflex is crucial for the infant's adequate weight gain. Relaxation techniques are therefore important for successful lactation. Humor is useful in helping the nursing mother relax; it should be encouraged by the nurse or other health care professional.

Breast Engorgement

Breast engorgement is a common occurrence in the first few days after delivery. Temporary measures to release excess milk include taking a warm shower or leaning with exposed breasts over a sink full of warm water. When engorgement is diminished, the infant will be better able to grasp the nipple, thereby allowing emptying of the breasts. Short, frequent nursings can help keep engorgement under control. The amount of milk produced by the new lactating mother will eventually even out to meet the infant's needs.

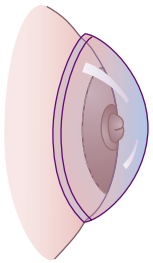


A

Hoffman Technique
For women with flat or inverted nipples

Place your thumbs opposite each other on either side of the nipple. Gently draw your thumbs away from the nipple. Then place your thumbs above and below the nipple and repeat.

Do this twice a day for a few minutes.



B

Milk Cup
For women with flat or inverted nipples

Begin by wearing the cup under the bra for short periods and gradually work up to 8 to 10 hours a day.

You can allow your skin to breathe by removing the cup for short periods or by wearing only the base part.

Wearing the cup is painless. It is not noticeable when worn in the bra unless the woman is wearing a tight-fitting jersey.

Milk cups/shells can be purchased from Medela, Inc.,
1101 Corporate Drive, McHenry, IL 60050;
800-835-5968; www.medela.com.

FIGURE 11-5 **A,** Hoffman technique. **B,** Milk cup. (From Health Education Associates, Sandwich, Mass.)

Increased use of breast implant procedures are now linked with another cause of breast engorgement. **Galactorrhea** (excessive milk flow irrespective of nursing) and **galactocele** formation (cystic enlargement of the mammary gland) after breast implants can occur. This is believed to be due to postoperative fibrosis and blockage of the mammary ducts. This can lead to painful massive engorgement and inability to breastfeed (Acartürk, Gencel, and Tuncer, 2005).

Sore or Cracked Nipples

The most likely reason for sore nipples is from friction of the newborn's tongue on the mother's nipple. Comfort measures for sore or cracked nipples include the following:

1. Using relaxation techniques, such as deep breathing, at the beginning of each feeding and warm washcloths with gentle breast (not nipple) massage to encourage milk flow before the infant's suckling begins
2. Nursing on the less-sore side first
3. Changing feeding positions (Figure 11-6), using the football hold (holding the baby like a football with the baby's feet pointing outward from the mother rather than inward) or the regular position, or even lying down with the baby's feet pointing up toward the mother's head (awkward, but effective for getting the baby's tongue off the sore spot on the mother's nipple)

FIGURE 11-6 Proper positioning at the breast. **A,** Football hold. **B,** Cradling. **C,** Lying down. (**A,** from Lowdermilk DL, Perry SE: *Maternity nursing,* ed 7, St. Louis, 2006, Mosby; **B** and **C** courtesy of Marjorie Pyle, RNC, Lifecircle, Costa Mesa, Calif.)

4. Giving short, frequent nursings (the major portion of breast milk is removed within about 5 to 10 minutes; frequent nursings will prevent the baby from becoming overly hungry, thereby lessening excessive suckling, and shorter feeding periods will decrease friction on the mother's nipples)
5. Making sure that the baby's mouth is well back on the areola and that the tongue is underneath the nipple
6. Making sure that the baby is removed properly from the breast, breaking suction with the mother's finger inserted into the corner of the baby's mouth
7. Air-drying the nipples after each feeding
8. Using cold compresses or washcloths between nursing sessions

Fact & Fallacy

FALLACY A lactating woman who is experiencing sore nipples should be advised to wear a soft rubber nipple shield while breastfeeding.

FACT Although this solution may provide relief in the short term, it can cause severe problems in the long term. Because tactile stimulation is necessary to continue the production of milk, the physical barrier of the shield between the mother's nipple and the baby's jaw and tongue will inhibit milk production and promote lactation failure. ■

Other Causes of Sore Nipples

A relatively unknown but common cause of sore nipples is **tongue-tie,** more correctly referred to as **ankyloglossia.** This is a structural malformation that prevents the tongue from moving normally and is estimated to occur in approximately 5% of neonates (Dollberg and colleagues, 2006). Affected infants are significantly more likely to be exclusively bottle-fed by 1 week of age (Ricke and colleagues, 2005). Surgical intervention can be beneficial, and the procedure is quick and simple, not requiring any analgesia or anesthesia. This can improve the ability of the infant to latch onto the nipple and reduce nipple soreness (Wallace and Clarke, 2006).

Another relatively recently identified cause of nipple soreness is **Raynaud's phenomenon** (vasospasm of arterioles). This condition affects up to 20% of women of childbearing age. Raynaud's phenomenon can cause extremely painful breastfeeding, with symptoms precipitated by cold temperatures and associated with color changes of the nipple. The pain is so severe and throbbing, it is often mistaken for *Candida albicans* infection and treated inappropriately with antifungal agents. Treatment options include methods to prevent or decrease cold exposure, avoidance of vasoconstrictive drugs/nicotine that could precipitate symptoms, and use of a calcium channel blocker that allows vasodilation (Anderson, Held, and Wright, 2004).

The Premature Infant

Premature infants or those with cleft palate may be fed breast milk or commercial formula using bottles with special nipples. **Gavage feeding** (a form of force-feeding through a flexible tube or pump) may be required for those premature infants who do not have adequate suckling ability. Premature infants have special nutritional needs, primarily because of immature GI functioning. These infants now use either

special formula or fortified breast milk. This breast milk ideally comes from the premature infant's own mother and is called **preterm milk.** In addition, commercial fortifiers are usually added to this breast milk to increase the amount of kcalories and other nutrients.

Multiple Births

Many people believe that twins or multiples preclude the option of breastfeeding. However, because milk supply is most strongly influenced by frequency of feeding (remember supply and demand: the more the mother nurses, the more milk is produced), it is feasible to nurse twins. Adequate quantity and quality of milk production has been documented even for high multiples. However, a good support system is needed (Flidel-Rimon and Shinwell, 2006).

Babies can be positioned at each breast simultaneously with the infants' feet both facing the same direction or with each twin's feet facing outward from the mother (see Figure 11-6). For multiple births, a combination of breastfeeding and bottle-feeding may be the ideal solution.

Inappropriate Fluid Intake

Milk production necessitates increased fluid intake; however, the mother only needs to drink enough fluids to satisfy her thirst. A sudden excess in fluid intake may actually decrease milk yield because the release of **antidiuretic hormone** (a hormone that regulates water loss through the kidneys) is inhibited when fluid intake is in excess of need, resulting in **diuresis** (excess water loss through the kidneys).

LATER ISSUES WITH LACTATION

Inadequate Weight Gain

A breastfed infant will gain weight more slowly than a bottle-fed infant. This is natural and appropriate. If the infant gains less than the recommended 1 to 2 lb per month, great care must be taken not to discourage the lactating mother, but rather to assess possible causes and provide appropriate counseling in a highly sensitive manner. The nurse or health care provider can help assess the reasons while still promoting the continuation of breastfeeding. One assessment area is determining if the let-down reflex is inadequate (the nurse can ask the mother if she feels a tingling sensation during nursing), and the nurse should ask how often breastfeeding occurs. Women often try to maintain a feeding schedule and ignore the hunger cues of the baby, thinking, "The baby can't be hungry yet." Alternately, the infant may be a "sleepy baby," that is, one who does not indicate hunger. An appropriate schedule generally allows for feeding about every 2 to 3 hours, but for infants who gain weight slowly, more frequent feedings may be in order until the milk supply and weight gain increase.

Increased Demand

During periods of growth spurts the baby may want to nurse more often than usual. Growth spurts often occur during the third week after delivery (just when the mother is likely to be going through the postpartum blues) and again at 6 weeks and 3 months. This does not mean formula needs to be added; rather, it is nature's way of increasing milk production to meet additional needs. Good advice is to encourage

bed rest with continuous nursing (although strong family support is a prerequisite for this approach). After a couple of days of very frequent nursing, milk production will have increased, and the baby will go for longer periods between feedings again.

Another helpful point concerning frequency of feeding is that the total number of feedings is more important than their spacing. For example, an infant who sleeps through the night but feeds more frequently during the day and has the recommended 8 to 12 feedings will most likely gain weight in just the same manner as the infant who wakes up regularly all night and day but nurses the same number of times.

Fewer than six wet diapers per day with low number of bowel movements (less than three times per day) might be a warning of failure of lactation with potential for dehydration and hypernatremia or high blood sodium level. The most common presenting complaint that led to the diagnosis of hypernatremia was jaundice. Weight loss in an infant of greater than 7% from birth weight increases the risk of hypernatremia. In such a situation more intensive evaluation of breastfeeding and possible interventions to correct problems and improve milk production and release are necessary (Uras and colleagues, 2007).

Women in the Workforce

The combination of working outside the home and breastfeeding can work if there is adequate support such as refrigeration at the work site for storage of the breast milk and time and space for women to manually express (Figure 11-7) or pump the breast milk. Even the military is being encouraged to facilitate breastfeeding by active duty mothers after they return to work (Bell and Ritchie, 2003). Optimally, long periods of separation from the newborn infant will not occur until the infant is at least 3 months of age. At this point, breastfeeding is well established and bottles can be introduced without causing confusion to the infant. Good family and day care support is also required with regard to such issues as avoiding the early introduction of solid foods.

1. Do breast massage.
2. Place the thumb and index finger on the areola or darker skin around the nipple—about an inch back from the nipple. Press inward toward the chest wall and squeeze the thumb and finger together gently: push back and squeeze. Don't slide the thumb and finger. Don't pull the nipple out.
3. Keep the thumb and finger in that position and express until no more drops come out. Then move to another location around the nipple and repeat.
4. Lean over the sterile container and catch the milk. Switch to the other breast and again massage before beginning to express.

FIGURE 11-7 Instructions for hand expression of milk. (From Health Education Associates, Sandwich, Mass.)

It is helpful to advise a mother that if she expresses only 1 or 2 oz of breast milk initially, she is doing very well. Expressed milk cooled in the refrigerator can be added to previously frozen expressed milk to obtain full bottles (4-oz bottles are the handiest for collecting and storing expressed milk). Such bottles are visually very interesting in that blue layers (composed of fore milk, the milk from the front of the breast) and thick white layers (composed of the fat-rich hind milk) are formed. Women expressing milk should be relaxed and may find it easier after a warm shower initially. After a woman is comfortable with the technique and her ability, she can easily express milk anytime, such as during her lunch break at work. The milk can then be stored in a portable ice chest or refrigerator. Expressed milk can be kept for 1 to 2 days in sterile bottles at 40° F or refrigerator temperature, for 1 to 2 weeks in a freezer with temperatures less than 32° F, or for up to 6 months if the freezer maintains a constant temperature of less than 0° F (about –17.8° C).

Teaching Pearl

The mother who is pumping her milk will likely need extra support to maintain breastfeeding, particularly to relax in this tense situation. A picture of the baby that she can look at during the milk collection process can help elicit positive feelings—"Oh, don't I have a beautiful baby!"—feelings that are difficult to experience while the baby lies in the intensive care unit hooked up to tubes and other medical paraphernalia. A relaxed nursing staff is of particular importance; again, the use of humor is a positive approach to help encourage the let-down reflex. It is difficult to achieve the same high level of tactile stimulation to the nipple by artificial means because no pumping machine fully mimics the action of the baby's tongue and jaw movements. Larger institutions may have a special type of pump that gently squeezes each breast, helping with the need for tactile stimulation in the production of breast milk. ■

Weaning

The La Leche League generally advocates **baby-led weaning** (accustoming the baby to nourishment other than breast milk). However, if the mother needs or wants to wean before the baby does, a variety of strategies may be used. The early-morning and late-night feedings are often the most difficult for the baby to give up. This can be the ideal situation for the working woman who wants to continue partial breastfeeding because she can continue to breastfeed her baby before and after work. Then, when the mother is ready to stop the morning feeding, the baby is often old enough to sit in a high chair. When babies are fed cereal before the morning nursing, they often begin to wean themselves. Parents may need to try a variety of bottle nipples before the baby accepts one. Older infants (9 to 12 months of age and older) may be weaned directly to a cup.

WHAT ARE SOME BOTTLE-FEEDING CONCERNS?

Although it is preferable for infants to be breastfed because of the nutritional and health benefits, commercial formulas that closely resemble breast milk have fortunately been developed for those women who cannot breastfeed because they are taking medications that contraindicate it or who have medical problems. The perfect

food for human babies is clearly breast milk, but many successful adults were bottle-fed as infants.

The U.S. Food and Drug Administration (FDA) has approved the addition of omega-3 fatty acids to commercial infant formulas. This is believed to help match the role of breastfeeding in cognitive development and motor skills for bottle-fed babies.

Teaching Pearl

A good question to ask is, "Are you aware of what formula is made from?" followed by explaining that it is cow's milk with the excess protein removed and vitamins and minerals added to make it more nutritious, like breast milk. A further explanation can be provided by saying that so much protein is needed in whole cow's milk to help the calf grow that it causes GI irritation (stomach bleeding) in the human baby (using your hands to depict the size difference between a calf and a human baby can be very effective). This can support the continued use of formula versus changing to whole milk before the infant is physiologically ready to do so. ■

Nursing-bottle mouth (also known as baby-bottle tooth decay; see Figure 12-7) is a condition in which the two front top teeth are severely decayed or completely eroded away in the older infant or child. This condition is caused by the infant's continuous suckling on a bottle that contains a source of carbohydrates. Sleeping with a bottle is particularly harmful because of decreased production of saliva that helps cleanse the teeth. As a general rule, juice should be given in a cup and only water bottles should be allowed at bedtime. It is also possible for a breastfed infant who continually nurses throughout the night (i.e., an infant who sleeps with the mother) to develop similar tooth decay.

Milk anemia is caused when so much milk (not iron-fortified formula) is consumed that it replaces the consumption of food high in iron. Breast milk or formula containing iron is advised during the first year of life when iron needs are high because of rapid growth of the infant, especially if the infant is not eating meat. For infants who have a strong need to suckle, pacifiers or water bottles can be substituted as necessary.

Microwave heating of bottles can allow excess steam to develop, resulting in bottles exploding in the infant's face. Also, because hot spots in the liquid can develop, a seemingly safe temperature can actually cause the infant's mouth to be severely burned. The safest way to heat a bottle is to allow very warm water from a faucet to flow over it until the chill is gone.

The only appropriate liquids for regular use in a bottle are expressed breast milk, formula, and water. Although occasional use of juice is acceptable (such as in a car, when drinking from a cup is difficult), the regular use of juice in a bottle can cause nursing-bottle mouth (see earlier discussion). Other sweet liquids such as Kool-Aid or soft drinks should be avoided entirely. Formula replacements, such as nondairy creamer or milk products that are not specifically designed for infant use, should never be used. Formula should be mixed according to directions, not underdiluted or overdiluted unless specifically recommended by a pediatrician (a physician specializing in the care of infants, children, and adolescents) or a registered dietitian.

TYPES OF INFANT FORMULAS

Commercial cow's milk–based formulas closely approximate human milk. They are available in powder, liquid concentrated, and ready-to-feed form. Powdered forms are more economical but require mixing and careful measuring. Liquid concentrated formulas require proper dilution with water (in a 1:1 ratio) before they are used. A safe water source is necessary. This may be tap water as appropriate or commercial bottled water. Commercial formulas are fortified to meet all known infant vitamin and mineral requirements. Formulas containing iron are available and are recommended by the American Academy of Pediatrics. Examples of infant commercial formulas are Enfamil and Similac.

Examples of soybean-based formulas are ProSobee, Neo-Mull-Soy, and Isomil. Soy formulas have vitamin B_{12} added. Soy protein formula ensures normal growth and development in healthy term infants, but they have no nutritional advantages over cow's milk protein formula. Soy formula may be used with severe lactose intolerance, galactosemia, and vegan babies. Soy formula is now suggested as having no role in preventing allergy or in management of infantile colic and regurgitation. It is not advised for preterm infants or infants with food allergy before age 6 months. After 6 months, soy protein formula may be appropriately used (Turck, 2007).

A new concern related to soy-based formulas is the natural phytoestrogen content. Such concerns arise from reports of increased incidences of male reproductive problems and falling sperm counts. The most vulnerable periods for adverse effect of phytoestrogens on male reproduction are believed to be during the in utero period and in early infancy, when irreversible damage may occur with the developing germinal epithelium. However, little is known about the effects of dietary phytoestrogens on male reproductive health (West and colleagues, 2005). Treating mice neonatally with genistein as found in soy products caused adverse consequences on female development that are manifested in adulthood. Whether adverse effects occur in human infants exposed to soy-based products such as soy infant formulas is unknown (Jefferson, Pedilla-Banks, and Newbold, 2007).

Special hydrolyzed-protein formulas are available for infants with digestive disturbances, allergies such as to soybeans, or inborn metabolic errors. Examples are Pregestimil (hypoallergenic formula with medium-chain triglyceride [MCT] oil) and Lofenalac (for infants with PKU). For infants with a strong family history of allergies, the elemental formulas may be the best choice if the mother cannot breastfeed.

WHAT INFLUENCES INFANT GROWTH AND DEVELOPMENT?

INFANT GROWTH AND DEVELOPMENT

A well-nourished infant shows a steady gain in weight and length (with some fluctuations from week to week), is happy and vigorous, sleeps well, has firm muscles, has some tooth eruption at about 5 to 6 months (about 6 to 12 teeth will have erupted by 12 months), and has good elimination characteristic of the type of feeding—breast or formula. The nutrients found in milk, especially the protein, are essential in the development of the new tissues that accompany this growth.

Each infant has an individual rate of growth, but all grow faster in weight than in length. A steady weight gain is more important than a large amount gained. In interpreting growth with the National Center for Health Statistics growth charts (see

Appendix 12 on the Evolve website), percentiles are used. A child at the 50th percentile for age is considered average. There is no concern with growth if the height and weight for age are above the 10th percentile and are consistent (i.e., not dropping in percentile). Weight for height should be between the 25th and 90th percentiles without showing a significant change in percentile.

FEEDING GUIDELINES DURING THE FIRST YEAR

Although it was once a common practice to wait until the infant reached 4 months of age to start introducing cereal and other solid foods, many parents today feel that is too long. Before 1920, solid foods were seldom offered to infants younger than 1 year. As time progressed, our knowledge of infant nutrition expanded, and women relied more on bottle-feeding. By the 1960s the age at which solid foods were commonly introduced had become a few months or even weeks. This trend, however, was a rational response to the nutritionally inadequate formulas used at that time (often evaporated milk mixed with water and corn syrup). A source of vitamin C such as orange juice and iron-fortified cereal were necessary then at an early age.

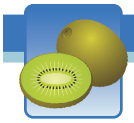
With the current return of breastfeeding and the development of highly nutritious commercial infant formulas, the risks associated with early introduction of solids (such as development of an allergy from orange juice and cereal) outweigh any benefits. The reasons to delay the introduction of solid foods until 4 to 6 months are as follows:

1. The inability of the young infant to digest complex carbohydrates such as those found in cereal, vegetables, and fruits (thus infants can fill up their stomachs without getting the nutrients they need to grow)
2. The immature intestinal tract of the young infant, which allows large, undigested food molecules to pass through the intestinal wall (which can activate an allergic reaction and may become a permanent condition)
3. Inadequate physiologic readiness of the infant to use tongue thrust (it is felt that the human species may have developed this characteristic to prevent inappropriate ingestion of food)
4. The inability of the infant to indicate a desire for food by opening his or her mouth when a spoonful of food is presented or to indicate satiety by leaning back and turning away; it is felt that until an infant can respond in this manner (at about 5 months of age), feeding solid food may represent a type of force-feeding

Neither breast milk nor a milk formula will furnish adequate amounts of all nutrients required by the infant in later months. One important reason for introducing some solid foods into the infant's diet is to replenish the depleting stores of iron at about 6 months of age. The general guidelines for the introduction of foods are as follows:

1. Introduce iron-fortified baby rice cereal at about 6 months of age (no earlier than 4 months of age) to help replenish iron stores used in the growth process.
2. Add pureed vegetables and fruits, one at a time, at about 7 to 8 months (starting with vegetables may help to increase acceptance by the infant not yet exposed to the sweet taste of fruits).
3. Add pureed meats at about 8 to 9 months.
4. Add juice when the infant is old enough to drink from a cup, at about 9 to 10 months.

5. Add foods with more texture and finger foods at about 9 to 10 months (chopped meats, crackers, and so on).
6. Add allergenic foods, such as egg whites (or whole eggs), whole milk, wheat products, and orange juice, after 1 year (especially important for the infant with a family history of allergies or asthma).



Cultural Considerations

Hispanic infants younger than 1 year of age are more likely than non-Hispanics to have ever been breastfed, and those who were 4 to 5 months of age were more likely than non-Hispanics to be eating pureed baby foods on a daily basis. It was found 6- to 11-month-old Hispanics were more likely to be eating fresh fruits, fruit-flavored drinks, baby cookies, and foods such as soups, rice, and beans. This higher prevalence of being fed soups, rice, beans, and sweetened fruit-flavored drinks, as well as tortillas, was also observed among 12- to 24-month-old toddlers (Mennella and colleagues, 2006). ■

Infants who are fed a vegan diet (no animal products) can receive adequate nutrition if they are breastfed or receive soy milk formula. Breastfed infants of vegan mothers generally require a vitamin B_{12} supplement and a vitamin D supplement. Older infants need a good source of vitamins D and B_{12} and the mineral zinc. Legumes may provide additional protein starting at about 7 to 8 months if there is low risk of allergy.

Fact & Fallacy

FALLACY Cereal helps babies sleep through the night.

FACT There is no scientific evidence to support this belief. Many experienced parents admit that their babies wake up regardless of how much food they have eaten. Parents should be strongly discouraged from giving an infant cereal before he or she is 4 to 6 months old, particularly when there is a family history of allergies.

With regard to the introduction of solid foods, a good assessment question is, "Have you thought about when you are going to start solid foods such as cereal?" followed by, "What have you heard from other people about when to start?" This will help tailor the message to the beliefs the parents may hold. At about the time the growing infant develops the pincer grasp (the ability to put the thumb and index finger together)—beginning about 8 months of age—a sense of independence also begins to grow. This can be exasperating to a parent, particularly as the baby begins to spill food on the floor or decides to empty a full bowl of food on his or her own head. Because this is believed to be a normal part of development, parents are advised to cope with this behavior through positive strategies: an old shower curtain can be placed under the high chair to catch spills, a large bib can help prevent damage to the baby's clothes, small quantities of food can be given at one time to lessen waste, and bath time can be scheduled after mealtime. If the infant is being allowed additional servings, adequate intake can be achieved while the parents enjoy a lowered frustration level. Bribing and coaxing the infant to eat and not to spill food can cause repetition of the negative behaviors as the infant learns he or she can control the parents' actions (as in thinking, "Let's see if I can get Mom and Dad to jump up and down if I drop this glass of juice"). Older infants prefer finger foods. ■

INAPPROPRIATE FOODS

Aside from the special requirements for allergy-sensitive infants or for those who have metabolic disorders (a referral to a registered dietitian or a qualified nutritionist is in order in these cases), it should be stressed that parents should not give honey to babies because of the potential for botulism, because honey contains botulism spores (in a quantity too low to cause adverse effects in older children and adults).

The high sodium content of some processed foods (such as canned vegetables or cured meats) can be detrimental to the immature renal functioning of infants. Steamed fresh vegetables, fruits, and other low-sodium foods may be safely used in preparing homemade baby foods. Special baby food grinders can be purchased for a reasonable price and allow the baby to eat the same foods as the family. It is important to avoid excess salt and sugar in baby food, whether store-bought or prepared at home.

To prevent choking, parents should avoid serving the infant any foods that have a hard texture (such as a raw apple or carrot) or are served in large pieces until the infant is old enough to chew adequately. Hot dogs should never be given to an infant and can also be problematic for an older child unless they are sliced into thin strips so they cannot cause choking if chewed inadequately.

WHAT ARE SOME CLINICAL PROBLEMS IN INFANCY?

PREMATURITY

Babies born before they have had a chance to grow adequately are at nutritional risk. Babies less than 5 lb at birth generally stay in the hospital after delivery until they have reached at least this weight. Lung function may be compromised. The ability to suckle may be impaired because of immature muscle development. Special feeding devices, including feeding tubes, may be required until the infant is strong enough to suck. Oral stimulation, such as use of a pacifier, is important for the infant who is tube fed. Guidance on the introduction of solid foods needs to account for how early the premature infant was born. For example, cereal is usually started at 4 months. If the infant was born 3 months prematurely, the introduction of cereal should be delayed until the infant is at least 7 months old. This is especially true if there is a strong family history of allergies.

The benefits of breast milk in the NICU persist at 30 months' corrected age among extremely low-birth-weight infants. Efforts must be made to offer breast milk to all such infants both in the NICU and after discharge (Vohr and colleagues, 2007).

Hyperglycemia has been noted among infants born more than 10 weeks early. This is believed to be related to impaired function of beta cells in the pancreas and insulin resistance. Insulin infusion may be used with caution (Mitanchez, 2008).

LOW BIRTH WEIGHT

The optimal intervention for babies who are born with **very low birth weight (VLBW)** (less than 3.3 lbs) appears to be the goal of slow, but steady weight gain. Infants with LBW require adequate catch-up growth to improve cognitive develop-

ment while avoiding excess weight gain because of adulthood health issues of obesity, cardiovascular disease, and diabetes. It is advised that health care providers monitor weight, length, head circumference, and weight/length ratio and counsel on altered nutrition and caloric intake as needed (Casey, 2008). Other short-term benefits of catch-up growth include reduced risk of cerebral palsy and improved neurologic development (Ehrenkranz and colleagues, 2006).

Type of feeding for VLBW infants is important. Breast milk is optimal, but where alternative feedings are necessary, the use of preterm infant formula appears optimal rather than use of hydrolyzed formulas. Preliminary evidence of infants with a birth weight less than or equal to 1750 g (less than or equal to 3.8 lb) and gestational age less than or equal to 34 weeks who were on hydrolyzed formula appeared to have less nutritional benefits. Higher renal excretion of essential amino acids may have been the cause (Maggio and colleagues, 2005).

FAILURE TO THRIVE

Failure to thrive (FTT) was first observed in infants raised in institutional settings in which they did not receive adequate amounts of attention (physical touch and emotional warmth). Since this was recognized, volunteers have been used to cuddle premature infants in hospital settings to help their chance of survival and growth.

FTT is a medical diagnosis that includes a weight and length of less than the 3rd percentile for the infant's age (see Appendix 12 on the Evolve website) and less-than-normal ability in the Denver Developmental Screening Test (an observational test based on infant developmental progress). A total health care team approach may be in order.

Malnutrition in infancy appears to program for the metabolic syndrome later in life. Higher levels of central obesity and increased levels of insulin resistance in adulthood have been noted among those previously malnourished in infancy and childhood. This appears to worsen as BMI increases, even within normal limits (Gonzalez-Barranco and Rios-Torres, 2004).

ALLERGIES

Food allergy is more common in children than in adults. However, overdiagnosis is quite common (Ferreira and Seidman, 2007). Refer to Chapter 4 regarding testing for food allergies.

Reduction in risk of allergies may occur with increased intake of omega-3 fatty acids (Miyake and colleagues, 2007). This is likely due to decreased inflammatory substances in the system as a consequence of increased eicosapentaenoic acid (EPA) and DHA intake.

For infants with milk allergy, casein hydrolysate formulas may be used. Although these generally do not invoke an allergic response, they are not always tolerated. Liver dysfunction associated with casein hydrolysate formula can occur (Yada and colleagues, 2008).

INBORN ERRORS OF METABOLISM

The term **inborn errors of metabolism** refers to a group of diseases that affect a wide variety of metabolic processes. Certain enzymes are lacking because of a genetic

defect, requiring the diet to be modified to prevent toxicity from the excessive accumulation of by-products such as with PKU. When inborn errors of metabolism are not identified and treated early, a variety of severe problems can result, such as damage to the central nervous system and body organs. There are many inborn errors of metabolism that require specific diets for treatment. A specific diet order from the physician should be obtained, and the dietitian should provide a list of acceptable foods for various special occasions.

GALACTOSEMIA

Features that characterize galactosemia include a lack of transferase (a liver enzyme that converts galactose to glucose), toxic levels of galactose in the blood, diarrhea, drowsiness, edema, liver failure, hemorrhage, and mental retardation.

The lack of the enzyme transferase requires elimination of all milk products or other milk ingredients including lactose, nonfat dry milk solids, casein, whey, and whey solids. Acceptable infant formulas are Isomil, Neo-Mull-Soy, ProSobee, meat-based formulas, Nutramigen, and Pregestimil. Additional nutrients are provided according to the DRI.

It is very important that all ingredient labels for processed and packaged foods be read carefully. Any foods containing milk, lactose, nonfat dry milk solids, casein, whey, or whey solids cannot be tolerated by individuals with galactosemia. Lactate, lactic acid, and lactalbumin are acceptable. The complete list of ingredients may not be found on some foods, such as bread and imitation milk. Therefore frequent monitoring of red blood cell levels of galactose and galactose-1-phosphate is recommended to ensure adherence to the diet.

PHENYLKETONURIA

PKU is an autosomal recessive disorder characterized by a lack of the enzyme necessary to metabolize phenylalanine, one of the essential amino acids. Because phenylalanine is not metabolized, high levels accumulate and there is a characteristic excretion of phenylketones in the urine. Infants are usually blond, blue eyed, and fair and often have eczema. All infants are now tested at birth for PKU. When untreated, the infants are hyperactive and irritable, with an unpleasant personality and a musty or gamey odor. Severe retardation results if treatment is delayed. However, some studies have shown improvement in behavior in untreated individuals later in life even when the diet was not started at birth.

Bottle-fed infants with PKU require special infant formulas that prevent buildup of toxic levels of phenylalanine. Lofenalac, Phenyl-Free, and PKU-Aid are acceptable. A 10% to 30% increase of protein over the DRI is necessary to ensure adequate utilization of amino acids. Kcalories need to be adjusted for the age, appetite, and growth pattern of the child. Special tables showing the phenylalanine content of various foods are available. Many products on the market contain aspartame, which is a source of phenylalanine and can be a problem for individuals with PKU.

HOMOCYSTINURIA

Homocystinuria is characterized by a lack of the enzyme necessary for sulfur amino acid metabolism. The purpose of the diet for homocystinuria is to lower blood

methionine and homocystine levels. Adequate L-cystine must be supplied; it is used to prevent the buildup of methionine and homocystine in the plasma and homocystine in the urine. Typically, the untreated child is retarded, has a fair complexion, and has detached retinas. Death usually occurs from spontaneous thrombosis.

TYROSINOSIS

Tyrosinosis is a result of an error in tyrosine metabolism. The purpose of the diet for tyrosinosis is to reduce plasma tyrosine and phenylalanine levels and to prevent liver and kidney damage. It may prevent mental deterioration if started early in life.

MAPLE SYRUP URINE DISEASE

In maple syrup urine disease (MSUD) there is an inability to use branched-chain amino acids. This condition received its name because the urine smells like maple syrup. The purpose of the diet for this disease is to reduce leucine, isoleucine, and valine plasma levels to normal. The diet is used to prevent neurologic damage and rapid death by reducing these branched-chain amino acids in the diet.

HISTIDINEMIA

Histidinemia is caused by a lack of the enzyme for histidine metabolism. The purpose of the diet is to lower the plasma histidine level and to treat the signs and symptoms of histidinemia, which results in speech disorders and mental retardation. Special formulas are available for homocystinuria, tyrosinosis, MSUD, and histidinemia.

OTHER ISSUES

Infants with intractable convulsions may respond to vitamin supplementation of biotin, pyridoxine, and folate (Ogier de Baulny, 2002). Infants at risk for micronutrient deficiencies may have impaired motor development. Iron and zinc administered together and with other micronutrients have been found to have a beneficial effect on infant motor development and orientation—engagement with their surroundings (Black and colleagues, 2004). A rare hereditary disorder caused by impaired absorption of zinc is characterized by dermatitis of the extremities and near the mouth, hair loss, and diarrhea. Signs usually begin on weaning from breastfeeding or formula-feeding and can be treated with zinc supplementation (Perafan-Riveros and colleagues, 2002).

WHAT ARE RISK FACTORS AND PREVENTION STRATEGIES FOR POSTPARTUM DEPRESSION?

It is common for women to experience the **postpartum blues** (a feeling of depression) within a few weeks after pregnancy. It has been estimated that the "baby blues" are extremely common, affecting up to 75% of new mothers, and that 10% to 15% of women will develop depression within the first 2 to 3 months post partum. The most severe form, **postpartum psychosis,** is estimated to occur in approximately 1 to 2 deliveries per 1000 women (Seyfried and Marcus, 2003). Postpartum psychosis requires medical monitoring and intervention, including hospitalization.

There is increasing evidence that postpartum psychosis is related to **bipolar disorder** (manic depression). A history of bipolar disorder, history of postpartum psychosis, and family studies support a link between postpartum psychosis and bipolar disorder (Chaudron and Pies, 2003). Hypomanic symptoms, such as feeling elated, energetic, and not needing sleep, are particularly characteristic of the early postpartum period in women who later develop psychosis. These types of symptoms should be carefully monitored (Heron and colleagues, 2008).

Fatigue is predictive of postpartum depression (Bozoky and Corwin, 2002). Although sleep deprivation contributes to fatigue, iron deficiency anemia does as well. Women suffering early postpartum anemia appear to be at increased risk for developing postpartum depression (Corwin, Murray-Kolb, and Beard, 2003). This may be related to the majority of pregnant adolescents demonstrating symptoms of depression postpartally (Logsdon and colleagues, 2004). The growth needs of an adolescent promote iron deficiency at this time of life, and because the adolescent is also attending school, sleep deprivation is very likely. School nurses are in a good position to monitor young mothers for signs of postpartum depression.

There are a variety of potential causes of postpartum depression. Metabolic problems may be related. One case study involved the buildup of ammonia combined with psychiatric symptoms in the postpartum period, which was related to an enzyme deficiency for protein metabolism (Enns and colleagues, 2005). In a subgroup of women the hormonal fluctuation of estrogen triggers depressive symptoms throughout the reproductive years, including the postpartum period, through the effect on serotonin and other factors (Payne, 2003).

Uncontrolled diabetes is related to increased rates of depression. Although intervention for gestational diabetes with education and monitoring is known to reduce the rate of perinatal complications, the same intervention was found to be associated with reduced rates of depression at 3 months postpartum, along with improved health status (Crowther and colleagues, 2005).

It may help to advocate the regular consumption of balanced meals to help prevent or treat postpartum depression, as is done in the management of gestational diabetes. A highly insulin-resistant state develops by the end of pregnancy. The natural production of insulin increases in response to the opposing action of placental hormones. Once delivery occurs, the mother's insulin production may not lessen adequately, leading to a drop in blood glucose level. Cortisol is released by the body in response to the lowering of blood glucose. By including several meals and snacks over the course of the day, a postpartum woman's insulin and glucose levels are more likely to be stabilized, with reduction in cortisol release. A focus on whole grains and a variety of vegetables and fruits and the inclusion of milk and other protein-based foods help ensure intake of a variety of nutrients that may help promote proper cellular metabolism for the goal of reduced depression.

Poor omega-3 fatty acid status increases the risk of depression. Fish oil and folic acid supplements each have been used to treat depression successfully. Folate deficiency reduces the response to antidepressants. Deficiencies of folate, vitamin B_{12}, iron, zinc, and selenium tend to be more common among depressed than nondepressed persons (Bodnar and Wisner, 2005).

Breastfeeding should also be advised because it appears to lower the incidence of postpartum depression. This is felt to be a result of a reciprocal hormonal effect

on the mother and infant. Leptin, produced in the adipose tissue and present in maternal milk, appears to reduce the stress response in breastfeeding infants. Women who breastfeed have lower hormonal responses to several types of stressors (Walker and colleagues, 2004). For women who require antidepressants, the selective serotonin reuptake inhibitors (SSRIs) appear to be safe, with small or no detectable amounts of the medication found in breastfed infants (Berle and colleagues, 2004).

WHAT IS THE ROLE OF THE NURSE AND OTHER HEALTH CARE PROFESSIONALS IN MATERMAL AND INFANT NUTRITION?

DURING PREGNANCY

A nurse or other health care professional should be aware of potential biopsychosocial barriers to adequate nourishment during pregnancy. Examples are poor attitude (denial of pregnancy or desire to maintain slimness), misinformation (belief that salt restriction and low weight gain are desirable), or physical barriers to adequate nourishment (insufficient money for food, lack of adequate food preparation facilities, or hyperemesis). Once such a barrier is identified, referral to a registered dietitian or a qualified nutritionist, such as one associated with the WIC program, may be in order; immediate contact with the woman's obstetrician is also recommended.

Reinforcing the goal of good nutritional intake is always beneficial. Informal assessments in a conversational mode are often effective. Reviewing the fact that prenatal vitamins do not provide all necessary nutrients for fetal growth may help encourage improved dietary intake, particularly if specific foods are reviewed for their nutritional contribution. Advice to avoid caffeinated beverages or alcohol, with examples provided, may be appropriate.

It is especially important for health care professionals to recognize the strong need of pregnant teenagers (and in fact all adolescents) to rebel against authority figures. Rather than telling a pregnant teen what to do, the health care professional should inform her of alternative actions and their likely outcomes. Work as the teen's advocate and ask her in a positive manner how you can best assist her. Ask what her perceived needs are and how she feels about your concerns. Encourage her involvement in other supportive programs in your community. Be a good listener and a supportive advocate for her.

Reviewing plans for infant feeding while a woman is still pregnant may help foster the goal of breastfeeding. Concerns such as lack of knowledge can be more effectively addressed before birth when emotions tend to run high.

AFTER PREGNANCY

After delivery, women should be encouraged to maintain good nutritional status to help provide themselves with adequate energy for infant care and to help restore nutritional stores for subsequent pregnancies. This is particularly true with regard to the inclusion of folic acid. Counseling can be provided as needed to encourage adequate spacing between pregnancies and proper nutrient intake to prepare the body for a healthy future pregnancy.

New mothers should also be monitored for postpartum depression. A personal history of mood disorder or premenstrual syndrome before pregnancy places a woman at high risk for postpartum mood disorders, which can lead to serious psychologic and social consequences and in some cases suicide or infanticide. Psychologic intervention is warranted before pregnancy for women at high risk for mood disorders. The encouragement of eating well-balanced, frequent meals, which can allow blood glucose levels to remain stable, may help to ward off or treat postpartum depression.

DURING LACTATION

The hospital obstetric nurse plays an important role in promoting successful breastfeeding in the first few hours after delivery. Of crucial importance are positive verbal encouragement and support. Extra caution needs to be used to avoid appearing inconsiderate with flippant remarks that can damage a woman's already sensitive emotions (related to hormonal changes associated with giving birth) and may impair her ability to breastfeed successfully. The use of appropriate humor can help a tense new mother relax, which is important for a successful let-down reflex. To avoid infant confusion, bottles should not be used. All new breastfeeding women should be alerted to the following support and information services:

- A local La Leche League group (www.llli.org)
- The WIC program, which supports breastfeeding education
- EFNEP, which may have breastfeeding support available through trained nutrition teaching assistants (see Chapter 14)
- Hospital-based lactation consultants

Breastfeeding buddy systems also exist in many communities. Volunteers experienced in breastfeeding are paired up with new mothers until breastfeeding is fully established. A nurse or other health professional can help set up such a system or make referrals to one already in existence.

FOR BOTTLE-FED INFANTS

In the case of a bottle-fed infant, it is important for the nurse or other health care professional to be aware of the parents' philosophy and knowledge about feeding. Do they adhere to rigid feeding schedules that impair the infant's consumption of formula, or do they go solely by the infant's crying, with the potential for either overfeeding or underfeeding? Are the parents receiving conflicting advice (which is likely) that undermines their confidence or that makes them adhere to inappropriate feeding practices? Do they believe that formula is made from "a bunch of chemicals" and that therefore whole milk is better? Do they realize that formula requires refrigeration after it has been prepared? Do they know how to properly prepare it? Is nursing-bottle mouth a potential problem? If so, recommend water bottles at bedtime (an older child may be given a choice: water bottle or no bottle).

REGARDING THE INTRODUCTION TO SOLID FOOD

Explaining why a grandmother or a mother-in-law may be giving one piece of advice while you are giving another can go a long way in building a new mother's trust in her own common sense. Because many new mothers are anxious and insecure in their first encounters with their infants, your efforts are best aimed at building confidence and strengthening decision-making skills.

Chapter Challenge Questions & Classroom Activities

1. What benefits may the mother-to-be expect if she is well nourished?
2. Why should the pregnant teenager be sure she receives adequate kcalories and sufficient amounts of all the other important nutrients?
3. How and why do the foods needed in the daily diet during pregnancy and lactation differ from those needed by nonpregnant women?
4. What can a nurse do to support breastfeeding in the hospital setting? What are the immediate and long-term concerns and their possible resolutions?
5. What guidelines would you give to a breastfeeding mother to help her determine whether breastfeeding is going well once she leaves the hospital?
6. Describe the likely effect of growth spurts on the nursing behavior of babies; how should this be addressed?
7. What are the advantages of breastfeeding? Why is breast milk so suitable for the infant?
8. What considerations for meal planning would be recommended for a pregnant or breastfeeding woman with diabetes (see Chapter 8 as needed)?
9. Have class members each provide at least one joke; the jokes can be compiled for later use with new lactating mothers to help promote the let-down reflex.
10. Arrange to have the class attend a local La Leche League meeting and to observe successful breastfeeding.

Case Study

Andrea was checking her morning ketones. She was trying to control how much she was eating because she had gained too much weight according to her obstetrician. Although her 1-hour blood glucose levels were mostly less than 110 mg/dL, she found she was constantly hungry. To keep her blood glucose level under control she just ate nuts and cheese. The doctor was worried she would need to have a cesarean section, but worse, if she had a big baby, her baby had an increased risk of developing obesity and diabetes. Her doctor also asked if she planned to breastfeed. She had told the doctor she had breastfed her first son for 3 months. The doctor did not ask any further questions.

Critical Thinking Applications

1. Why is Andrea at risk of having ketones?
2. If her prepregnancy BMI was 24, how much weight should she gain during pregnancy?
3. What should her 1- and 2-hour blood glucose levels be according to ACOG; ADA?
4. How much cheese and nuts can she eat and maintain a low-fat diet based on 2000 kcal?
5. What can Andrea eat other than nuts and cheese to meet her hunger and blood glucose needs? How much carbohydrate is appropriate for a 2000-kcal intake?
6. How long should Andrea plan to breastfeed for her baby's health; what questions might her doctor ask her regarding this goal and her experience with breastfeeding?

REFERENCES

Acartürk S, Gencel E, Tuncer I: An uncommon complication of secondary augmentation mammoplasty: bilaterally massive engorgement of breasts after pregnancy attributable to postinfection and blockage of mammary ducts, *Aesthetic Plast Surg* 29(4):274-279, 2005.

ACOG Practice Bulletin #60: Pregestational diabetes mellitus, *Obstet Gynecol* 105:675, 2005.

Albuquerque KT, Sardinha FL, Telles MM, Watanabe RL, Nascimento CM, Tavares do Carmo MG, Ribeiro EB: Intake of trans fatty acid–rich hydrogenated fat during

pregnancy and lactation inhibits the hypophagic effect of central insulin in the adult offspring, *Nutrition* 22(7-8): 820-829, 2006.

Allen LH: Multiple micronutrients in pregnancy and lactation: an overview, *Am J Clin Nutr* 81(5):1206S-1212S, 2005.

American Diabetes Association: Preconception care of women with diabetes, *Diabetes Care* 27(Suppl 1):S76, 2004.

Anderson JE, Held N, Wright K: Raynaud's phenomenon of the nipple: a treatable cause of painful breastfeeding, *Pediatrics* 113(4):e360-e364, 2004.

Andrus SS, Wolfson AB: Postpartum preeclampsia occurring after resolution of antepartum preeclampsia, *J Emerg Med*, June 10, 2008 (Epub ahead of print).

Artal R, Catanzaro RB, Gavard JA, Mostello DJ, Friganza JC: A lifestyle intervention of weight-gain restriction: diet and exercise in obese women with gestational diabetes mellitus, *Appl Physiol Nutr Metab* 32(3):596-601, 2007.

Baggot PJ, Eliseo AJ, DeNicola NG, Kalamarides JA, Shoemaker JD: Pyridoxine-related metabolite concentrations in normal and Down syndrome amniotic fluid, *Fetal Diagn Ther* 23(4):254-257, 2008.

Bartell S, Zallek S: Intravenous magnesium sulfate may relieve restless legs syndrome in pregnancy, *J Clin Sleep Med* 2(2):187-188, 2006.

Bell MR, Ritchie EC: Breast-feeding in the military. II. Resource and policy considerations, *Mil Med* 168(10):813-816, 2003.

Berger K, Luedemann J, Trenkwalder C, John U, Kessler C: Sex and the risk of restless legs syndrome in the general population, *Arch Intern Med* 164(2):196-202, 2004.

Bergmann RL, Haschke-Becher E, Klassen-Wigger P, Bergmann KE, Richter R, Dudenhausen JW, Grathwohl D, Haschke F: Supplementation with 200 mg/day docosahexaenoic acid from mid-pregnancy through lactation improves the docosahexaenoic acid status of mothers with a habitually low fish intake and of their infants, *Ann Nutr Metab* 52(2):157-166, 2008.

Berle JO, Steen VM, Aamo TO, Breilid H, Zahlsen K, Spigset O: Breast-feeding during maternal antidepressant treatment with serotonin reuptake inhibitors: infant exposure, clinical symptoms, and cytochrome p450 genotypes, *J Clin Psychiatry* 65(9):1228-1234, 2004.

Betz O, Kranke P, Geldner G, Wulf H, Eberhart LH: Is ginger a clinically relevant antiemetic? A systematic review of randomized controlled trials, *Forsch Komplementarmed Klass Naturheilkd* 12(1):14-23, 2005.

Black MM, Baqui AH, Zaman K, Ake Persson L, El Arifeen S, Le K, McNary SW, Parveen M, Hamadani JD, Black RE: Iron and zinc supplementation promote motor development and exploratory behavior among Bangladeshi infants, *Am J Clin Nutr* 80(4):903-910, 2004.

Bodnar LM, Wisner KL: Nutrition and depression: implications for improving mental health among childbearing-aged women, *Biol Psychiatry* 58(9):679-685, 2005.

Boney CM, Verma A, Tucker R, Vohr BR: Metabolic syndrome in childhood: association with birth weight, maternal obesity, and gestational diabetes mellitus, *Pediatrics* 115(3):e290-e296, 2005.

Bourre JM: Dietary omega-3 fatty acids for women, *Biomed Pharmacother* 61(2-3):105-112, 2007.

Bozoky I, Corwin EJ: Fatigue as a predictor of postpartum depression, *J Obstet Gynecol Neonatal Nurs* 31(4):436-443, 2002.

Cabezuelo Huerta G, Vidal Micó S, Abeledo Gómez A, Frontera Izquierdo P: 25-Hydroxyvitamin D levels in infants: relation with breast-feeding, *An Pediatr* 66(5):491-495, 2007.

Candito M, Rivet R, Herbeth B, Boisson C, Rudigoz RC, Luton D, Journel H, Oury JF, Roux F, Saura R, Vernhet I, Gaucherand P, Muller F, Guidicelli B, Heckenroth H, Poulain P, Blayau M, Francannet C, Roszyk L, Brustié C, Staccini P, Gérard P, Fillion-Emery N, Guéant-Rodriguez RM, Van Obberghen E, Guéant JL: Nutritional and genetic determinants of vitamin B and homocysteine metabolisms in neural tube defects: a multicenter case-control study, *Am J Med Genet A* 146A(9):1128-1133, 2008.

Casey PH: Growth of low birth weight preterm children, *Semin Perinatol* 32(1):20-27, 2008.

Castrucci BC, Hoover KL, Lim S, Maus KC: Availability of lactation counseling services influences breastfeeding among infants admitted to neonatal intensive care units, *Am J Health Promot* 21(5):410-415, 2007.

Catalano PM: Management of obesity in pregnancy, *Obstet Gynecol* 109(2 Pt 1):419-433, 2007.

Champagne CM: Magnesium in hypertension, cardiovascular disease, metabolic syndrome, and other conditions: a review, *Nutr Clin Pract* 23(2):142-151, 2008.

Chaudron LH, Pies RW: The relationship between postpartum psychosis and bipolar disorder: a review, *J Clin Psychiatry* 64(11):1284-1292, 2003.

Chen R, Ben-Haroush A, Weismann-Brenner A, Melamed N, Hod M, Yogev Y: Level of glycemic control and pregnancy outcome in type 1 diabetes: a comparison between multiple daily insulin injections and continuous subcutaneous insulin infusions, *Am J Obstet Gynecol* 197(4):404.e1-5, 2007.

Cheng RK, MacDonald CJ, Williams CL, Meck WH: Prenatal choline supplementation alters the timing, emotion, and memory performance (TEMP) of adult male and female rats as indexed by differential reinforcement of low-rate schedule behavior, *Learn Mem* 15(3):153-162, 2008.

Chiossi G, Neri I, Cavazzuti M, Basso G, Facchinetti F: Hyperemesis gravidarum complicated by Wernicke encephalopathy: background, case report, and review of the literature, *Obstet Gynecol Surv* 61(4):255-268, 2006.

Chittumma P, Kaewkiattikun K, Wiriyasiriwach B: Comparison of the effectiveness of ginger and vitamin B_6 for treatment of nausea and vomiting in early pregnancy: a randomized double-blind controlled trial, *J Med Assoc Thai* 90(1):15-20, 2007.

Coppage KH, Sibai BM: Treatment of hypertensive complications in pregnancy, *Curr Pharm Des* 11(6):749-757, 2005.

Corwin EJ, Murray-Kolb LE, Beard JL: Low hemoglobin level is a risk factor for postpartum depression, *J Nutr* 133(12):4139-4142, 2003.

Crawford P: Best practice guidelines for the management of women with epilepsy, *Epilepsia* 46(Suppl 9):117-124, 2005.

Crowther CA, Hiller JE, Moss JR, McPhee AJ, Jeffries WS, Robinson JS; Australian Carbohydrate Intolerance Study in Pregnant Women (ACHOIS) Trial Group: Effect of treatment of gestational diabetes mellitus on pregnancy outcomes, *N Engl J Med* 352(24):2477-2486, 2005.

Defrère S, Lousse JC, González-Ramos R, Colette S, Donnez J, Van Langendonckt A: Potential involvement of iron in the pathogenesis of peritoneal endometriosis, *Mol Hum Reprod* 14(7):377-385, 2008.

Devereux G: Early life events in asthma—diet, *Pediatr Pulmonol* 42(8):663-673, 2007.

Dollberg S, Botzer E, Grunis E, Mimouni FB: Immediate nipple pain relief after frenotomy in breast-fed infants with ankyloglossia: a randomized, prospective study, *J Pediatr Surg* 41(9):1598-1600, 2006.

Dunne F: Type 2 diabetes and pregnancy, *Semin Fetal Neonatal Med* 10(4):333-339, 2005.

Eddib A, Penvose-Yi J, Shelton JA, Yeh J: Triplet gestation outcomes in relation to maternal prepregnancy body mass index and weight gain, *J Matern Fetal Neonatal Med* 20(7):515-519, 2007.

Ehrenkranz RA, Dusick AM, Vohr BR, Wright LL, Wrage LA, Poole WK: Growth in the neonatal intensive care unit influences neurodevelopmental and growth outcomes of extremely low birth weight infant, *Pediatrics* 117(4):1253-1261, 2006.

Engstrom JL, Meier PP, Jegier B, Motykowski JE, Zuleger JL: Comparison of milk output from the right and left breasts during simultaneous pumping in mothers of very low birthweight infants, *Breastfeed Med* 2(2):83-91, 2007.

Enns GM, O'Brien WE, Kobayashi K, Shinzawa H, Pellegrino JE: Postpartum "psychosis" in mild argininosuccinate synthetase deficiency, *Obstet Gynecol* 105(5 Pt 2):1244-1246, 2005.

Ensiyeh J, Sakineh MA: Comparing ginger and vitamin B_6 for the treatment of nausea and vomiting in pregnancy: a randomised controlled trial, *Midwifery* Feb 11, 2008 (Epub ahead of print).

Fassett MJ, Dhillon SH, Williams TR: Effects on perinatal outcome of treating women with 1 elevated glucose tolerance test value, *Am J Obstet Gynecol* 196(6):597, 2007.

Ferreira CT, Seidman E: Food allergy: a practical update from the gastroenterological viewpoint, *J Pediatr* 83(1):7-20, 2007.

Flidel-Rimon O, Shinwell ES: Breast feeding twins and high multiples, *Arch Dis Child Fetal Neonatal Ed* 91(5):F377-F380, 2006.

Folope V, Coëffier M, Déchelotte P: [Nutritional deficiencies associated with bariatric surgery], *Gastroenterol Clin Biol* 31(4):369-377, 2007.

Gaby AR: Natural approaches to epilepsy, *Altern Med Rev* 12(1):9-24, 2007.

Georgieff MK: Nutrition and the developing brain: nutrient priorities and measurement, *Am J Clin Nutr* 85(2):614S-620S, 2007.

Gonzalez JM, Edlow AG, Silber A, Elovitz MA: Hyperosmolar hyperglycemic state of pregnancy with intrauterine fetal demise and preeclampsia, *Am J Perinatol* 24(9):541-543, 2007.

Gonzalez-Barranco J, Rios-Torres JM: Early malnutrition and metabolic abnormalities later in life, *Nutr Rev* 62(7 Pt 2):S134-S139, 2004.

Goodwin TM, Poursharif B, Korst LM, MacGibbon KW, Romero R, Fejzo MS: Secular trends in the treatment of hyperemesis gravidarum, *Am J Perinatol* 25(3):141-147, 2008.

Gossell-Williams M, Fletcher H, Zeisel SH: Unexpected depletion in plasma choline and phosphatidylcholine concentrations in a pregnant woman with bipolar affective disorder being treated with lithium, haloperidol and benztropine: a case report, *J Med Case Reports* 2:55, 2008.

Groth S: Are the Institute of Medicine recommendations for gestational weight gain appropriate for adolescents? *J Obstet Gynecol Neonatal Nurs* 36(1):21-27, 2007.

Grover V, Lipton RB, Sclove SL: Seasonality of month of birth among African American children with diabetes mellitus in the city of Chicago, *J Pediatr Endocrinol Metab* 17(3):289-296, 2004.

Gutiérrez-Aguilar G, Abenia-Usón P, García-Cazorla A, Vilaseca MA, Campistol J: [Encephalopathy with methylmalonic aciduria and homocystinuria secondary to a deficient exogenous supply of vitamin B_{12}], *Rev Neurol* 40(10):605-608, 2005.

Hackmon R, James R, O'Reilly Green C, Ferber A, Barnhard Y, Divon M: The impact of maternal age, body mass index and maternal weight gain on the glucose challenge test in pregnancy, *J Matern Fetal Neonatal Med* 20(3):253-257, 2007.

Hallan S, Euser AM, Irgens LM, Finken MJ, Holmen J, Dekker FW: Effect of intrauterine growth restriction on kidney function at young adult age: the Nord Trøndelag Health (HUNT 2) Study, *Am J Kidney Dis* 51(1):10-20, 2008.

Hedderson MM, Weiss NS, Sacks DA, Pettitt DJ, Selby JV, Quesenberry CP, Ferrara A: Pregnancy weight gain and risk of neonatal complications: macrosomia, hypoglycemia, and hyperbilirubinemia, *Obstet Gynecol* 108(5):1153-1161, 2006.

Henriksen T: The macrosomic fetus: a challenge in current obstetrics, *Acta Obstet Gynecol Scand* 87(2):134-145, 2008.

Heron J, McGuinness M, Blackmore ER, Craddock N, Jones I: Early postpartum symptoms in puerperal psychosis, *BJOG* 115(3):348-353, 2008.

Hirnle L, Kowalska M, Petrus A, Hirnle G, Zimmer M: [The analysis of risk factors for fetal macrosomia and the complications in the course of pregnancy and delivery of macrosomic baby], *Ginekol Pol* 78(4):280-283, 2007.

Hofmeyr GJ, Atallah AN, Duley L: Calcium supplementation during pregnancy for preventing hypertensive disorders and related problems, *Cochrane Database Syst Rev* 3:CD001059, 2006.

Holmgren C, Aagaard-Tillery KM, Silver RM, Porter TF, Varner M: Hyperemesis in pregnancy: an evaluation of treatment strategies with maternal and neonatal outcomes, *Am J Obstet Gynecol* 198(1):56.e1-4, 2008.

Indraccolo U, Gentile G, Pomili G, Luzi G, Villani C: Thiamine deficiency and beriberi features in a patient with hyperemesis gravidarum, *Nutrition* 21(9):967-968, 2005.

Irminger-Finger I, Jastrow N, Irion O: Preeclampsia: a danger growing in disguise, *Int J Biochem Cell Biol* 40(10):1979-1983, 2008.

Jain NJ, Denk CE, Kruse LK, Dandolu V: Maternal obesity: can pregnancy weight gain modify risk of selected adverse pregnancy outcomes? *Am J Perinatol* 24(5):291-298, 2007.

Jansson T, Cetin I, Powell TL, Desoye G, Radaelli T, Ericsson A, Sibley CP: Placental transport and metabolism in fetal overgrowth—a workshop report, *Placenta* 27(Suppl A):S109-S113, 2006.

Jefferson WN, Padilla-Banks E, Newbold RR: Disruption of the developing female reproductive system by phytoestrogens: genistein as an example, *Mol Nutr Food Res* 51(7):832-844, 2007.

Jevitt C, Hernandez I, Groër M: Lactation complicated by overweight and obesity: supporting the mother and newborn, *J Midwifery Womens Health* 52(6):606-613, 2007.

Kaaja RJ: Metabolic syndrome and the menopause, *Menopause Int* 14(1):21-25, 2008.

Kabali C, Werler MM: Pre-pregnant body mass index, weight gain and the risk of delivering large babies among nondiabetic mothers, *Int J Gynaecol Obstet* 97(2):100-104, 2007.

Kaiser L, Allen LH: American Dietetic Association. Collaborators (15) Denny S, Hager MH, Myers E, Nutrition Education for the Public Dietetics Practice Group, Procter S, Public Health Community Nutrition Dietetics Practice Group, Murphy LT, Risica PM, Tansman L, Weber JA, Women's Health and Reproductive Nutrition Dietetics Practice Group, Paris E, Holt K, Polly D, Stang J: Position of the American Dietetic Association: nutrition and lifestyle for a healthy pregnancy outcome, *J Am Diet Assoc* 108(3):553-661, 2008.

Kiziler AR, Aydemir B, Onaran I, Alici B, Ozkara H, Gulyasar T, Akyolcu MC: High levels of cadmium and lead in seminal fluid and blood of smoking men are associated with high oxidative stress and damage in infertile subjects, *Biol Trace Elem Res* 120(1-3):82-91, 2007.

Kovacheva VP, Mellott TJ, Davison JM, Wagner N, Lopez-Coviella I, Schnitzler AC, Blusztajn JK: Gestational choline deficiency causes global and Igf2 gene DNA hypermethylation by up-regulation of Dnmt1 expression, *J Biol Chem* 282(43):31777-31788, 2007.

Krishna AP, Ramakrishna T: Effect of pyridoxine deficiency on the structural and functional development of hippocampus, *Indian J Physiol Pharmacol* 48(3):304-310, 2004.

Krishna Mohan S, Venkataramana G: Status of lipid peroxidation, glutathione, ascorbic acid, vitamin E and antioxidant enzymes in patients with pregnancy-induced hypertension, *Indian J Physiol Pharmacol* 51(3):284-288, 2007.

Krishnamurthy KB: Pregnancy and epilepsy: update on pregnancy registries, *Curr Treat Options Neurol* 10(4):246-252, 2008.

Labarere J, Gelbert-Baudino N, Ayral AS, Duc C, Berchotteau M, Bouchon N, Schelstraete C, Vittoz JP, Francois P, Pons JC: Efficacy of breastfeeding support provided by trained clinicians during an early, routine, preventive visit: a prospective, randomized, open trial of 226 mother-infant pairs, *Pediatrics* 115(2):e139-e146, 2005.

Lampinen KH, Rönnback M, Groop PH, Kaaja RJ: A relationship between insulin sensitivity and vasodilatation in women with a history of preeclamptic pregnancy, *Hypertension* 52(2):394-401, 2008.

Lawlor DA, Riddoch CJ, Page AS, Andersen LB, Wedderkopp N, Harro M, Stansbie D, Smith GD: Infant feeding and components of the metabolic syndrome: findings from the European Youth Heart Study, *Arch Dis Child* 90(6):582-588, 2005.

Lee HJ, Rubio MR, Elo IT, McCollum KF, Chung EK, Culhane JF: Factors associated with intention to breastfeed among low-income, inner-city pregnant women, *Matern Child Health J* 9(3):253-261, 2005.

Lee PJ, Ridout D, Walter JH, Cockburn F: Maternal phenylketonuria: report from the United Kingdom Registry 1978-97, *Arch Dis Child* 90(2):143-146, 2005.

Lewallen LP, Dick MJ, Flowers J, Powell W, Zickefoose KT, Wall YG, Price ZM: Breastfeeding support and early cessation, *J Obstet Gynecol Neonatal Nurs* 35(2):166-172, 2006.

Litonjua AA, Rifas-Shiman SL, Ly NP, Tantisira KG, Rich-Edwards JW, Camargo CA Jr, Weiss ST, Gillman MW, Gold DR: Maternal antioxidant intake in pregnancy and wheezing illnesses in children at 2 y of age, *Am J Clin Nutr* 84(4):903-911, 2006.

Logsdon MC, Cross R, Williams B, Simpson T: Prediction of postpartum social support and symptoms of depression in pregnant adolescents: a pilot study, *J Sch Nurs* 20(1):36-42, 2004.

Love AL, Billett HH: Obesity, bariatric surgery, and iron deficiency: true, true, true and related. *Am J Hematol* 83(5):403-409, 2008.

Lovelady CA: The impact of energy restriction and exercise in lactating women, *Adv Exp Med Biol* 554:115-120, 2004.

Lücke T, Korenke GC, Poggenburg I, Bentele KH, Das AM, Hartmann H: [Maternal vitamin B_{12} deficiency: cause for neurological symptoms in infancy], *Z Geburtshilfe Neonatol* 211(4):157-161, 2007.

Luke B, Hediger ML, Nugent C, Newman RB, Mauldin JG, Witter FR, O'Sullivan MJ: Body mass index—specific weight gains associated with optimal birth weights in twin pregnancies, *J Reprod Med* 48(4):217-224, 2003.

Maggio L, Zuppa AA, Sawatzki G, Valsasina R, Schubert W, Tortorolo G: Higher urinary excretion of essential amino acids in preterm infants fed protein hydrolysates, *Acta Paediatr* 94(1):75-84, 2005.

Mahaffey KR, Clickner RP, Jeffries RA: Methylmercury and omega-3 fatty acids: co-occurrence of dietary sources with emphasis on fish and shellfish, *Environ Res* 107(1):20-29, 2008.

Manconi M, Govoni V, De Vito A, Economou NT, Cesnik E, Casetta I, Mollica G, Ferini-Strambi L, Granieri E: Restless legs syndrome and pregnancy, *Neurology* 63(6):1065-1069, 2004.

Mannion CA, Gray-Donald K, Johnson-Down L, Koski KG: Lactating women restricting milk are low on select nutrients, *J Am Coll Nutr* 26(2):149-155, 2007.

Martin JN Jr, Thigpen BD, Moore RC, Rose CH, Cushman J, May W: Stroke and severe preeclampsia and eclampsia: a paradigm shift focusing on systolic blood pressure, *Obstet Gynecol* 105(2):246-254, 2005.

Mathey C, Di Marco JN, Poujol A, Cournelle MA, Brevaut V, Livet MO, Chabrol B, Michel G: [Failure to thrive and psychomotor regression revealing vitamin B_{12} deficiency in 3 infants], *Arch Pediatr* 14(5):467-471, 2007.

McArdle HJ, Andersen HS, Jones H, Gambling L: Copper and iron transport across the placenta: regulation and interactions, *J Neuroendocrinol* 20(4):427-431, 2008.

McGee CL, Schonfeld AM, Roebuck-Spencer TM, Riley EP, Mattson SN: Children with heavy prenatal alcohol exposure demonstrate deficits on multiple measures of concept formation, *Alcohol Clin Exp Res* 32(8):1388-1397, 2008.

Mennella JA, Ziegler P, Briefel R, Novak T: Feeding Infants and Toddlers Study: the types of foods fed to Hispanic infants and toddlers, *J Am Diet Assoc* 106(1 Suppl 1):S96-S106, 2006.

Mitanchez D: Ontogenesis of glucose regulation in neonate and consequences in neonatal management, *Arch Pediatr* 15(1):64-74, 2008.

Miyake Y, Sasaki S, Tanaka K, Ohya Y, Miyamoto S, Matsunaga I, Yoshida T, Hirota Y, Oda H; Osaka Maternal and Child Health Study Group: Fish and fat intake and prevalence of allergic rhinitis in Japanese females: the Osaka Maternal and Child Health Study, *J Am Coll Nutr* 26(3):279-287, 2007.

Momoi N, Tinney JP, Liu LJ, Elshershari H, Hoffmann PJ, Ralphe JC, Keller BB, Tobita K: Modest maternal caffeine exposure affects developing embryonic cardiovascular function and growth, *Am J Physiol Heart Circ Physiol* 294(5):H2248-H2256, 2008.

Montouris G: Importance of monotherapy in women across the reproductive cycle, *Neurology* 69(24 Suppl 3):S10-S16, 2007.

Mortensen EL, Michaelsen KF, Sanders SA, Reinisch JM: Breast feeding and intelligence, *Ugeskr Laeger* 165(13):1361-1366, 2003.

Mostafa T, Tawadrous G, Roaia MM, Amer MK, Kader RA, Aziz A: Effect of smoking on seminal plasma ascorbic acid in infertile and fertile males, *Andrologia* 38(6):221-224, 2006.

Neault NB, Frank DA, Merewood A, Philipp B, Levenson S, Cook JT, Meyers AF, Casey PH, Cutts DB, Black MM, Heeren T, Berkowitz C; Children's Sentinel Nutrition Assessment Program Study Group: Breastfeeding and health outcomes among citizen infants of immigrant mothers, *J Am Diet Assoc* 107(12):2077-2086, 2007.

Nguyen P, Nava-Ocampo A, Levy A, O'Connor DL, Einarson TR, Taddio A, Koren G: Effect of iron content on the tolerability of prenatal multivitamins in pregnancy, *BMC Pregnancy Childbirth* 8:17, 2008.

Ogden CL, Schoendorf KC, Kiely JL, Gillman MW: Fetal growth and childhood cholesterol levels in the United States, *Paediatr Perinat Epidemiol* 22(1):5-11, 2008.

Ogier de Baulny H: Management and emergency treatments of neonates with a suspicion of inborn errors of metabolism, *Semin Neonatol* 7(1):17-26, 2002.

Ogonowski J, Miazgowski T, Czeszyńska MB, Jaskot B, Kuczyńska M, Celewicz Z: Factors influencing risk of macrosomia in women with gestational diabetes mellitus undergoing intensive diabetic care, *Diabetes Res Clin Pract* 80(3):405-410, 2008.

Okanishi T, Maegaki Y, Ohno K, Togari H: Underlying neurologic disorders and recurrence rates of status epilepticus in childhood, *Brain Dev* 30(10):624-628, 2008.

Oken E, Radesky JS, Wright RO, Bellinger DC, Amarasiriwardena CJ, Kleinman KP, Hu H, Gillman MW: Maternal fish intake during pregnancy, blood mercury levels, and child cognition at age 3 years in a US cohort, *Am J Epidemiol* 167(10):1171-1181, 2008.

Olsen SF, Halldorsson TI, Willett WC, Knudsen VK, Gillman MW, Mikkelsen TB, Olsen J; NUTRIX Consortium: Milk consumption during pregnancy is associated with increased infant size at birth: prospective cohort study, *Am J Clin Nutr* 86(4):1104-1110, 2007.

Olson CM: Achieving a healthy weight gain during pregnancy, *Annu Rev Nutr* 28:411-423, 2008.

Onyeije CI, Divon MY: The impact of maternal ketonuria on fetal test results in the setting of postterm pregnancy, *Am J Obstet Gynecol* 184(4):713-718, 2001.

Palladino AA, Bennett MJ, Stanley CA: Hyperinsulinism in infancy and childhood: when an insulin level is not always enough, *Clin Chem* 54(2):256-263, 2008.

Palma S, Perez-Iglesias R, Prieto D, Pardo R, Llorca J, Delgado-Rodriguez M: Iron but not folic acid supplementation reduces the risk of low birthweight in pregnant women without anaemia: a case-control study, *J Epidemiol Community Health* 62(2):120-124, 2008.

Payne JL: The role of estrogen in mood disorders in women, *Int Rev Psychiatry* 15(3):280-290, 2003.

Perafan-Riveros C, Franca LF, Alves AC, Sanches JA Jr: Acrodermatitis enteropathica: case report and review of the literature, *Pediatr Dermatol* 19(5):426-431, 2002.

Philipp BL, McMahon MJ, Davies S, Santos T, Jean-Marie S: Breastfeeding information in nursing textbooks needs improvement, *J Hum Lact* 23(4):345-349, 2007.

Philipp BL, Merewood A, Gerendas EJ, Bauchner H: Breastfeeding information in pediatric textbooks needs improvement, *J Hum Lact* 20(2):206-210, 2004.

Pisani LP, Oyama LM, Bueno AA, Biz C, Albuquerque KT, Ribeiro EB, Oller do Nascimento CM: Hydrogenated fat intake during pregnancy and lactation modifies serum lipid profile and adipokine mRNA in 21-day-old rats, *Nutrition* 24(3):255-261, 2008.

Power ML, Milligan LA, Schulkin J: Managing nausea and vomiting of pregnancy: a survey of obstetrician-gynecologists, *J Reprod Med* 52(10):922-928, 2007.

Quigley MA, Henderson G, Anthony MY, McGuire W: Formula milk versus donor breast milk for feeding preterm or low birth weight infants, *Cochrane Database Syst Rev* 4:CD002971, 2007.

Quinlivan EP, Gregory JF III: Reassessing folic acid consumption patterns in the United States (1999-2004): potential effect on neural tube defects and overexposure to folate, *Am J Clin Nutr* 86(6):1773-1779, 2007.

Rasmussen KM, Kjolhede CL: Prepregnant overweight and obesity diminish the prolactin response to suckling in the first week postpartum, *Pediatrics* 113(5):e465-471, 2004.

Reader DM: Medical nutrition therapy and lifestyle interventions, *Diabetes Care* 30(Suppl 2):S188-S193, 2007.

Ricke LA, Baker NJ, Madlon-Kay DJ, DeFor TA: Newborn tongue-tie: prevalence and effect on breast-feeding, *J Am Board Fam Pract* 18(1):1-7, 2005.

Satija P, Ondo WG: Restless legs syndrome: pathophysiology, diagnosis and treatment, *CNS Drugs* 22(6):497-518, 2008.

Schlapbach LJ, Schütz B, Nuoffer JM, Brekenfeld C, Müller G, Fluri S: [Floppy baby with macrocytic anemia and vegan mother], *Praxis (Bern 1994)* 96(35):1309-1314, 2007.

Segal P, Hamilton JK, Sermer M, Connelly PW, Hanley AJ, Zinman B, Retnakaran R: Maternal obesity and familial history of diabetes have opposing effects on infant birth weight in women with mild glucose intolerance in pregnancy, *J Matern Fetal Neonatal Med* 21(1):73-79, 2008.

Semmekrot BA, de Vries MC, Gerrits GP, van Wieringen PM: [Optimal breastfeeding to prevent hyperbilirubinaemia in healthy, term newborns], *Ned Tijdschr Geneeskd* 148(41): 2016-2019, 2004.

Seyfried LS, Marcus SM: Postpartum mood disorders, *Int Rev Psychiatry* 15(3):231-242, 2003.

Sheehan P: Hyperemesis gravidarum—assessment and management, *Aust Fam Physician* 36(9):698-701, 2007.

Shrim A, Boskovic R, Maltepe C, Navios Y, Garcia-Bournissen F, Koren G: Pregnancy outcome following use of large doses of vitamin B_6 in the first trimester, *J Obstet Gynaecol* 26(8):749-751, 2006.

Sibai BM: Diagnosis, prevention, and management of eclampsia, *Obstet Gynecol* 105(2):402-410, 2005.

Sisk PM, Lovelady CA, Dillard RG, Gruber KJ: Lactation counseling for mothers of very low birth weight infants: effect on maternal anxiety and infant intake of human milk, *Pediatrics* 117(1):e67-e75, 2006.

Song GJ, Norkus EP, Lewis V: Relationship between seminal ascorbic acid and sperm DNA integrity in infertile men, *Int J Androl* 29(6):569-575, 2006.

Spear HJ: Breastfeeding behaviors and experiences of adolescent mothers, *MCN Am J Matern Child Nurs* 31(2):106-113, 2006.

Spears K, Cheney C, Zerzan J: Low plasma retinol concentrations increase the risk of developing bronchopulmonary dysplasia and long-term respiratory disability in very-low-birth-weight infants, *Am J Clin Nutr* 80(6):1589-1594, 2004.

Suellentrop K, Morrow B, Williams L, D'Angelo D; Centers for Disease Control and Prevention: Monitoring progress toward achieving maternal and infant Healthy People 2010 objectives—19 states, Pregnancy Risk Assessment Monitoring System (PRAMS), 2000-2003, *MMWR Surveill Summ* 55(9):1-11, 2006.

Tarif N, Al Badr W: Euglycemic diabetic ketoacidosis in pregnancy, *Saudi J Kidney Dis Transpl* 18(4):590-593, 2007.

Telisman S, Colak B, Pizent A, Jurasović J, Cvitković P: Reproductive toxicity of low-level lead exposure in men, *Environ Res* 105(2):256-266, 2007.

Thomas JD, Garrison M, O'Neill TM: Perinatal choline supplementation attenuates behavioral alterations associated with neonatal alcohol exposure in rats, *Neurotoxicol Teratol* 26(1):35-45, 2004.

Tobias JH, Steer CD, Emmett PM, Tonkin RJ, Cooper C, Ness AR: Bone mass in childhood is related to maternal diet in pregnancy, *Osteoporos Int* 16(12):1731-1741, 2005.

Todorova K, Mazneikova V, Ivanov S: [Can education during pregnancy improve the perinatal outcome in diabetic pregnancies?] *Akush Ginekol (Sofiia)* 43(3):21-27, 2004.

Turck D: Soy protein for infant feeding: what do we know? *Curr Opin Clin Nutr Metab Care* 10(3):360-365, 2007.

Uras N, Karadag A, Dogan G, Tonbul A, Tatli MM: Moderate hypernatremic dehydration in newborn infants: retrospective evaluation of 64 cases, *J Matern Fetal Neonatal Med* 20(6):449-452, 2007.

van Eijsden M, Hornstra G, van der Wal MF, Vrijkotte TG, Bonsel GJ: Maternal n-3, n-6, and trans fatty acid profile early in pregnancy and term birth weight: a prospective cohort study, *Am J Clin Nutr* 87(4):887-895, 2008.

Vergnes JN: Studies suggest an association between maternal periodontal disease and pre-eclampsia, *Evid Based Dent* 9(2):46-47, 2008.

Vergne-Salle P, Coyral D, Dufauret K, Bonnet C, Bertin P, Treves R: Is restless legs syndrome underrecognized? Current management, *Joint Bone Spine* 73(4):369-373, 2006.

Vohr BR, Poindexter BB, Dusick AM, McKinley LT, Higgins RD, Langer JC, Poole WK; National Institute of Child Health and Human Development National Research

Network: Persistent beneficial effects of breast milk ingested in the neonatal intensive care unit on outcomes of extremely low birth weight infants at 30 months of age, *Pediatrics* 120(4):e953-e959, 2007.

Voldner N, Frøslie KF, Bo K, Haakstad L, Hoff C, Godang K, Bollerslev J, Henriksen T: Modifiable determinants of fetal macrosomia: role of lifestyle-related factors, *Acta Obstet Gynecol Scand* 87(4):423-429, 2008.

Walker CD, Deschamps S, Proulx K, Tu M, Salzman C, Woodside B, Lupien S, Gallo-Payet N, Richard D: Mother to infant or infant to mother? Reciprocal regulation of responsiveness to stress in rodents and the implications for humans, *J Psychiatry Neurosci* 29(5):364-382, 2004.

Wallace H, Clarke S: Tongue tie division in infants with breast feeding difficulties, *Int J Pediatr Otorhinolaryngol* 70(7):1257-1261, 2006.

Wallis K: Severe vitamin D deficiency presenting as hypocalcaemic seizures in a black infant at 45.5 degrees south: a case report, *Cases J* 1(1):12, 2008.

Watson PE, McDonald BW: Seasonal variation of nutrient intake in pregnancy: effects on infant measures and possible influence on diseases related to season of birth, *Eur J Clin Nutr* 61(11):1271-1280, 2007.

Weingärtner J, Lotz K, Fanghänel J, Gedrange T, Bienengräber V, Proff P: Induction and prevention of cleft lip, alveolus and palate and neural tube defects with special consideration of B vitamins and the methylation cycle, *J Orofac Orthop* 68(4):266-277, 2007.

Weissgerber TL, Wolfe LA, Davies GA, Mottola MF: Exercise in the prevention and treatment of maternal-fetal disease: a review of the literature, *Appl Physiol Nutr Metab* 31(6):661-674, 2006.

Wender-Ozegowska E, Sporna M, Zawiejska A, Sporna A, Brazert J: Components of metabolic syndrome in women after gestational diabetes, *Pol Arch Med Wewn* 117(10):457-462, 2007.

West MC, Anderson L, McClure N, Lewis SE: Dietary oestrogens and male fertility potential, *Hum Fertil (Camb)* 8(3):197-207, 2005.

Wilson RD, Johnson JA, Wyatt P, Allen V, Gagnon A, Langlois S, Blight C, Audibert F, Désilets V, Brock JA, Koren G, Goh I, Nguyen P, Kapur B: Pre-conceptional vitamin/folic acid supplementation 2007: the use of folic acid in combination with a multivitamin supplement for the prevention of neural tube defects and other congenital anomalies, *J Obstet Gynaecol Can* 29(12):1003-1026, 2007.

Xu Y, Liu P, Li Y: Impaired development of mitochondria plays a role in the central nervous system defects of fetal alcohol syndrome, *Birth Defects Res A Clin Mol Teratol* 73(2):83-91, 2005.

Yada K, Yoshida K, Sakurai Y, Kimura M, Yasuhara H, Tanaka I, Yoshioka A: Casein hydrolysate formula–induced liver dysfunction in a neonate with non-immunoglobulin E–mediated cow's milk allergy, *J Investig Allergol Clin Immunol* 18(1):67-70, 2008.

Yang W, Shaw GM, Carmichael SL, Rasmussen SA, Waller DK, Pober BR, Anderka M; The National Birth Defects Prevention Study: Nutrient intakes in women and congenital diaphragmatic hernia in their offspring, *Birth Defects Res A Clin Mol Teratol* 82(3):131-138, 2008.

Yorifuji J, Yorifuji T, Tachibana K, Nagai S, Kawai M, Momoi T, Nagasaka H, Hatayama H, Nakahata T: Craniotabes in normal newborns: the earliest sign of subclinical vitamin D deficiency, *J Clin Endocrinol Metab* 93(5):1784-1788, 2008.

chapter

12

Growth and Development Issues in Promoting Good Health

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Chapter Topics

Nutritional Needs for Optimal Growth and Development
Use of Growth Charts in Assessing Nutritional Status of Children
Feeding Management for Young Children and Impact of Growth and Development
Eating Patterns in Adolescence
Common Nutritional Issues of Children and Adolescents
Developmental Disabilities
Sports Nutrition Issues During Childhood and Adolescence
The Role of the Nurse and Other Health Care Professionals in Growth and Development

Objectives

After completing this chapter, you should be able to:

- Describe nutritional needs of children and adolescents.
- Assess a child's nutritional needs based on growth charts.
- Describe methods to promote optimal nutritional intake.
- Describe assessment and intervention strategies for common childhood health concerns.
- Discuss the nutritional needs of athletic children.
- Apply knowledge of the nutrient needs to the meal environment.

Terms to Identify

Amenorrhea
Anorexia nervosa (AN)
Asthma
Attention-deficit/hyperactivity disorder (ADHD)
Autism
Baby-bottle tooth decay
Bulimia
Bulimorexia
Cariogenic
Cerebral palsy
Cystic fibrosis (CF)
Decalcification
Dental caries
Dental enamel
Dental erosion
Dental plaque
Dermatitis herpetiformis
Development
Developmental disability
Down syndrome
Ecchymoses
Epilepsy
Ergogenic
Female athlete triad
Food jags
Gingival disease
Growth
Hematocrit
Hyperkinesis
Hyperphagia
Ketogenic diet
Mental retardation
Oligomenorrhea

Peptides
Periodontal disease
Purging
Sickle cell anemia
Spasticity
Tongue thrust
Transferrin saturation
Xerosis
Xerostomia

INTRODUCTION

Although the rapid growth that occurs prenatally and during infancy slows in childhood and only picks up in adolescence, developmental changes are rapid. From learning to walk to climbing trees, and from being totally dependent to growing into independence, the changes that take place from early childhood to adolescence are truly remarkable.

Nutrition plays a key role in this process. Breastfeeding may continue for the first few years. Some children need to rely on bottle use beyond the first year, although this is generally discouraged because of concerns about dental health and obesity. The texture of food changes as toddlers develop the full ability to chew. Peer pressure becomes more of a factor in food choices as childhood advances.

Eating disorders generally have their roots in childhood. These can range from physiologic issues of disliking the taste of some foods, as with picky eaters, to psychologic issues of eating disorders. Eating for reasons other than hunger can lead to bulimia and obesity. Negative family functioning may be part of the cause of an eating disorder or may result from attempts to deal with food issues. Involving families in the assessment and planning stages of nutrition intervention promotes their support of the plan. The school setting and the peer group also have an important impact on food choices.

This chapter reviews the nutritional needs and issues related to acceptance of a variety of foods from toddler age through adolescence. The needs of the young adult are reviewed in Chapter 13.

WHAT IS THE IMPACT OF NUTRITION FOR OPTIMAL GROWTH AND DEVELOPMENT?

GROWTH

Growth is the increase with age in weight and height, or size as it is popularly designated, that comes about as a result of the increased number of cells and their differentiation for various functions in the body. During fetal life and infancy the rate of growth is very rapid if there are adequate nutrients available. The same holds true in adolescence, whereas a slowing of growth is expected and natural during the early childhood years.

Bone growth is the growth that occurs in length and thickness of bones. Although there is a genetically defined potential for growth, without adequate nutrients the growth process will be stunted. Chronic long-term undernutrition generally results in stunted growth (Figure 12-1).

The adverse effect on growth with zinc deficiency has been known for over 40 years. Nutritional growth retardation refers to stunting of growth from lack of

FIGURE 12-1 Stunting is shown with Nigerian children, born in the same month in the same village, who have genetically similar parents. (Photo courtesy of Michael Latham, Division of Nutritional Sciences, Cornell University, Ithaca, NY, and David Morley, Institute of Child Health, London, England.)

nutrients required to achieve genetic growth potential. Poverty is a known factor contributing to nutritional growth retardation around the world (see Figure 12-1). This results from lack of protein and kcalories (kcalories or kcal) along with inadequate intake of the various vitamins and minerals, including zinc. There may be no clinical or laboratory evidence of malnutrition other than a deceleration in growth (Cole and Lifshitz, 2008). Health care professionals should assess a child's diet based on the MyPyramid food guide if nutritional growth retardation is suspected.

Clearly calcium and vitamin D are integral to the growth of bone. Calcium can come from a variety of sources. Traditional Asian cuisine includes regular intake of small whole fish. With the intake of fish bones and fish liver, both calcium and vitamin D needs can be met. Vitamin D–fortified milk is another source. Adult height was shown to be affected by milk consumption during childhood and adolescence (Wiley, 2005). Other factors found to affect children's bone mineral content include intakes through the younger years of protein, kcalories, vitamin K, and the minerals phosphorus and iron (Bounds and colleagues, 2005). These nutrients are found in milk, with the exception of iron.

It is appropriate for a child to have flavored milk as needed to encourage intake because this will promote growth and development and not obesity in recommended quantities (Murphy and colleagues, 2008). Parents from a variety of backgrounds (Asian, Hispanic, and non-Hispanic white) were found to lack expectations for their children to drink calcium-rich beverages with meals (Cluskey and colleagues, 2008). Thus the health care professional can help promote bone strength and growth by

FIGURE 12-2 *Right*, Infant with "sugar baby" kwashiorkor, attributed to a high-sugar, low-protein diet. The infant has stunted growth, edema of the feet and hands, fatty liver, moon face, and dyspigmentation of the skin and hair. *Left*, Normal infant. (From Jellife DB: Hypochromotrichia and malnutrition in Jamaican infants, *J Trop Pediatr* 1:25, 1995; by permission of Oxford University Press.)

relaying to parents of young children the benefits of drinking milk and can advise flavored milk as needed.

Severe malnutrition, which is characterized by clinical manifestations, is of two basic types: kwashiorkor, a protein deficiency (Figure 12-2), and marasmus, an overall deficit of food, especially kcalories (also known as protein-energy malnutrition [PEM]) (Figure 12-3). Kwashiorkor generally occurs at or after weaning, when milk high in protein is replaced by a starchy staple food that provides insufficient protein. A child with this type of malnutrition usually has stunted growth, edema, skin sores, and discoloration of dark hair to red or blond. Infantile marasmus is frequently the result of early cessation of breastfeeding, overdilution of formula, or gastrointestinal infection early in life, and it is accompanied by wasting of tissues and extreme growth retardation. Marasmus and kwashiorkor do occur in the United States but have been quite rare in recent years. However, with the current rise in food prices, including milk, and other costs such as gasoline, families with young children may be forced to cut back on nutritious foods for their children, with the potential to see increased incidence of kwashiorkor especially. Refer back to Chapter 2 for more discussion of kwashiorkor and marasmus.

DEVELOPMENT

Development refers to the increasing ability of body parts to function. For example, being able to use a knife and fork successfully is a fine motor skill that is age

FIGURE 12-3 Marasmus. (From Zitelli BJ, Davis HW: *Atlas of pediatric physical diagnosis,* ed 4, Philadelphia, Mosby, 2002.)

dependent. The development of cellular structures and the neurologic system is essential for body parts to communicate.

Nutrition is vital in the process of communication of brain cells for processing information and controlling actions. Adequate blood glucose is essential for mental performance, particularly for demanding, long-duration tasks. Malnourished children who include breakfast have increased mental performance and with increased intake of vitamins and minerals have shown improved intelligence scores. Children with poor school performance were less likely to eat foods high in protein, vitamins, and minerals while having a higher intake of sugar and fats (Fu and colleagues, 2007).

In the brain the nerve endings contain one of the highest concentrations of vitamin C in the human body. Vitamin E is directly involved in nervous membrane protection and is actively taken up the brain. Vitamin K is involved in nervous tissue function. Iron is needed for oxygen-related production of energy in the brain. The B vitamins and iodine provided by the thyroid hormone ensures the energy metabolism of brain cells (Bourre, 2006).

Every child has different nutrient requirements based on factors such as chronologic age, individual growth rate, stage of maturation, level of physical activity, and the efficiency of absorption and use of nutrients (Table 12-1). Guidelines such as Dietary Reference Intakes (DRIs) and the Dietary Guidelines give general indications of needed nutrients for growth. Among adolescents low bone mineral density, as related to osteoporosis, was associated with evidence of low vitamin B_{12} status. This

Table 12-1 Daily Macronutrient and Fluid Needs for Children

Calories	
≤10 kg	100 kcal/kg
10-20 kg	1000 kcal for first 10 kg + 50 kcal/kg > 10 kg
>20 kg	1500 kcal for first 20 kg + 20 kcal/kg > 20 kg
Protein	
≤ 6 months	2.2 g/kg
6-12 months	2.0 g/kg
1-10 years	1.8 declining to 0.8 g/kg
Fluids	
≤10 kg	100 mL/kg
11-20 kg	Additional 50 mL/kg > 10 kg
≥21 kg	Additional 25 mL/kg > 20 kg
≥16 years through childhood	40 mL/kg

was particularly evident among adolescents who were fed a macrobiotic diet during early childhood, which contributed to low vitamin B_{12} levels (Dhonukshe-Rutten and colleagues, 2005).

Growth charts are another important tool (see Appendix 12 on the Evolve website and discussion later). If the child's growth is appropriate, it can be generally assumed that nutritional intake is adequate. Health problems can lead to poor growth, even though an adequate diet is being consumed, because of altered use of nutrients. For example, among prepubertal and early pubertal boys, obesity appears to be associated with decreased bone strength in the lower extremities (Falk and colleagues, 2008).

Because the human is a social being, appropriate interaction is important for emotional growth and development. Food often serves as a social link, such as at mealtimes (see Figure 1-3). Children should eat as part of a family unit, ideally at the table. Eating with others can stimulate appetite and reinforce that eating is a pleasurable experience. Development of social skills around the table is an important life skill.

WHAT ARE NUTRITIONAL NEEDS OF CHILDREN?

Children need a variety of nutrients to support growth and development. Zinc and folic acid are crucial for growth to occur. A variety of vitamins and minerals are needed to support bone growth. The B vitamins and omega-3 fatty acids are essential for neurologic health. By following the guidelines of MyPyramid.gov with an emphasis on high-fiber plant-based foods, including whole grains, legumes, vegetables, fruits, and nuts, a good foundation of nutrient intake will occur. When milk (low-fat for over the age of 2 years) and other high-protein sources are included, all needed nutrients can be provided. See also Chapter 1 for the foundation of a healthy diet and the DRI table at the back of the book.

Role of Protein in Growth and Development

The major role of protein is to build and repair body tissues. Protein needs as based on body weight are the highest in infancy and slowly decline with age, although a slight increase occurs late in life (see Table 12-1 and Chapter 13). The total amount of protein is greater as weight and stature increase. Thus it may seem that a young child needs less protein than an adolescent, but based on grams of protein per pound, the child has a higher need. The Recommended Dietary Allowance (RDA) for protein reflects the total amount of protein required (see the back of the book). Various factors will affect individual protein needs. For example, the protein requirements of 14-year-old male athletes are above the RDA for nonactive male adolescents at 1.4 g/kg of body weight (Boisseau and colleagues, 2007).

Kilocalorie Needs

Consuming sufficient kcalories is important to ensure protein is used for its building purposes, rather than as a fuel source. Avoiding excess kcalories helps to prevent the development of obesity. Kcalorie needs have been determined for the various ages and weights (see Table 12-1 for younger children). Individual requirements may need to be modified from these general guidelines. For older children the following calculations approximate kcalorie needs:

- 80 kcal/kg of body weight for prepubescent children
- 45 kcal/kg of body weight for active adolescent males
- 38 kcal/kg of body weight for active adolescent females
- 30 kcal/kg of body weight for nonactive adolescents

Adolescent male athletes may require as many as 5000 kcal to maintain weight. With few exceptions, an adolescent male athlete should eat at least 2000 kcal/day, and a female athlete should eat at least 1700 to 1800 kcal/day.

Fluid Needs

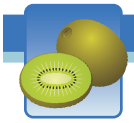
The Adequate Intake (AI) for fluids for children is about 2.5 L or more (see the back of the book). Individual calculations can be undertaken (see Table 12-1). A child who has constipation should be assessed for fluid intake as a possible cause. For athletic children the fluid needs are greater based on various factors such as air temperature and body size. Children involved in endurance sports should have their weight measured both before and after a prolonged training or even an athletic practice of short duration during hot weather. This will help determine fluid needs for individual children (see later section on athletics).

WHAT IS THE NUTRITIONAL STATUS OF U.S. CHILDREN?

In general the quality of the diet is appropriate in the United States to support growth and development of children. This is reflected in the height increase among children that has occurred beginning in the 1940s and the more recent rise in heights since the 1970s. There has been an average increase of about 1 inch between birth cohorts between 1971 and 2002 (Komlos and Breitfelder, 2008).

A study among preschoolers found that consumption of grains, fruits, and vegetables increased from 1977 to 1998, but added sugar and juice intake also increased

(Kranz, Siega-Riz, and Herring, 2004). Excess intake of sugar and juice can result in excess caloric intake, leading to obesity. It is anticipated that the recent downturn in the economy and the increase in food prices, fuel, and other costs of living will have an adverse impact on intake of fruits and vegetables and other low-processed food sources.



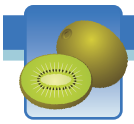
Cultural Considerations

Hispanic infants were found to intake approximately 50 mg less calcium (575 mg) and 175 mg more sodium (650 mg) than non-Hispanic children. Sodium intake was reversed for toddlers, with nearly 60% non-Hispanic toddlers exceeding the Upper Limit (UL) of safety, whereas closer to 50% of Hispanic toddlers exceeded the UL for sodium intake. For toddlers, most nutrient needs were met with the exception of vitamin E; almost two thirds of Hispanic toddlers met their needs, whereas only 50% of non-Hispanic toddlers did. In general Hispanic toddlers had higher average intakes of vitamins A, C, E, and folate; the mineral potassium; and fiber as compared with non-Hispanic toddlers. However, almost one half of toddlers exceeded the UL for vitamin A and zinc (Briefel and colleagues, 2006). Children of Latino immigrants who did not take supplements had normal plasma concentrations of vitamin C and selenium (Kim and colleagues, 2006). ■

One study found almost one half of toddlers consumed all meals and snacks at home, whereas another half ate at least one meal or snack away from home, and about 1 in 10 ate a meal or snack at day care. The fewest average kcalories at lunch were from home (about 280 kcal), whereas the most were at day care (about 330 kcal). However, lunches eaten at day care were significantly higher in nutrients from milk (calcium, phosphorus, magnesium, potassium, and vitamins B_2 and D) compared with those eaten at home or away. Meals eaten away from home were higher in average intake of trans fat, with French fries being the most frequently consumed item by over one third of toddlers. About 3% of toddlers consumed carbonated beverages at home whereas five times this amount did so away from home, and no carbonated beverages were consumed at day care. Snacks generally focused on water, milk, 100% juices such as apple juice or fruit-flavored drinks, crackers, and cookies (Ziegler and colleagues, 2006).

With the rise in childhood obesity, the intake of 100% fruit juice and sweetened fruit drinks is being considered a cause. However, on average, preschool children were found to drink less than 6 oz/day of 100% fruit juice. Other sweetened beverages were associated with an increase in the total kcalories, but this was not reflected in an increased body mass index (BMI). It may be that over time the increased kcalories from sweetened beverages contribute to obesity. It also has been found that, on average, preschool children drank less milk than the recommended amount of 16 oz/day. Less than 10% of children over 2 years of age drank low-fat or skim milk as recommended to reduce risk of adulthood cardiovascular disease (O'Connor, Yang, and Nicklas, 2006). According to the 1999-2002 data from the National Health and Nutrition Examination Survey (NHANES), only 2- to

3-year-olds met the MyPyramid recommendation for milk intake (Kranz, Lin, and Wagstaff, 2007).



Cultural Considerations

Higher rates of childhood and adolescent obesity in rural areas have been noted compared with urban and suburban populations (Dalbey, 2008). Higher rates also have been found in the Southeast and South Central regions of the United States at over 18% (Kentucky, North Carolina, Tennessee, Texas, and West Virginia). The Rocky Mountain areas had the least amount of obesity at about 10% in Utah (Singh, Kogan, and van Dyck, 2008). Among West Virginia adolescents, females were more concerned with weight than males. Issues of guilt, fear of developing chronic disease as observed among family members, and diminished self-esteem were prevalent. However, a general acceptance of obesity also was indicated with students stating "you just get used to [seeing] it" (Williams and colleagues, 2008). ■

There also can be nutritional problems from excess milk intake when it displaces other foods in the diet. A 4-year-old girl with brittle, dry hair leading to hair loss was found to be healthy based on laboratory testing, but her diet revealed a strong preference for milk. This led to the suspicion of zinc deficiency, and with supplementation of 50 mg daily, her hair loss stopped after 3 weeks, and her hair was normal by the fourth month of supplementation (Alhaj, Alhaj, and Alhaj, 2007). Children can develop milk anemia as well, with milk displacing foods high in iron.

There are children who do not meet their nutritional needs for optimal growth and development. Among preschoolers in nine child-care centers in central Texas, 3-year-old children were found to have adequate intake of fruits and meat or alternatives but did not meet the goal of two thirds of the recommended servings for grains, vegetables, and dairy. Intakes at home did not compensate for lack of grain and vegetable consumption during child care (Padget and Briley, 2005).

One study of 3-year-olds found that snack foods, desserts, and pizza contribute approximately one third of total daily kcalorie intake (Van Horn and colleagues, 2005). Many preschoolers do not meet the goal for fiber of "age plus 5," and most lacked the 14 g/1000 kcal of energy consumed (Kranz and colleagues, 2005).

With low intake of vegetables and whole grains, a variety of vitamin and mineral needs may not be met. These include folate, zinc, and magnesium, which are vital for optimal growth and development. Children who eat nuts have improved intake of these minerals along with protein, fiber, vitamins A and E, and the minerals calcium and iron. No excess weight gain has been attributed to eating nuts. This is felt to be due to increased satiety from eating nuts, resulting in reduced intake of other kcalorie sources.

A significant number of young children use vitamin supplements. Excess intake may result. For apparently healthy children it is recommended to base guidance on use of supplements on dietary habits to avoid inadequate or excess intake (Eichenberger Gilmore and colleagues, 2005). Health care professionals should educate caregivers of infants and toddlers about the importance of foods and promotion of lifelong eating habits for short-term growth and development and lifelong health rather than focusing on just nutrients (Fox and colleagues, 2006).

Fact & Fallacy

FALLACY All children should take a multivitamin and mineral supplement.

FACT Although commercial vitamin and mineral supplements contain much of what is needed for good health, food contains even more, such as protein and phytochemicals. There are some exceptions such as the need to provide vitamin D to young infants. Generally a balanced diet consisting of a variety of foods is more likely than a vitamin preparation to supply all the necessary nutrients for growth and repair. In addition to being unnecessary most of the time (and therefore a waste of money), excess vitamin intake can be fatal. If a parent feels safer giving vitamins, he or she should make sure that the content does not exceed 100% of the Recommended Dietary Allowance (RDA). ■

HOW IS NUTRITIONAL STATUS OF CHILDREN ASSESSED WITH GROWTH CHARTS?

Percentiles are used to compare a child's growth with other children of the same age and gender to reflect the changes in children's sizes. For example, if 100 children have their weight determined, and if a child's weight falls in the 5th percentile, it means that only five children in that group are of a lesser weight, and the others are of a higher weight. Or, for a child who is in the 50th percentile, there are as many children who are bigger as are smaller. Percentiles are based on a given population. Because children are taller and consequently heavier than previous generations, the growth charts have been updated to reflect these standards (see Appendix 12 on the Evolve website).

The BMI for children is still the same mathematic calculation as used for adults (refer to Chapter 6). However, for children the calculated BMI number is then put onto an age-based growth chart to assess the percentile number. The BMI percentile is used to assess a child's level of adiposity. The website of the Centers for Disease Control and Prevention (CDC) provides a multipage chart to determine BMI for young children (see Appendix 1 on the Evolve website for the website address).

If children have a BMI over the 85th percentile, they are considered overweight. A high BMI indicates the child is consuming too many kcalories for his or her individual needs. One concern with this is the increased likelihood that these children will become overweight adults. In the Bogalusa Heart study, overweight 2- to 5-year-olds were over four times as likely to become overweight adults as children with a BMI under the 50th percentile (Freedman and colleagues, 2005). On the other hand, children with a BMI under the 25th percentile may be having inadequate kcalorie intake, which can lead to stunted bone growth.

Length (lying in a recumbent position) or height (a measurement when the child is standing) is assessed by age. A child who is under the 10th percentile in height or length is assumed to have inadequate nutritional intake or a medical problem interfering with use of food nutrients to support growth. This is particularly true if a child or adolescent's growth "falls off the curve" (Figure 12-4). A child who is not growing in height to allow "following the curve" should be assessed by a registered dietitian for possible nutrient inadequacies.

Bone growth is the best barometer of nutritional status. If height growth is adequate, as indicated by following or exceeding the height percentile curve, it can be assumed that the child is meeting nutrient needs for growth and development.

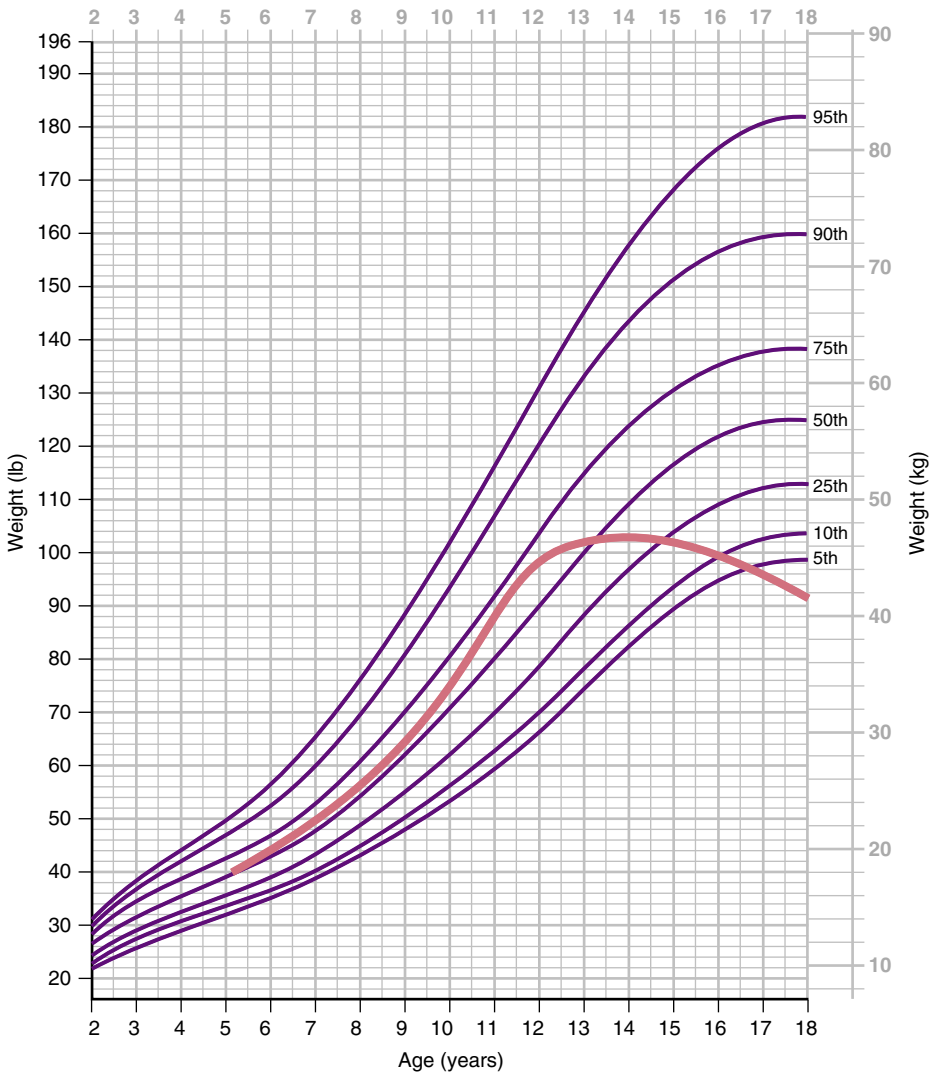


FIGURE 12-4 Sample growth fall from normal curve as assessed using the weight-for-age chart for girls 2 to 18 years of age.

WHAT ARE FEEDING MANAGEMENT CONCERNS FOR CHILDREN?

IMPORTANT CONSIDERATIONS IN FEEDING THE TODDLER AND PRESCHOOL-AGE CHILD (1 TO 5 YEARS OLD)

The continuation of healthy eating into young childhood is enhanced through positive eating experiences and exposure to a wide variety of foods by the end of the first year of life (see Chapter 11 for infant feeding guidelines). Toddlers can become difficult at mealtimes because of issues of independence. Choice is always useful, from the toddler stage through the elder years. The use of structured choices with meal choices works well with toddlers. For example, the parent or caretaker might

ask, "Would you like carrots or cantaloupe for lunch today?" This affords the toddler a feeling of independence while still encouraging the child to include adequate vitamin A intake. If the child resists the choices offered and asks for something else, the caretaker can reply, "No, that is not the choice. Would you like the carrots cut into strips or cooked, or do you want to help make melon balls with the cantaloupe?" Having children take their own portion from a serving dish further helps develop a sense of autonomy and interest in eating a variety of foods. The one-taste rule is also helpful, especially when it is explained that learning to like new foods takes time. Focus on the positive: "Try just one taste, and if you like it you can have more." Helping toddlers and preschoolers to have positive experiences with eating will help maintain good eating habits through their later years.

It also is important that parents or other caretakers use common sense and follow the MyPryamid food guidelines. One case study of scurvy (refer back to Chapter 3), which is extremely rare in modern times, was found with an otherwise apparently healthy 2-year-old white girl. Symptoms that brought her for medical assessment included refusal to walk because of leg pain, irritability, sleep disturbance, and malaise. Physical examination revealed pale, bloated skin with swollen gums and loosening of a few of her teeth. Dermatologic findings included **xerosis** (abnormal dryness of eyes or mouth) and multiple scattered **ecchymoses** (discoloration of the skin similar to a bruise due to hemorrhage). This was due to adherence to an organic diet recommended by the Church of Scientology that included a boiled mixture of organic whole milk, barley, and corn syrup with no fruits and vegetables (Burk and Molodow, 2007).

It is paramount that families and caretakers provide vegetables and fruits and work to help make them fun and appealing to eat. This might include breaking fresh broccoli into tiny little "trees" or combining colors such as sliced kiwi and mandarin oranges at the same meal for good visual appeal. Spinach-topped pizza flavored with pesto (an Italian sauce made with olive oil and basil, which can easily be purchased commercially) is particularly appealing to young children when it is called "Popeye Pizza" and they sing the Popeye song:

I'm Popeye the sailor man,
I'm Popeye the sailor man,
I'm strong to the finish,
'Cause I eat my spinach,
I'm Popeye the sailor man,
Toot, Toot!

Teaching Pearl

One woman captured the idea of positive values associated with vegetables. When someone commented on the wide variety of vegetables her children liked, her reply was, "Do you know how I did it? Whenever I offered a reward I would say, 'If you are good you can have a vegetable!' " Rewarding with food is not recommended, especially because candy is often the reward of choice. Rewarding with vegetables in this scenario, however, allowed the children to develop a strong appreciation for a healthy food group. ■

Table 12-2 Age-Related Childhood Food Guidelines

AGE (YEARS)	SUGGESTIONS
1 to 2	Provide plain, simple finger foods; avoid foods that are choking hazards or cut into very small pieces, and use foods that may be swallowed safely. Place small amounts on the plate (about 1 tbsp of each food for each year of child's age). Provide cups that do not tip easily and have handles, large-handled silverware, and plates with edges (for pushing food against); show toddlers by example how to use utensils, and provide foods that are easy to manage with utensils. Trust child's hunger cues because appetite can vary from day to day.
2 to 3	Encourage the "one-taste" rule to expose children to new foods but do not force child to eat. Make mealtimes pleasant and enjoyable. Offer structured food choices to allow for a growing sense of independence. Recognize that food jags (eating the same food day after day) are common at this age and beyond. Continue to increase the variety of foods offered but with continued attention to avoidance of choking hazards.
3 to 5	Begin to include the child in food shopping (the young child can recognize numbers on food labels; give guidelines such as cereals with no more than 6 g of sugar per serving). Include the child in simple cooking techniques such as stirring and pouring. Avoid using food as a bribe or as a reward. Continue to increase the variety of foods offered but with continued attention to choking hazards.
5 to 10	Continue to provide breakfast, which is especially important for better school performance. Help the child categorize foods into groups of the MyPyramid. Be sensitive to the effects of food advertising; help the child understand that many foods advertised are high in fat and sugar.
10 to 18	Recognize that increased body fat often precedes puberty. Be sensitive to the influence of friends on food and beverage choices. Provide information on healthy food choices at fast-food restaurants and for snacks. Help the child find time to eat breakfast and to eat around sports and school events.

One goal for young children is the "age plus 5" goal for fiber intake. In other words, for a 2-year-old toddler, the goal would be 7 g of fiber per day. Achieving this goal will help with bowel management, but more importantly will help with growth and development. As reviewed in Chapters 2 and 3, fiber-based foods are high in a variety of vitamins and minerals necessary to support health in young children.

As children grow, their eating habits change. The attraction to sweet and the rejection of bitter and sour tastes become more pronounced until there is a decreased taste perception in adulthood. Exposure to a variety of foods helps the child develop a preference for a variety of flavors. This process begins in utero via the amniotic fluid (Nicklaus, Boggio, and Issanchou, 2005b). Exposing the toddler and young child to a variety of vegetables can help develop acceptance into older ages.

Among toddlers and preschoolers, simple foods are favorites (Table 12-2 and Figure 12-5). Mixed foods are generally unpopular with this age-group. Differences in food textures interest children. Each meal might include something soft (such as

FIGURE 12-5 Pasta is a favorite dish of young children.

Box 12-1 Suggested Snacks and Finger Foods

FRUITS	VEGETABLES	MEATS AND MEAT SUBSTITUTES
Apple wedges	Cabbage wedges	Cheese cube
Banana slices	Carrot sticks	Cooked meat cubes
Berries	Cauliflower florets	Hard-cooked eggs
Dried apples	Celery sticks*	Small sandwiches (quartered)
Dried apricots	Cherry tomatoes (sliced)	Toast fingers with peanut butter
Dried peaches	Cucumber slices	Whole-grain crackers with cheese
Dried pears	Green pepper sticks	
Fresh peach wedges	Tomato wedges	
Fresh pear wedges	Turnip sticks	
Fresh pineapple sticks	Zucchini or summer squash strips	
Grapefruit sections (seeded)		
Grapes		
Melon cubes or balls		
Orange sections (seeded)		
Pitted plums		
Pitted prunes		
Raisins		
Tangerine sections		

From U.S. Department of Agriculture: *A planning guide for food service in child care centers,* FNS-64, Washington, DC, Food and Nutrition Service.
*May be stuffed with cheese or peanut butter.

macaroni and cheese), something chewy or crunchy (such as pineapple chunks and thinly cut carrot sticks), and something dry (such as peas). Small portions of a variety of foods at a meal can enhance satiety—the recognition of hunger being satisfied.

Snacks should be planned to enhance the nutritional value of the diet (Box 12-1) while decreasing risk for dental caries (Box 12-2). Snacks should be served at least 1

Box 12-2 Good Snack Foods for Dental Health

Carrot and celery sticks
Zucchini "matchsticks"
Radishes
Green and red pepper rings
Cucumber slices
Peanuts and other nuts (for children over 3 years, to avoid choking)
Cheese, regular in moderation or low-fat varieties
Hard-cooked egg, with or without the yolk (for cholesterol control)
Grain products (crackers, toast, bagels) with peanut butter or cheese
Apple wedges with peanut butter
Milk or yogurt

hour before meals, but ideally 2 to 3 hours in order to allow sufficient appetite for foods served at mealtime. However, a compromise may be needed if the child is very hungry. A premeal snack before dinner can be considered an appetizer. Good choices for premeal snacks include a dish of peaches and/or yogurt, both nutritious for the young child and easily digested.

The child should be equipped with eating utensils and dishes that are easy to handle. The child should be offered only small amounts of food at a time. By eating at the table with the family, children are likely to develop an interest in food that mirrors that of their parents. Toddlers can help serve themselves with foods that do not require utensils. By the age of 3 or 4 years, the child will be able to dish food onto a plate if smaller serving dishes and utensils are used. This further helps the child develop a sense of mastery over eating.

When compared with the growth spurt in infancy, the toddler and the preschool-age child experience a slowing rate of growth and development. A decrease in the consumption of food generally parallels this decrease in metabolic rate. A parent should not become alarmed if the following changes in eating behavior occur; rather, these changes are considered normal for the preschool child:

- Wanting foods plain, with no sauces and not mixed together
- Varying interest and lack of interest in food, with appetites that go up and down
- **Food jags**—eating only a few foods day after day or week after week until the next food jag starts

Keeping a record of food portions may help to allay parents' fears that their child is not eating enough. Being able to see the whole day or a whole week very often makes it apparent that the child is eating the recommended food servings to support growth and development. Recommended amounts of foods for toddlers and preschoolers can be found in Table 12-3. This knowledge, in addition to a comparison of the child's growth with a growth chart, can help calm parents' fears of nutritional inadequacy. A healthy appearance and high levels of energy in children provide further evidence of good nutritional status (Figure 12-6).

If the child's diet does appear to be lacking in a food group such that growth is affected, offering previously disliked foods with favorite foods can help. Getting children to accept new foods can take time and patience. A child may need to be

Table 12-3 Pattern of Feeding for Toddlers and Preschool-Age Children

MEAL	CHILDREN 1 TO 3 YEARS	CHILDREN 3 TO 6 YEARS
Breakfast		
Milk, fluid[a]	½ c	¾ c
Juice or fruit	¼ c	½ c
Cereal or bread, enriched or whole-grain[b]	¼ c[c]	⅓ c[d]
	½ slice	½ slice
Midmorning or Midafternoon Supplement		
Milk, fluid[a], or juice or fruit or vegetable	½ c	½ c
Bread or cereal, enriched or whole-grain[b]	½ slice	½ slice
	¼ c	⅓ c[d]
Lunch or Dinner		
Milk, fluid[a]	½ c	¾ c
Meat or meat alternate[e]		
Meat poultry, or fish, cooked[f]	1 oz	1½ oz
Cheese	1 oz	1½ oz
Egg	1	1
Cooked dry beans and peas	⅛ c	¼ c
Peanut butter	1 tbsp	2 tbsp
Vegetables and fruits[g]	¼ c	½ c
Bread, enriched or whole-grain[b]	½ slice	½ slice

From U.S. Department of Agriculture: *A planning guide for food service in child care centers,* FNS-64, Washington, DC, Food and Nutrition Service.
[a]Includes whole milk, low-fat milk, skim milk, cultured buttermilk, or flavored milk made from these types of fluid milk, which meet state and local standards.
[b]Or an equivalent serving of an acceptable bread product made of enriched or whole-grain meal or flour.
[c]¼ c (volume) or ⅓ oz (weight), whichever is less.
[d]⅓ c (volume) or ½ oz (weight), whichever is less.
[e]Or an equivalent quantity of any combination of foods listed under meat and meat alternates.
[f]Cooked lean meat without bone.
[g]Must include at least two kinds.

exposed to the food on several occasions before deciding that it is worth eating. Seeing the food in the grocery store or being prepared in the kitchen and having a small portion served on the plate all help to decrease the fear of eating new foods. The use of choice also helps.

Modeling good food habits is also beneficial. One study found that mothers who consumed more fruits and vegetables were less likely to pressure their daughters to eat and had daughters who were less picky and consumed more fruits and vegetables. It is advised that parents focus less on "picky eating" and more on modeling fruit and vegetable consumption for their children (Galloway and colleagues, 2005).

Picky eating can be related to food textures. Children with tactile defensiveness generally have a fair to poor appetite. They may hesitate to eat unfamiliar foods, may not eat at other people's houses, or may refuse to eat some foods because of smell and temperature. These children may gag when eating. However, it is felt that tactile or oral defensiveness can be treated with a team approach of health professionals (Smith and colleagues, 2005). Attempting to force a picky child to eat can

FIGURE 12-6 Healthy children love to play.

backfire. An authoritarian feeding style was found to negatively affect children's vegetable intake (Patrick and colleagues, 2005).

Fact & Fallacy

FALLACY Once a picky eater, always a picky eater!

FACT It takes time for food preferences to develop. Children do not like many foods when they first try them, but with repeated exposure in a positive environment, even the most finicky eaters can learn to appreciate a wide variety of foods. Children should be encouraged to have one taste of all foods served, but beyond that, forcing or begging a child to eat has no place in the development of long-term food preferences. It may be helpful for the anxious parent to follow the advice of Ellyn Satter, registered dietitian, social worker, and author of *How to Get Your Kid to Eat, but Not Too Much,* who asserts that it is the parent's responsibility to offer nutritious foods in a positive meal setting, but that it is the child's responsibility to determine how much and what he or she eats. Children seem to eat better if they perceive they are eating because it makes them feel good and not simply to please their parents. It should be remembered, however, that it is common for a child to need at least 10 tries of a new food before it becomes a well-liked food. ■

The self-fulfilling prophecy should be recalled when parents are encouraging their children to try new foods. The focus should be on the positive. For example, it is better to say, "Now that you are older, you may find you like spinach and want

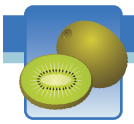
more." Focusing on the negative discourages acceptance; that is, avoid saying, "If you don't like it, you don't have to eat it."

A Growing Sense of Independence Among Preschoolers

A growing sense of independence occurs naturally in preschoolers. Parents will be well advised to offer the preschooler structured choices to allow for a sense of independence. This applies to food and to other daily activities (for example, "Are you going to put on your shoes, or am I?"). Recognition of this facet of the growing child can foster positive parent-child interaction and healthy food selection. A structured food choice at the dinner table might be, "Would you like apple slices or a banana for dessert?" A structured food choice at the supermarket might be to allow the child a choice of any cereal with 6 g (1½ tsp) or less of sugar; an additional guideline of 2 g or more of fiber will help meet the need for whole grains in the diet.

Developing Sound Food Values

The manner in which food is offered is fundamental to the development of interest in a variety of nutritious foods. If you reflect for a moment on the types of holiday foods promoted, such as chocolate on Valentine's Day and candy at Halloween, you will quickly realize the value our society places on food. However, it is possible to promote nutritious foods. Kiwi fruit might be offered in Easter baskets and dried fruit offered at Halloween. As described previously, one of the best methods to promote positive food habits in children is observation of parental intake. A consistent marker for infants at risk for poor diet quality is having a mother who skipped breakfast and omitted fruits, vegetables, or dairy products (Lee, Hoerr, and Schiffman, 2005).



Cultural Considerations

In Mexican-American families there is a desire among parents to provide foods to their children that they did not have growing up. Furthermore, families delayed meals until the children were hungry. However, child-led snacking was common every 30 to 60 minutes, such that there was no appetite for traditional Mexican foods. Parents were found to commonly offer other foods when children refused to eat. Thus, with good intentions, Mexican-American families may discourage maintenance of traditional eating habits (Kaiser and colleagues, 1999). ■

Fact & Fallacy

FALLACY Once a sweet tooth, always a sweet tooth.

FACT Children whose diets are continually high in sugar can lose the ability to appreciate the natural sweetness of foods such as fruit and some vegetables. As with salt and other substances, the taste for sweetness can be enhanced or diminished. Gradual reduction in quantities of sugar-based foods is the easiest and surest way to overcome a sweet tooth. ■

Coping With Food Advertisements

Because many television or written advertisements promote foods that are not very nutritious (when was the last time you saw an ad for broccoli?), children need to be empowered to resist the negative messages. One approach is to divide food into two categories: foods that help you grow and those that do not, or foods that make you grow tall versus those that make you grow wide. This approach can help the child appreciate that the adult is being helpful by providing nutritious foods that are not advertised on television. Most children aspire to grow tall.

Working Parents

Two parents working or single mothers working can put added stress on mealtime. Finding time to prepare meals and to offer them in a relaxed, positive manner can be a challenge. Quick meal ideas for the working family may be helpful. Examples include a meal of scrambled eggs, whole-grain toast, baby carrots, and milk, or a meal might consist of bean and cheese burritos using either commercial or homemade refried beans rolled into warmed flour tortillas and served with fresh fruit and a beverage of choice.

IMPORTANT CONSIDERATIONS IN FEEDING THE SCHOOL-AGE CHILD (5 TO 11 YEARS OLD)

Meeting the nutritional requirements of the 5- to 11-year-old child takes larger amounts of the same foods needed by the preschool-age child. Growth during prepuberty is expected to be slow and steady, with gradual increases in height and weight.

With the introduction of school into the child's daily routine, the child's meal pattern is likely to change. However, with a good foundation of food exposure before the age of 4 years, the older child is more likely to accept a variety of foods (Nicklaus and colleagues, 2005a). The child may have to eat breakfast earlier to allow sufficient time to get to school or plan on eating a school breakfast. A piece of fruit might be consumed while waiting for the school bus or while riding in the car to school. Children who skip breakfast are less well fed because it is difficult to make up missed nutrients at other meals. Without breakfast, learning at school is impaired. This is the basis of the school breakfast program (see Chapter 14). If the family has good breakfast habits, the child will likely continue this practice. The child may be taught to prepare a simple but nutritious breakfast. Parents should eat breakfast with their children; even setting aside 5 minutes for eating a quick bowl of whole-grain cereal is helpful. The importance of eating with the family continues with other meals.

At school the child is introduced to group feeding. Peers and teachers may influence eating behavior, and the child may be more or less willing to try an unfamiliar food, depending on the eating behavior of others in the group.

Whether the child brings a lunch prepared at home or buys lunch from the National School Lunch Program, lunch should supply approximately one third of the DRI for all nutrients (see the back of the book). Nutrition education may occur at school through such means as cooking and identifying foods. Ideally, this food exposure at school should positively promote sound food choices without labeling foods as good or bad.

Caffeine intake may be a problem for children. The recommended UL is 45 mg/day for children (Knight and colleagues, 2004). Other than coffee and tea, a variety of soft drinks, hot chocolate, and chocolate candy contain caffeine or an equivalent stimulant. For a child with poor sleeping habits or irritability, intake of caffeine should be assessed.

HOW DO THE CHANGES OF ADOLESCENCE AFFECT EATING PATTERNS AND NUTRITIONAL NEEDS?

During the rapid growth period of adolescence, kcalorie and nutrient needs are higher to provide for increases in bone density, muscle mass, and blood volume and for the developing endocrine system. There is an increased need for kcalories, calcium, iron, and iodine (see the back of the book).

Girls especially tend to increase their amount of body fat just before puberty and their growth spurt (the time of increased long-bone growth). Eventually boys catch up to the girls, with increased muscle mass and long-bone growth.

Some adolescents try weight control diets either to lose baby fat or to regain a sense of control over their rapidly changing bodies. This can result in conditions such as anorexia and bulimia. Others ignore sound nutritional practices (for example, by eating potato chips in place of fruits or by drinking soft drinks in place of milk) to feel accepted among their peers. The need for a sense of self-worth and of identity can take priority over good nutritional practices.

Other barriers to good nutritional intake that adolescents encounter include the following:

- *Society's emphasis on slimness:* Clothes sold today go as low as size 0. Young women may still aspire to the 19-inch waists once common among nineteenth-century women, who achieved their hourglass figures by wearing tight-laced corsets and commonly fainted from the inability to breathe. Because twenty-first-century women are taller and proportionally larger than their earlier counterparts, good nutrition can suffer in the quest to achieve this unrealistic image.
- *Access to jobs and spending money:* Having money allows the adolescent greater freedom in purchasing food, and having a job restricts the time to eat; teenagers often dash to part-time work directly from school. Fast-food outlets are a common lure for this population. Adolescents' sense of immortality can overshadow their knowledge of the importance of good nutrition, which can result in a decreased intake of wholesome foods. Because eating habits can become entrenched, it may be difficult to alter negative eating habits in adulthood when the need becomes more apparent.
- *Sports:* After-school sports, although a positive influence on teens' physical and mental health, can make it difficult for a student to eat appropriately. Dinnertime with family is often usurped by practice or game times. Limited mealtime promotes reliance on processed foods, which often are high in fat and sugar. Safe portable foods can be packed by the teen, such as a peanut butter sandwich and banana or dried apricots and nuts with bottled water or juice as a beverage. Milk intake can be promoted at other meals and as a bedtime snack in the form of yogurt or a bowl of cereal with milk. Other adverse effects of athletics on nutritional status can also occur, such as dieting to meet weight goals for wrestling.

- *More time spent away from home:* Adolescents are increasingly in a position to determine what or if they eat. This freedom, coupled with adolescent rebellion, can result in their consuming the opposite of what they know they should. If this is a problem for the adolescent's health needs, problem solving with the teen should be emphasized. Just as young children better accept and practice desired behaviors when they are given choices, so do persons of all ages.
- *Alcohol as a rite of passage:* Alcohol increasingly becomes an issue for teenagers. Television advertising can lure them into thinking that alcohol, such as beer, brings with it fun and glamour. Alcohol use can make teenagers feel more adult and independent. Many teenagers regularly drink beer and wine, and alcoholism can occur. Alcohol can seriously impair the final stages of growth and development by replacing foods or more nutritious beverages such as milk and juice. The sense of immortality in adolescence can contribute to motor vehicle accidents and alcohol poisoning from excess intake.
- *Caffeine as a drug of choice:* A seemingly innocuous source of caffeine increasingly being consumed among adolescents is energy/sports drinks. These drinks generally contain as much as 80 to 300 mg of caffeine and 35 g of sugar per 8-oz serving. Commonly reported adverse effects seen with caffeine in the quantities present in most energy drinks are insomnia, nervousness, headache, and rapid heart rate. Four documented case reports of caffeine-associated death were found, as well as four separate cases of seizures related to energy drinks (Clauson and colleagues, 2008). Seizure activity was found to cease with avoidance of energy drinks. Other factors that may contribute to seizure activity with energy drinks, besides caffeine, include the commonly found ingredients taurine and guarana seed extract (Iyadurai and Chung, 2007). Caffeine acts on the central nervous system. Its main effects are as a stimulant to the respiratory, muscular, and cardiovascular systems. Acute or chronic consumption of caffeine can induce several adverse effects, including intoxication that can be lethal (Pardo Lozano and colleagues, 2007). Intake of 300 mg caffeine has been found to significantly increase systolic and diastolic blood pressures. Large doses of caffeine increases nitric oxide production, which affects endothelial function (Umemura and colleagues, 2006).

WHAT ARE COMMON NUTRITIONAL ISSUES OF CHILDREN AND ADOLESCENTS?

There are a variety of issues that may occur, some commonly found, some rarely. The following sections in alphabetical order discuss some of the more common conditions found in children and adolescents.

ALLERGIES

Environmental allergies have historically received the most attention. Increasingly the impact of food allergies is being recognized. Prevalence of reported food hypersensititivy along with an actual medical diagnosis of food allergy is about 3% at 1 year of age and over 7% at 8 years of age. With age, allergic reactions to milk, egg, fish, and wheat have been found to decrease, whereas there is an increased prevalence for allergies to peanuts and tree nuts. Food allergies at a younger age to egg, peanuts, or tree nuts increase risk of food allergies at older ages, along with increased

risk for asthma, eczema, and allergic rhinitis at 8 years of age (Ostblom and colleagues, 2008).

The increase in peanut allergy among school-age children has altered the meal environment in schools. Some schools ban all peanut products. However, with careful adherence to food safety guidelines and education of staff and students, such a severe policy may not be necessary. See more on food and peanut allergies in Chapter 4.

Atopic dermatitis is a chronic, itchy, inflammatory skin disease affecting over 1 in 10 children. A defective skin barrier and increased intestinal permeability appear to facilitate allergen sensitization. Appropriate skin care to maintain skin barrier function and avoidance of highly allergenic foods during infancy may help reduce the severity of atopic dermatitis (Hauk, 2008).

Parents of children who are restricting their diet because of suspected food allergies need to consult with a registered dietitian to ensure adequate nutritional intake is being obtained. See Chapter 4 for more information on food allergies.

ANEMIA AND IRON DEFICIENCY

In the U.S. National Health and Nutrition Examination Survey III, the prevalence of iron deficiency (which was not always actual anemia) ranged from 6% to 18% in some groups of toddlers. Anemia is a condition in which there is reduced delivery of oxygen to the tissues. Although iron deficiency remains common in the United States, most cases of anemia in toddlers are not from iron deficiency. The current detection strategy using hemoglobin as the indicator of anemia can result in false-positive and false-negative results (White, 2005). Controversy exists regarding the blood levels that constitute iron deficiency anemia. Generally, hemoglobin values greater than 12 g/dL and **hematocrit** (the amount of packed red blood cells) values greater than 37% are considered normal. Hemoglobin readings of less than 11 g/dL and hematocrit readings of less than 33% should be evaluated further, and complete blood counts will often show low **transferrin saturation** levels (transferrin is an important part of red blood cell formation). Hemoglobin values of less than 10 g/dL (roughly equal to a hematocrit value of less than 30%) are signs of iron deficiency anemia and require immediate medical attention with iron supplementation.

Young children and adolescents are particularly susceptible to iron deficiency anemia because of the rapid use of iron during growth and the love of foods that are generally low in iron (see Figure 12-5). Other reasons include blood loss caused by parasites among young children who do not practice good hand washing. Adolescent girls are at an increased risk for anemia because of the start of menstruation, the rapid growth of adolescence, and insufficient iron in their diets.

With regard to diet, children often find eating meat difficult. This may be because the meat is too tough from being overcooked (meat cooked at low temperatures using moist methods, such as the meat cooked in stews, is more tender); because they have not acquired a taste for meat (such as with liver); or because the family avoids meat for economic, religious, moral, or other reasons.

Aside from increased meat intake, other foods high in iron should be eaten freely. As noted in Chapter 3, the iron found in meat, or heme iron, is well absorbed, whereas iron from other food sources (nonheme iron) needs to be eaten with a vitamin C–containing food to enhance absorption. For example, iron-fortified cereal

Box 12-3 Home-Packed School Lunch Ideas

Choose one food or a combination of foods from each group to meet one third of the Recommended Dietary Allowance (RDA).

VITAMIN A (½ c OR EQUIVALENT)
Apricot or apricot nectar
Broccoli (raw florets)*
Cantaloupe*
Carrot sticks or juice
Peaches
Spinach (raw for a salad)*
Sweet potato (as in pudding)
Tomato slices, juice, or soup*
Watermelon (½ slice)*

VITAMIN C (½ c OR EQUIVALENT)
Cabbage (for coleslaw)
Cauliflower (raw florets)
Grapefruit or juice
Orange or juice
Strawberries
Tangelo or juice
Tangerine or juice

PROTEIN (1 oz OR ¼ c OR EQUIVALENT)
Any meat, chicken, or fish
Peanut butter (2 tbsp)
Egg (hard cooked or egg salad)
Cottage cheese
Hard cheese
(Meat and peanut butter are also high in iron and B vitamins)

CALCIUM (1 c OR EQUIVALENT)
Milk
Yogurt
Hard cheese (1½ oz)
Cream soup
(These foods are also high in protein and vitamins D and B_2)

Other foods are important, for example, whole-grain or enriched white-flour products such as muffins, graham crackers, bread, noodles, rice, or pasta and other foods, for variety and to contribute other essential nutrients.
*Also contributes one third of the RDA for vitamin C.

followed by a glass of orange juice or other food high in vitamin C will greatly enhance the absorption of iron (see Chapter 3 for other iron sources and Box 12-3 for suggested vitamin C–containing foods that can be packed for school lunches).

In **sickle cell anemia** the red blood cells are sickle shaped. The disease has a genetic predisposition, occurring mainly in persons of African or Mediterranean heritage. It is now believed that historically persons with the sickle cell trait were protected against malaria. This form of anemia is not caused by dietary deficiencies;

however, diet has health implications. Because of the rapid turnover of blood cells, increased folic acid intake is beneficial.

ASTHMA

The inflammatory condition **asthma** is increasing in prevalence. Although the cause is not fully known, there are some nutritional implications. Mild zinc deficiency worsens lung function. In a study of mice, the reduction of inflammatory cells by zinc in the airways provides further evidence for zinc supplementation trials in asthmatic individuals (Lang and colleagues, 2007).

Elevated levels of linolenic and arachidonic fatty acids in children with asthma have been observed. However, modifying the ratio with omega-3 fatty acids has not shown benefit. (Bolte and colleagues, 2006). Infants' regular intake of fruit or vegetables appears to decrease the risk of asthma after 1 year of age (Nja and colleagues, 2005). This may be related to antioxidant vitamins and minerals found in fruits and vegetables. Levels of antioxidant vitamins C, E, and beta-carotene were found to be significantly lower in children with asthma. The amino acids glycine and glutamine also were significantly lower in children with asthma (Sackesen and colleagues, 2008).

A possible causal agent of asthma is food allergies. Six common food allergens (egg, milk, soy, peanut, wheat, and fish) have been implicated. Food allergen sensitivity may be a marker for increased asthma severity (Wang, Visness, and Sampson, 2005).

For children with asthma, magnesium supplementation (200 mg up to age 7; 290 mg over 7 years of age) is recommended concomitantly with asthma medications and has shown an ability to reduce need for bronchodilator use (Bede and colleagues, 2003). In a severe asthma episode, intravenous magnesium sulfate improves lung function and may reduce the need for hospitalization (Rowe and Camargo, 2008).

ATTENTION-DEFICIT/HYPERACTIVITY DISORDER

Attention-deficit/hyperactivity disorder (ADHD) is an official term sanctioned by the American Psychiatric Association. The term attention deficit disorder (ADD) is an older, but still used, term for the same condition. This disorder relates to a child's inability to pay attention, to problem solve, and to sustain effort along with hyperactivity. It is the most common cognitive and behavioral disorder diagnosed among school children, estimated to affect 5% to 10% of children, that can last into adulthood. There is an increased prevalence among other members of the family, indicating a genetic predisposition although an environmental component also is believed related (Banerjee, Middleton, and Faraone, 2007).

Altered metabolism may be a genetic connection. Despite intake of essential fatty acids, adolescents with ADHD continue to display abnormal red blood cell levels of fatty acids. Further research may help establish the benefit of omega-3 supplements with ADHD (Colter, Cutler, and Meckling, 2008).

Many dietary theories have evolved over the years. It is widely believed that sugar and food additives cause hyperactivity among children, although research has shown this to be generally false. Part of the public's confusion with the belief that sugar causes hyperactivity is that the consumption of sweets often coincides with stimulating activities such as school recess, birthday parties, or holidays (at which

time the activity or excitement, and not the sugar, causes excess activity). Many families and teaching personnel may limit intake of sugar-based foods among children with ADHD in a belief that it is a causal factor. This may lead to negative dynamics between the child and adult caretakers or parents that can lead to disordered eating by the child with ADHD. Families and caregivers of ADHD children may need to be reminded of the adage "cause no harm" when it comes to restricting foods in the child's diet.

There is newer research with nutritional implications. In ADHD children, magnesium was found to be moderately decreased in plasma and erythrocytes (red blood cells); also reduced is the level of a magnesium-based enzyme needed for adenosine triphosphate (ATP) activity (Nogovitsina and Levitina, 2005). Children with clinical symptoms of ADHD who received a supplement of magnesium and vitamin B_6 (6 mg/kg/day of magnesium, 0.6 mg/kg/day of vitamin B_6) for at least 2 months significantly reduced their levels of hyperactivity and aggressiveness with improved attention noted at school. When the supplement was stopped, clinical symptoms of the disease reappeared in a few weeks (Mousain-Bosc and colleagues, 2006).

Other nutrients have implications in reduced school performance. Deficiencies of vitamins B_1, B_3, and B_{12}, zinc, and iron have been linked with poorer cognitive performance. Behavioral problems, including attention deficits, have also been associated with food insufficiency and malnutrition (Fanjiang and Kleinman, 2007).

AUTISTIC SPECTRUM DISORDERS

Autism includes a range of sensory deficits that lead to diminished social interaction, extreme withdrawal, and an obsessive desire to maintain the present status; temper tantrums and language disturbances are also evident. It generally occurs in young children after a seemingly normal infancy. Nationally in 2003 to 2004, the prevalence of autism was found to be about half for Latinos as for non-Latinos, in which about 1 in every 200 children are diagnosed with autism. Whites and blacks had comparable rates. The lowest preschool rate of autism, less than 1 per 500, occurred in poor children. However, Latinos and poor families rated their children's autism as more severe (Liptak and colleagues, 2008).

There remain many unanswered questions as to its etiology. One theory is about mercury as used in a preservative in childhood immunizations. In 1999 mercury as a preservative was present in approximately 30 different U.S. vaccines used in childhood. Because of concerns of potential neurologic toxicity, and with a cumulative dose of mercury received by young infants after vaccination being high enough, the U.S. Food and Drug Administration (FDA) requested that vaccine manufacturers remove mercury-based preservatives from vaccine formulations. Since 2002 all childhood vaccines used in Europe and the United States are made without mercury or contain only minute amounts of this form of preservative. Although the use of mercury has mostly been eliminated from immunizations, the rate of autism has not declined in tandem (Schechter and Grether, 2008). The statistical analysis has been called into question regarding the impact of mercury from immunizations with concerns that even trace amounts may be toxic for some children. It appears that persons with autism may be less efficient and more variable at eliminating mercury from the

blood, as evidenced by lower hair content of mercury despite higher blood levels. A significant relation has been found between blood levels of mercury and diagnosis of an autism spectrum disorder (Desoto and Hitlan, 2007).

One potential cause of mercury toxicity, aside from immunizations, is environmental contamination. A study in Texas found that for every 1000 lb of industrial release, there was a corresponding increase of approximately 2.5% in autism rates. The further the distance from industrial or power plant sources, the greater the reduction in risk of autism (Palmer, Blanchard, and Wood, 2009).

Traces of mercury may play a more potent role with infants who receive antibiotic treatment in at least their first year of life. This appears to be the case with children with autism. Children with autism were found to have had antibiotic treatment, and high levels of mercury were found in their baby teeth. Antibiotic use is known to virtually prevent excretion of mercury in rats because of altered intestinal bacterial. Higher usage of oral antibiotics in infancy may also help explain the high rate of chronic gastrointestinal problems in individuals with autism (Adams and colleagues, 2007).

Another theory is that gluten (found in wheat, barley, rye, and U.S. oats) and casein (milk protein) are involved. This is thought to be related to a "leaky gut," with **peptides** (forms of incompletely digested protein) from gluten and casein abnormally causing excessive opioid activity in the brain. However, there is no evidence a diet free of gluten and casein works (Millward and colleagues, 2008) or that there are opioid products in urine (Dettmer and colleagues, 2007). However, antibodies against gliadin (the protein found in gluten) have been shown in a significant percentage of individuals with autism (Vojdani and colleagues, 2004).

Altered cellular metabolism is implicated in autism. Impaired calcium homeostasis has been implicated in biochemical changes leading to autism (Palmieri and colleagues, 2008). Autistic children and children with other autistic spectrum disorders have been found to have significantly lower plasma concentrations of magnesium than normal subjects (Strambi and colleagues, 2006). There is a known interplay between calcium and magnesium at the cellular level. This may even be implicated in the increased prevalence of epilepsy found with autism. The prevalence of epilepsy was found to be over 1 in 5 persons with autism subjects who also had impaired cognition. Of those with autism with normal cognition, 8% had a higher incidence of epilepsy (Amiet and colleagues, 2008).

Other alterations in nutritional status have been linked to autism. Whether this is a cause of autism or a result of autism due to dietary restrictions is not yet known. However, iodine levels were 45% lower in the children with autism. This supports earlier findings of abnormal thyroid function with consequent adverse impact on speech and cognitive skills. Children who also had low muscle tone had very low levels of potassium and high levels of zinc. There may be a prenatal link as evidenced by mothers of young children with autism who had very low levels of lithium, which can adversely affect fetal neurologic development. However, young children (ages 3 to 6 years) with autism also had low lithium levels (Adams and colleagues, 2006).

The increased rate of autism has coincided with fortification of the food supply with folate in the late 1990s. Although this was positive in reducing incidence of neural tube defects, it may have contributed to an increased number of live births

that would have previously succumbed to miscarriage because of a variant enzyme that has a high need for folate. This variant enzyme is found in high levels among persons with autism. The outcome is that these infants require higher intake of folate for methylation in order to allow for normal neurodevelopment. Identifying such infants and supplying them with a higher intake of folate may help to reduce incidence of autism (Rogers, 2008). Genetic polymorphisms adversely affecting sulfur metabolism, methylation, detoxification, dopamine signaling, and the formation of neuronal networks occur more frequently in autistic subjects (Deth and colleagues, 2008).

In clinical research with autism it has been found that foods are better accepted if flavor is mild (bread products are generally preferred foods with autism). More adverse reactions occur to foods that are highly flavored. The implication is that a defect in the ability to manage aromatic compounds or sulfur is present. Diet modification has resulted in reduction in body, breath, and urine odor found with autism (Breakey, 2004).

One area of concern is protein malnutrition, which can impair growth and development. This may result from either a child's limited food acceptance or dietary restrictions aimed at improving autistic traits. Children with autism who were on restricted diets have been found to have more essential amino acid deficiencies, especially of tyrosine and tryptophan, both important for neurotransmission (Arnold and colleagues, 2003).

For now, the best advice for families with a child with autism is to first do no harm. Use of diets restricted in gluten, casein, or sulfur should be assessed by a registered dietitian to ensure no nutritional deficiencies occur. Acceptance of a variety of foods may be promoted through very gradual incorporation such that the child with autism is not threatened by perceived change. Success may be considered if a child with autism will merely allow a disliked food to be seen on the plate. This is the first step toward acceptance of a variety of foods necessary to promote optimal growth and development.

CELIAC DISEASE

One cause of poor weight gain may be genetically linked celiac disease. This immune-mediated intestinal condition was once felt to be rare in the United States, but with newer laboratory techniques the incidence is now considered common. It has long been known that there is a high-rate of celiac disease among persons of British heritage. With the advent of screening in 1993 in Italy, it is now recognized that this country also has a high rate of celiac disease.

Celiac disease is one of the most common causes of intestinal malabsorption during childhood, which leads to impairment of iron absorption and subsequent growth. Apart from providing a gluten-free diet high in iron, early detection and treatment of iron deficiency anemia with iron and a multivitamin and mineral supplement will go a long way toward optimizing mental and psychologic functions (Fayed et al., 2008).

In untreated celiac disease the absorptive surface of the intestinal tract is damaged because of the destruction of the villi from the ingestion of gluten or gliadin (refer to Chapter 4) in genetically susceptible persons. Infants and children with chronic diarrhea but without generalized malabsorption may have celiac disease. Short

stature and anemia are frequently found with celiac disease and may be related to iron deficiency anemia and/or low levels of vitamin B_{12}. Other symptoms in children and adolescents with celiac disease include **dermatitis herpetiformis** (a chronic itchy skin inflammation involving lesions, often resulting in skin discoloration and scarring), dental enamel defects, osteoporosis, delayed puberty, and persistent iron deficiency anemia. It may be found with type 1 diabetes and genetically based syndromes such as Down, Turner, and Williams syndromes (Hill and colleagues, 2005).

One test for celiac disease that measures antiendomysial antibodies has high false-negative results (Kwiecien and colleagues, 2005). The North American Society for Pediatric Gastroenterology, Hepatology and Nutrition recommends that children and adolescents who have signs and symptoms of or who are at risk for celiac disease have a blood test for antibody to tissue transglutaminase (TTG), with a follow-up intestinal biopsy for those with an elevated TTG and adherence to a strict gluten-free diet if the diagnosis is confirmed.

Celiac disease involves malabsorption and an alteration of gut permeability from damage to the villi. Individuals with a history of a childhood celiac condition have an increased risk for developing schizophrenia. The gut may lose its capacity to block exogenous psychosis-causing substances that may enter the body, thereby causing the development of schizophrenia and other mental conditions (Wei and Hemmings, 2005).

CONSTIPATION

The seemingly benign condition of constipation can turn fatal with bowel obstruction. Childhood constipation accounts for 3% of visits to general pediatric clinics and as many as 30% of visits to pediatric gastroenterologists. In the majority of cases, physicians prescribe some form of laxative or stool softener. In only about half of cases of childhood constipation, physicians recommend dietary intervention. It is felt that primary care physicians tend to undertreat childhood constipation, and after 2 months of treatment, nearly 40% of constipated children were found still symptomatic (Borowitz and colleagues, 2005).

Children who lack adequate fiber and fluids in their diets are more prone to constipation. Factors associated with childhood constipation include low intake of vegetables, legumes, fruits, and fluids, family history, and irregular toilet habits. About three quarters of children with constipation drink less than four glasses of water per day (Comas Vives and Polanco Allue, 2005). The three-pronged approach of increased fiber, increased fluids, and increased exercise should always be employed for preventing episodes of childhood constipation.

Over-the-counter preparations for the management of constipation require medical supervision, especially for children. One fatal incident involved a 7-year-old child who was given an Epsom salt enema, which resulted in excess absorption and high serum levels of magnesium (Tofil, Benner, and Winkler, 2005).

CYSTIC FIBROSIS

Cystic fibrosis (CF) is the most common fatal autosomal recessive disorder. The gene defect causes defective sodium and chloride transport across epithelial cells, resulting in thick mucous secretions. This leads to chronic lung infections and eventual

respiratory failure. In the gastrointestinal tract the mucus inhibits the use of pancreatic enzymes, leading to nutrient and fat malabsorption. With fat malabsorption the fat-soluble vitamins (A, D, E, and K) are generally in deficiency states. These vitamins are available as water-dispersible (A, D_3, and E) or water-soluble grades (K_3) to promote better absorption. With fat malabsorption comes steatorrhea (fatty stools). Supplementation with zinc is advised in persisting steatorrhea (Van Biervliet, Van Biervliet, and Robberecht, 2006).

The good news is that children with CF can now expect to live into adulthood with the advances made over the past 30 years. Medical nutrition therapy is a cornerstone of this success. Appropriate nutritional support includes pancreatic enzyme replacement therapy, a high-fat and high-kcalorie diet, and supplementation of fat-soluble vitamins and essential fatty acids (Wood, Gibson, and Garg, 2005). Early intervention is necessary to promote positive nutritional status. Delayed diagnosis and treatment are linked with prolonged malnutrition. If the duration of vitamin E deficiency is minimized, children with CF have better cognitive functioning (Koscik and colleagues, 2004). Even low-normal levels of serum vitamins A and E are associated with an increased rate of pulmonary complications in CF (Hakim and colleagues, 2007).

However, challenges remain in the goal of achieving positive nutritional status. It can be difficult for toddlers with CF to meet the recommended 120% to 150% of the RDA for kcalories. Parents understandably worry about their child's well-being. This can lead to unintentional parental negative behaviors, such as excessive coaxing of the child to eat, which can lead to the opposite of the desired behavior by the child. Parents of infants and toddlers with CF do report problematic mealtime behaviors. A research study looking at this issue involved videotaping mealtimes that were coded using the Dyadic Interaction Nomenclature for Eating (DINE). The videotaping showed parents of the children with CF giving a higher rate and frequency of commands to eat than parents who did not have a child with CF. Further, the young children exhibited more negative behaviors with eating as the meal progressed (Powers and colleagues, 2005). Intervention that includes the child in decision making along with use of positive strategies of praising good behavior and ignoring adverse behaviors has been shown to result in an average increased energy intake and weight gain.

Because children with CF are now surviving into adulthood, other issues can develop. One is decreased bone mineral density. Adequate intake of calcium and vitamin D is essential, but the goal still remains of meeting the guidelines of MyPyramid food guide to help ensure all nutrients important to bone health are consumed.

DENTAL DECAY

Dental caries, or tooth decay, begin with a genetic predisposition toward a thin layer of **dental enamel** (the outer hard surface of the teeth) or from inadequate intake of calcium by the mother during pregnancy. Childhood dental caries develop from a complex process of demineralization of the tooth (**decalcification** [removal of calcium from the tooth structure]) and acid destruction. Bacteria found in the mouth feed on carbohydrates—both sugars and starches—which results in the production of acid.

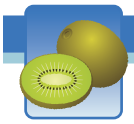
FIGURE 12-7 Examples of baby-bottle tooth decay. (Courtesy of F Ferguson, Department of Children's Dentistry, School of Dental Medicine, SUNY at Stony Brook, Stony Brook, NY.)

Carbohydrates are **cariogenic** (able to induce dental caries or cavities). Saliva helps neutralize the normal acid production that occurs with the combination of oral bacteria and carbohydrate intake.

It is saliva that protects the teeth against corrosion by the acids, which soften enamel and make it susceptible to wear. Medical conditions that put children at risk of dental caries include asthma, bulimia nervosa, caffeine addiction, diabetes mellitus, and exercise dehydration. Carbonated soft drinks are a primary source of acid implicated in the current rise of dental caries, and exercise dehydration is the main reason for inadequate amounts of saliva among children (Young, 2005). See Table 12-1 for fluid goals of children.

Baby-bottle tooth decay (also referred to as nursing-bottle mouth) occurs in babies as well as young children who use a bottle excessively, especially at bedtime (Figure 12-7). Sweet liquids such as juice and soft drinks are believed to be the primary culprits in baby-bottle tooth decay, especially when used in bedtime bottles. During sleep there is reduced production of saliva. For a child who cannot sleep without a bottle, a compromise of plain water in the bottle may be acceptable. However, regardless of what is in the bottle, children should not be put to bed with a bottle because of the risk of choking and aspiration. Use of a cup is recommended for older babies and children because the liquid does not continually bathe the teeth, unlike a bottle that is held in the mouth for long periods.

As soon as teeth first erupt, the older baby or toddler should have them cleaned daily at home. This can be accomplished with the parents using a clean washcloth to wipe off the teeth, or a child-size toothbrush may be used. The American Academy of Pediatric Dentistry recommends that infants be scheduled for an initial oral evaluation within 6 months of the eruption of the first primary tooth, but by no later than 12 months of age. This generally allows a positive first dental visit for a professional dental cleaning, which can help prevent future dental decay.



Cultural Consideration

Mexican and Salvadoran immigrant caregivers of children under 6 were found to have a good awareness of contributors to dental decay amongst children. However, although bottle-feeding was attributed, the majority of the caregivers thought the bottle's nipple was the cause (Horton and Barker, 2008). ■

Keeping the oral cavity clean with toothbrushing, flossing, and regular dental visits for professional removal of **dental plaque** (a buildup on dental surfaces that provides a growth medium for bacteria) can significantly reduce the risk of dental caries. The role of the dental professional should include the assessment of eating disorders (see later section) and between-meal snacking patterns.

Dietary guidelines for children to help prevent dental caries include the consumption of at least 2 cups of dairy foods daily, or the equivalent, for the benefit of calcium, limiting intake of 100% juice to a maximum of 6 oz daily, and restricting other sweet beverages to occasional use. However, dental decay is difficult to control through food choices alone. Limiting the frequency of carbohydrate snacks can help. Snacks containing carbohydrate foods that tend to stick to the teeth should be limited. Including a protein source with snacks can help to prevent dental decay. A snack that contains some fat, as found with protein-containing foods, helps neutralize the acid production of the oral bacteria.

All children should be encouraged to thoroughly chew their foods. This helps in a lot of areas, but in the case of dental health, chewing promotes the production of saliva. Saliva helps to neutralize the acid formed in the mouth by bacteria feeding on carbohydrate and also helps to rinse the mouth of food debris. Saliva also contains a variety of minerals, such as calcium, that bathe the teeth, thereby encouraging the retention of dental enamel.

Older children can chew sugar-free gum after meals to further stimulate the flow of saliva and help cleanse the teeth if using a toothbrush after meals is not possible. The use of chewing gum is not feasible for children with braces. For these children, at least a thorough rinsing of the mouth with water after meals is imperative to avoid dental caries. Other means to protect the enamel surface of the teeth include avoiding harsh abrasives on the teeth, not chewing ice (which can chip the teeth), not opening bottles with the teeth, and using pliable mouth guards in sports.

Fluoride, a mineral that helps promote the formation of strong enamel in childhood, can be obtained through fluoridated drinking water or, for children under the age of 12, from fluoride drops or tablets. Once the adult teeth are fully formed, fluoride rinses continue to be an effective preventive treatment by promoting retention of the enamel surface. Fluoride is believed to actually promote remineralization of the dental surface.

Another source of acid destruction is related to erosion of the dental enamel. **Dental erosion** does not involve bacterial action but happens in cases such as bulimia (see later section), in which constant **purging** (intentional vomiting) of meals allows the acid contents of the stomach to severely erode the dental enamel (Figure 12-8). A new role for the dental profession in diagnosing bulimia has evolved as a consequence of this nation's obsession with weight. Excess intake of acidic beverages such as some soft drinks can lead to dental erosion. Chewable tablets containing vitamin

FIGURE 12-8 Bulimia-induced dental erosion. (From Sapp JP, Eversole LR, Wysocki GW: *Contemporary oral and maxillofacial pathology*, ed 2, St. Louis, 2004, Mosby.)

C, also known as ascorbic acid, also have been found to be destructive to dental enamel.

Xerostomia (diminished or absent production of saliva) and irritation of the lining of the mouth can occur in connection with frequent purging. Xerostomia can further be caused by certain medications such as antihistamines and from destruction of salivary glands (glands near the mouth that produce saliva) that may occur in radiation treatment of cancers near the throat. Dehydration and a resulting dry mouth are caused by other forms of purging such as laxative and diuretic abuse. Persons with a dry mouth might suck on sugar-based candies, which can exacerbate dental decay. Use of sugar-free candies does not promote tooth decay, but adequate fluid intake is still important.

The supporting structure of the teeth, the gums or gingiva, requires a good nutritional status to remain strong and healthy. **Gingival disease** means disease of the gums. Irritants, such as plaque, can increase the risk of gingivitis. Brushing the teeth regularly and flossing daily, with at least annual dental visits for plaque removal, can help decrease the risk for **periodontal disease** (a painless gum disease that results in tooth loss in adulthood).

Fact & Fallacy

FALLACY The development of baby-bottle tooth decay is not important because the baby teeth are going to be replaced with adult teeth.

FACT The physical significance of baby-bottle tooth decay is that removal of the decayed teeth can cause jaw misalignment, preventing normal spacing for adult teeth as they erupt. The pain of dental decay is not pleasant for the infant or child and can cause excess crying and screaming—not pleasant for the child or the family. Furthermore, a young child with dental decay experiences a frightening and painful first dental visit. It is best to prevent dental caries in infants and young children for the sake of the child, the family, and the dental professional. ■

EATING DISORDERS

Psychologic eating disorders are increasingly recognized in childhood. Anorexia nervosa and bulimia not only are problems of weight control, but also involve biologic, psychologic, and social factors. Obsessive dieting, refusal to eat, binge eating, gorging, purging, fasting, and laxative and diuretic abuse can lead to malnutrition, electrolyte imbalance, and cardiac arrhythmia, which can result in death. Eating disorders occur in a variety of forms. The most common include **anorexia nervosa (AN)** (food restricting), **bulimia** (purging behavior), **bulimorexia** (food restricting with purging behavior), and binge-eating disorder. There is evidence that a significant contributor to eating disorders is genetically based. Any nonphysiologic reason to restrict or alter food intake might be termed an eating disorder when health is adversely affected.

Family relationships seem to contribute to the development of psychologic and behavioral traits that indicate risk for some eating disorders. Other psychiatric problems, such as bipolar disorder (see Chapter 13) and schizophrenia, may be associated with behavioral eating problems. Monitoring weight and diet is important in the management of psychiatric illness.

Dieting can lead to the development of eating disorders. A survey of dieters showed that they had significantly greater ratings of fear or guilt and number of feared foods than nondieters (Gonzalez and Vitousek, 2004).

Health professionals should be aware of signs and symptoms of eating disorders. Dermatologists can play a key role in identifying anorexia and bulimia. With severe anorexia nervosa or bulimia nervosa, symptoms are generally found. They include abnormal dryness of the skin with reduced secretions, fine hair covering the body, poor hair growth, yellowing of the skin with hyperpigmentation, acne, inflammatory skin condition or dandruff, bluish discoloration and coldness of the extremities, discolored skin spots and patches, skin infections, itchy skin, acquired impaired wound healing, edema, scurvy and pellagra, with the "4 Ds": diarrhea, dermatitis, dementia, and death (Strumia, 2005). The most common features of pellagra in anorexia nervosa are skin manifestations such as skin redness on sun-exposed areas, with tongue and oral cavity inflammation. Health care providers might consider a trial of 150 to 500 mg of niacin if anorexic persons exhibit these skin signs. Pellagra can be diagnosed if skin conditions resolve within 48 hours after oral vitamin B_3 administration.

Anorexia Nervosa

Anorexia nervosa (AN) is a serious psychiatric illness associated with significant morbidity and mortality. Successful treatment involves weight restoration, but the rate of relapse is estimated to be as high as 50%. Maintenance of a healthy diet is central to the recovery process. In recently treated women with AN as defined as BMI greater than or equal to 20, lower intake of energy-dense foods and limited variety were associated with poor outcome (Schebendach and colleagues, 2008).

Anorexia nervosa is characterized by a refusal to eat. This is often caused by a need to exert control. Affected children or teens can gain control in this area of life, when they may not feel able to gain control in other realms. Initially there is no real loss of appetite. However, once severe weight loss has occurred, hormonal changes

are believed to take place that alter perception. The syndrome occurs mainly in girls after puberty. There is an increased risk of anorexia nervosa among high achievers and upper socioeconomic populations. Some common correlates of anorexia are as follows:

- An intense fear of becoming obese that does not lessen as weight loss progresses
- A disturbance of body image, such as claiming to feel fat even when emaciated
- Weight loss of at least 25% of original body weight
- Refusal to maintain body weight over a minimal healthy weight for age and height
- No known physical illness that would account for the weight loss
- Amenorrhea caused by altered hormonal states
- Bizarre eating habits such as cutting food into tiny pieces or limiting intake to only a few foods
- Underlying low self-esteem
- Compulsive exercise habits

Dietary Treatment

The goal of treatment should be to restore good nutritional status and resolve the underlying psychologic problems. Outpatient treatment is the preferred method and should involve the whole family. The person with anorexia nervosa who is 30% below normal weight, fails to gain weight, and is in complete denial, or is suicidal, should be hospitalized. All members of the health care team must be aware of the need to individualize the care plan. The nurse's role includes closely supervising and encouraging the patient to eat all of the food provided. A trusting relationship between the individual and the health care professional is absolutely essential. It should be recognized that treatment will require a long-term, family-based approach, and a considerable amount of time will be needed. Treatment is not always successful.

Bulimia

Bulimia is characterized by binge eating followed by purging through self-induced vomiting, abusive use of laxatives, or both. The person is afraid of becoming overweight and is aware that the eating pattern is abnormal. However, the bulimic individual loses control over eating and often eats large amounts of food rapidly. High-kcalorie, easily ingested foods are chosen during binge episodes. Fasting then follows, often resulting in a weight fluctuation of as much as 10 lb. Bulimorexia or bulimia nervosa is the term used to describe cycles of binge eating and purging (vomiting or laxative abuse) with undereating. Health care professionals need to be aware of the existence of bulimia and its detrimental effect on electrolyte balance and dental health. A health care team approach is advised for bulimia, but also for dental care in general.

Dietary Treatment

In the hospital, food intake should be normalized to appropriate mealtimes, with close supervision after eating to control vomiting. Psychologic assessment should

take priority, and plans should be made for long-term, outpatient, family-based counseling with a health care professional trained in eating disorders. A total health care team effort is essential to ensure effective treatment. Short-term mortality, as compared with anorexia nervosa, is significantly lower; however, long-term adverse effects are found. Outpatient dietary treatment of bulimia emphasizes regular mealtimes with appropriate food portions to satisfy hunger needs. Food is discouraged as a means of reward or comfort.

EPILEPSY

Children with **epilepsy** have intermittent or chronic seizure activity. Grand mal seizures are those in which seizure activity is very pronounced, and the person may be harmed through the extreme physical movements. Petit mal seizures may go unnoticed and last for only seconds at a time. An underweight child who has intermittent periods of "staring" may be having chronic seizure activity that increases the need for kcalories but diminishes the ability to consume adequate amounts of food.

There are a variety of potential causes of seizure activity. One study linked seizures with zinc deficiency (Takeda and colleagues, 2005). Pyridoxine and its active form, pyridoxal phosphate, have shown success in some cases of seizures (HS Wang and colleagues, 2005). All infants in the first 2 years of life with refractory seizures with an unknown cause must be prescribed oral pyridoxine (50 to 200 mg/day) because of the potential for pyridoxine deficiency (Caraballo and colleagues, 2004). Celiac disease has been linked to higher incidence of epilepsy than in the general population, and therefore a gluten-free diet may be of benefit (Diaz, Gonzalez-Rabelino, and Delfino, 2005).

The **ketogenic diet** (a diet very restricted in carbohydrate, leading to ketosis) is receiving renewed interest worldwide in the management of epilepsy. This diet was originally introduced in the 1920s but went out of use with the promise of medications to prevent seizure activity. This was in part because the diet is very rigid, with extreme restriction on carbohydrate intake to less than 5% of kcalories. The remaining kcalories come from protein at 10%, and the remainder from fat. However, because not all cases of epilepsy have been successfully controlled with medications and/or surgery, the ketogenic diet has been tried once again. It is unknown why this diet helps control seizures. It is interesting to note, given the connection with celiac disease, that a very-low-carbohydrate diet will also be very low in gluten content.

The ketogenic diet has been found to be an effective treatment for some children with refractory epilepsy, being generally well tolerated and rarely associated with side effects (Mackay and colleagues, 2005). However, although the ketogenic diet has traditionally been considered an anticonvulsant therapy of last resort, it may be a valuable therapy before epilepsy becomes intractable (Rubenstein and colleagues, 2005).

Medical oversight is critical before a child is placed on a ketogenic diet. The diet generally is introduced with an initial period of fasting and fluid restriction, but there is some evidence suggesting this is unnecessary (Kim and colleagues, 2004). One concern with use of the ketogenic diet in children is some evidence showing impaired growth (Peterson and colleagues, 2005). See Appendix 1 on the Evolve website for a website on epilepsy.

LEAD TOXICITY

Screening for lead poisoning is now routinely advised, especially for young children who live in older homes in which lead paint or lead-soldered pipes are likely to be found. Adverse health effects caused by lead exposure include intellectual and behavioral deficits in children. Eliminating blood lead levels of 10 mcg/dL or higher in children is one of the national health objectives for 2010. Over a quarter million children age 1 to 5 years remain at risk for exposure to harmful lead levels (CDC, 2005). Running tap water for 2 minutes before use is recommended to reduce exposure from lead-soldered pipes. Good hand-washing techniques decrease exposure from accidental oral intake because of dust or dirt that contains residues of lead. Children who have iron deficiency are more at risk for lead toxicity.

MIGRAINE

Controlling pediatric migraine needs to be done without causing harm. The first step is to rule out triggers. It is well known that eating regular meals and getting adequate sleep are helpful. Trigger foods can be eliminated, but referral to a registered dietitian is advised to ensure that nutritional inadequacies do not result. Triggers of pediatric migraine include aged cheese, chocolate, citrus fruits, nitrites as found in hot dogs, foods containing monosodium glutamate (MSG), sulfite preservatives, aspartame, caffeine withdrawal, and alcoholic drinks, especially red wine and beer, when underage drinking is a possibility. Histamine is part of the mechanism of migraines induced by food triggers. Long-term preventive drug therapy is appropriate only after exclusion of causative factors.

Some herbs and nutrients have been identified as safe and effective for prevention of pediatric migraines. Consultation with a physician is always warranted before using such products. Reduction in frequency of migraines by at least 50% is the level of impact used to state that a product is effective at preventing migraines. No medications are 100% effective. A butterbur extract (50 to 150 mg based on age) effectively reduced frequency of migraines among three quarters of school-age children in one study. Burping was the primary adverse effect (Pothmann and Danesch, 2005). Germany produces an herbal extract of butterbur (also known as *Petasites*), which got its name from the traditional use of wrapping butterbur leaves around butter for storage.

The mineral magnesium works as a calcium channel blocker and appears to reduce frequency and severity of migraine attacks. A significant decrease was noted for magnesium oxide, with a total of 9 mg/kg of body weight daily divided into three doses (Wang and colleagues, 2003). Riboflavin, or vitamin B_2, has shown some promise in the prevention of migraines. It is felt to help by maintaining ATP or energy level in the cells.

OBESITY

There is a global epidemic of childhood obesity. A study from 34 countries found that the United States has the second highest rate of childhood overweight and obesity (about 25% and 7%, respectively), which was mostly associated with reduced physical activity and greater television viewing (Janssen and colleagues, 2005). Unless the rate and degree of childhood obesity are curbed, this generation may see

a reduced life expectancy because of issues of cardiovascular disease and type 2 diabetes.

The metabolic syndrome was found to be completely absent in adolescents with low abdominal fat. It was present in just under 15% of males and almost 10% of females with high abdominal body weight. As expected, this was associated with a higher level of triglycerides and C-reactive protein (CRP) and lower levels of high-density lipoprotein (HDL) cholesterol in both males and females; however, elevated blood pressure was found only among males (Syme and colleagues, 2008).

As discussed in Chapter 11, the prevention of obesity begins in utero and in early infancy, with breastfeeding providing some protection against the development of childhood obesity. For babies who are bottle-fed, prolonged use of the bottle past the age of 18 months is more likely to contribute to excess weight gain if used excessively and especially if the bottle contains sweet liquids.

Prevention of obesity is far easier than attempts to correct it. The use of growth charts as previously discussed can identify the risk for developing childhood obesity. If this risk is identified, appropriate follow-through is important.

The environment that influences the child's risk of obesity also needs to be explored because it was found that sedentary caretakers promote more television viewing and less activity in children (Polley and colleagues, 2005). Therefore the whole family of a child at risk for obesity needs encouragement to increase physical activity.

The effect of nutritional factors in preventing obesity needs to be reviewed with families. This should primarily be a positive approach of promoting strategies that encourage a child to accept a variety of foods.

Vegetables high in magnesium are of particular value for children at risk for insulin resistance due to a family history of the metabolic syndrome. The association between magnesium deficiency and insulin resistance is present during childhood (Huerta and colleagues, 2005). As reviewed in Chapter 3, dark green, leafy vegetables and legumes are particularly rich in magnesium. Whole grains, milk, and fish also contribute significant amounts of magnesium.

Beverage consumption is another important consideration in the prevention of obesity. Evidence suggests that decreasing soft drink and increasing dairy consumption among adolescent girls contributes to prevention of excess weight gain during adolescence (Novotny and colleagues, 2004).

Schools can reinforce positive strategies in the prevention of childhood obesity. Opportunities for physical activity are imperative. The cafeteria and vending-machine offerings are additional factors. Teachers, kitchen staff, and other school personnel can promote positive eating behaviors aimed at children's interest in eating well. One school-based intervention found a significant increase in children's intake of fruit and 100% fruit juice with snacks and vegetables at lunch (Cullen and colleagues, 2004).

For a child who is overweight, great care needs to be taken to ensure that the child's self-esteem is not damaged in attempting to control weight gain. Foods should not be labeled as good or bad. The health care professional can promote positive strategies of increasing physical activity, reducing television and computer use, and focusing on high-fiber foods that promote satiety and growth in height because

of the high mineral content of such foods. Refer to Chapter 6 for additional guidance on long-term weight management.

Only in extreme cases should surgical intervention be considered in adolescents with obesity. It has been approved for children if the BMI is at least 40 with a severe medical problem or if the BMI is at least 50 with chronic health issues. As reviewed in Chapter 6, there are potentially severe implications with nutritional status, quality of life, and impact on future reproduction, as well as risk of mortality from surgical intervention. A far more positive approach is to aim for slow, sustainable weight loss. If a child loses only 1 lb per month, in 5 years this amounts to 60 lb of likely permanent weight loss. To achieve this goal a reduction of kcalorie intake or increase of physical activity of only 117 kcal daily is required. This is less than one can of soda or 1 hour of daily exercise. There is evidence that the effect of behavioral therapy for weight loss in childhood will be longer lasting than that seen in adults (Daniels, 2005).

POOR WEIGHT GAIN

A child may weigh less than is desirable for many reasons. The child may be consuming the normal recommended amount of food and kcalories while having increased needs because of hypermetabolism. A hypermetabolic state occurs, for example, with fevers. A child who has chronic ear infections will have difficulty gaining adequate weight because of a reduced appetite in conjunction with an increased need for kcalories. Children with intestinal parasites or chronic diarrhea will not grow to the optimal level. A child who is constantly on the move will have increased needs for kcalories because of the excessive activity level. If sudden or excessive weight loss occurs, serious organic illness, such as diabetes or psychologic problems, should be ruled out.

An increase of 500 kcal/day in excess of need should result in a weight gain of 1 lb/week, assuming adequate intestinal absorption. An additional intake of two slices of bread, 2 tbsp of peanut butter, or 2 oz of cheese, and an extra glass of whole milk, provides 500 kcal. If there is an adequate nutritional intake (at least the minimum number of recommended servings according to the Dietary Guidelines), the additional kcalories can appropriately come from added fats and sugars. Adding gravy, butter, mayonnaise, or heavy cream to foods can increase the kcalorie density of foods. Between-meal snacks such as milkshakes, puddings, and ice cream can also help promote weight gain. Treatment is aimed at developing appropriate food habits so that good nutritional status and weight gain can be maintained. Persons with a family history of heart disease or diabetes would benefit from increased amounts of unsaturated fats (liquid oils and mayonnaise) versus solid fats (butter and hydrogenated fats—see Chapters 7 and 8).

UPPER RESPIRATORY INFECTION

Complementary and alternative medicine (CAM) for the prevention and treatment of upper respiratory infection (URI) is generally not recommended. The herb echinacea has not been shown to reduce the duration or severity of URI and was related to the development of rash in some children. Vitamin C was not effective. The efficacy of zinc was not clearly demonstrated, and it may be associated with adverse effects in children (Carr and Nahata, 2006).

WHAT ARE CONCERNS OF DEVELOPMENTAL DISABILITY?

The term **developmental disability**, according to the Developmental Disabilities Assistance and Bill of Rights Act, refers to a severe, chronic disability that:

1. Is attributable to a mental or physical impairment or a combination of mental and physical impairments
2. Is manifested before the person reaches the age of 22 years
3. Is likely to continue indefinitely
4. Results in substantial functional limitations in three or more of the following areas of major life activity: self-care, receptive and expressive language, learning, mobility, self-direction, capacity for independent living, and economic self-sufficiency
5. Reflects the person's need for a combination and sequence of special interdisciplinary or generic care, treatment, or other services that are lifelong or of extended duration and individually planned and coordinated

The subcategories of developmental disabilities include the following: autism; **mental retardation,** a general term for a wide range of conditions resulting from many different causes, some of which are directly related to various diseases; **cerebral palsy** (see Figure 12-9), characterized by a persistent qualitative motor disorder caused by nonprogressive damage to the brain; conditions that may involve sensory deficits and mental retardation; conditions that exhibit varying levels of **spasticity** (movements of the body); and epilepsy (Table 12-4).

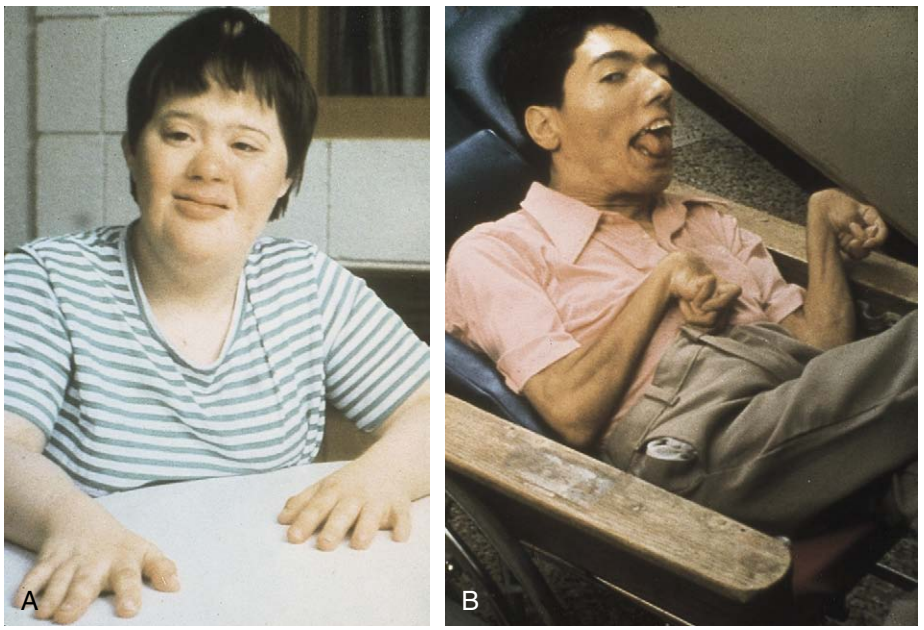


FIGURE 12-9 **A,** Person with Down syndrome. **B,** Person with cerebral palsy. (Personal Touch Slides, courtesy of Ross Products Division, Abbott Laboratories.)

Table 12-4 Description and Nutritional Implications of Some Developmental Disability Conditions

COMMON CHARACTERISTICS	NUTRITIONAL IMPLICATION
Down Syndrome (Caused by Chromosomal Abnormalities)	
Reduced muscle tone in varying degrees	Effects on chewing, swallowing, sucking, and tongue control
Growth retardation	Effects on appetite and behavior at mealtime
Small flattened skull	Weight control
Narrow nasal passage	
Delayed tooth development	Dental caries
Narrow palate	Problems with eating
Cerebral Palsy	
Neuromuscular impairment	Weight control
Motor disability	
Poor occlusion	
Types	Difficulties in chewing, swallowing, tongue control, and drooling
Spastic: disharmony of muscle movements	Overweight condition possible because of limited movement
Athetoid: involuntary movements of extremities	
Ataxic: inability or awkwardness in maintaining balance	Underweight condition possible
Hypotonic: muscles fail to respond to stimulation	
Hypersensitivity	Sensitivity to taste, temperatures, and consistency of food
Prader-Willi Syndrome (Endocrine, Hypothalamic Disorder)	
Hyperphagia	
Obesity	Weight control
Short stature	Feeding difficulties in infancy
Small hands and feet	Dental caries
Hypogenitalism	
Mild mental retardation	
Bizarre eating behaviors (gorging, food stealing, eating inappropriate foods such as pet food)	
Poor sucking ability and failure to thrive in infancy	
Rapid weight gain after 1 year of age	
Slow motor development	
Obesity-related diabetes in later childhood	
Frequent lack of emotional control	

WHAT ARE THE NUTRITION-RELATED PROBLEMS AND CONCERNS OF THE DEVELOPMENTALLY DISABLED?

Eating problems may result from neuromuscular dysfunction such as hyperactive gag reflex, **tongue thrust** (a condition in which the teeth are not brought together to initiate swallowing, the tongue pushes out saliva, and drooling occurs), poor lip

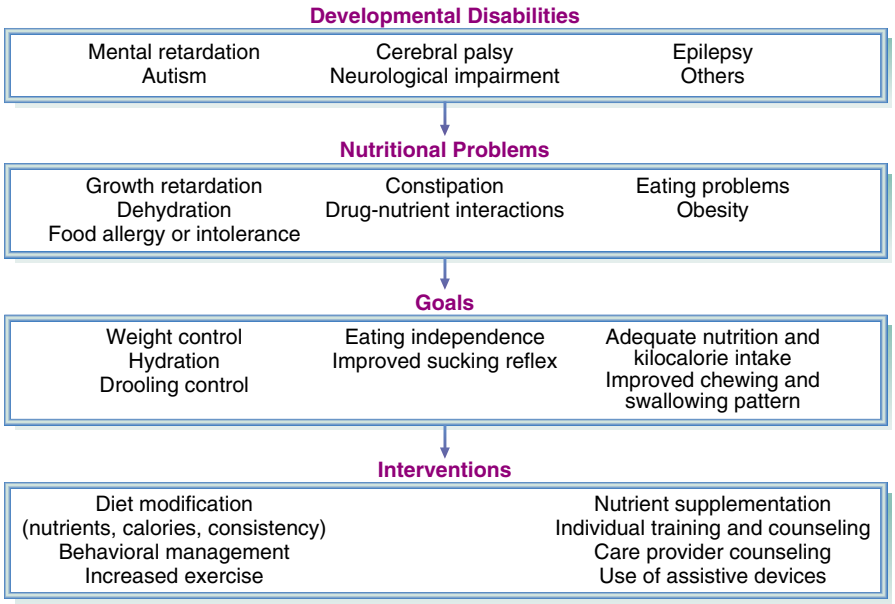


FIGURE 12-10 Flowchart for attaining nutritional goals for the developmentally disabled population.

closure, and inability to chew. Neuromuscular dysfunction refers to abnormal sensory input and muscle tone and is manifested in sucking, swallowing, and chewing movements that are hampered when oral muscles do not function properly. When chewing reflexes are lacking, ways must be found to stimulate them. For example, sweet and cold foods are found to be effective. The act of chewing also stimulates saliva production and facilitates swallowing.

Neuromuscular dysfunction is common in cerebral palsy, **Down syndrome** (a genetic anomaly caused by an extra X chromosome), and Prader-Willi syndrome (PWS). Anatomic defects and malformations, such as cleft palate, may cause food to pass into the nasal passages. Choking is a major concern in such a condition. Poor lip closure and tongue control, a strong bite reflex, tongue thrust, excessive drooling, choking, and delayed hand-to-mouth coordination are likely to cause inadequate nutrient intake. A flowchart indicating nutritional problems and goals for the developmentally disabled population is shown in Figure 12-10.

Individuals with Down syndrome have a normal-size tongue, but because of their facial structure, the oral cavity is frequently too small to accommodate the tongue, which may have deep fissures that can retain food particles. Consequently, tongue brushing should be part of daily oral hygiene. Autistic children may pouch their food rather than swallow it and prefer soft foods that require little chewing. This puts them at greater risk for dental caries. Suppressed immune function, drug therapy, oral motor dysfunction, and modified diets put the developmentally disabled child at high risk for oral infections. Caregivers are often so overwhelmed with medical, physical, psychologic, and feeding concerns that regular home dental care can be neglected.

Table 12-5 Energy Requirement Chart for Individuals with Disabilities

DIAGNOSIS	ENERGY REQUIREMENT
Cerebral palsy (mild spasticity), 5-11 years old	13.9 kcal/cm
Cerebral palsy (severe spasticity), 5-11 years old	11.1 kcal/cm
Down syndrome, boys	16.1 kcal/cm
Down syndrome, girls	14.3 kcal/cm

From Rhudy NT, Kristopher L, Miller A, Murphy P: *Calculating nutritional requirements for individuals with disabilities,* Morgantown, WV, Nutrition and Dietary Services, University Affiliated Center for Developmental Disabilities (UACDD).

Just as a period of anxiety can cause gastric distress in the normally functioning population, behavioral problems such as tantrums, agitation, rocking, and flailing of arms (forms of self-stimulation) can result in esophagitis, aspiration of food, dehydration, and malnutrition in the developmentally disabled. Pica (the ingestion of nonfood items) may cause malabsorption of certain nutrients or even intestinal blockage. Food stealing is another behavioral problem that often occurs in conditions such as PWS.

Persons with Down syndrome and PWS (a genetic condition of unknown cause) are frequently identified as being obese. Obesity is likely to occur whenever there is limited mobility, poor muscle tone, altered growth, lack of nutritional knowledge, hyperphagia, and feeding and eating problems, unless a preventive approach is taken by caregivers and parents. Unfortunately, some well-meaning people believe that food is the only source of enjoyment for those who are physically and mentally disabled. Such an attitude will lead only to more health problems. Estimation of kcalorie needs for children with developmental disabilities is based on length in centimeters (Table 12-5).

Children with PWS need fewer kcalories than are normally required to maintain weight. However, **hyperphagia** (excess hunger) is often present. Increased energy expenditure, such as with walks or dancing to music, is helpful to control weight gain. Kcalorie needs are increased with **hyperkinesis** (excessive movement) and seizure activity. Persons with cerebral palsy often have very rigid muscles, which can increase kcalorie needs (hypertonia). The hypotonic form of cerebral palsy will require reduced kcalories to allow for appropriate weight.

Scurvy and vitamin D deficiency have been documented in children with cognitive disorders. Thorough dietary histories are suggested before invasive diagnostic workups of various maladies. Overnutrition from excess kcalories may coexist with malnutrition, particularly among those with abnormal cognition or autistic spectrum disorders. A comprehensive dietary history and screening for vitamin deficiencies in at-risk children are important aspects of preventive health care and are essential for prompt diagnosis and treatment (Noble, Mandel, and Patterson, 2007).

Among children with cerebral palsy a low intake of iron, calcium, the B vitamin folate, and the fat-soluble vitamins E and D was found to be common, even among those who were receiving nutritional supplements. Laboratory tests confirmed low serum concentration of folate and vitamin B_6, vitamin E, iron, zinc, and selenium in some of the children. Children with neurologic disabilities should have their nutri-

tional status evaluated to ascertain sufficient intake of micronutrients (Hillesund and colleagues, 2007).

WHAT ARE NUTRITION CONCERNS FOR CHILDREN AND ADOLESCENTS INVOLVED IN SPORTS OR OTHER PHYSICAL ACTIVITIES?

Physical activity is essential for optimal bone growth. Bone mineral density reaches its peak by the end of adolescence, with a critical period for bone response to weight-bearing exercise near puberty. Increased physical activity for all children at this time of life can help prevent osteoporosis in later years.

With increased levels of overweight and obesity among children and adolescents the promotion of physical activity is especially important. Nutritional needs are not significantly altered in normal levels of exercise such as jumping rope or riding bicycles. Children and adolescents who are involved with endurance levels of physical activity have increased needs for kcalories, protein, and appropriate fluids. Soccer, football, basketball, track, and competitive swimming are common school-based high-endurance sports. Excess weight loss resulting from inadequate kcalorie intake for energy demands of sports promotes gluconeogenesis and consequent loss of muscle tissue. This can stunt growth and lead to impaired muscular function and increased susceptibility of muscle tissue to injury. For children who are not physically fit, exercise is best done at a slow, steady pace until the body is better conditioned. Extremely lean athletes or anorexic athletes who have very low body fat stores may have better endurance levels if the body fat level is increased to more normal amounts.

School nurses should be providing guidance to coaches, the student athletes, and their families on the increased nutritional needs to help ensure continued growth and development. Regular physical examinations should be encouraged. Criteria of weight goals should be established that prevent continued exercise or involvement in the sport if excess weight loss occurs.

In addition, nutritional status for vitamin and mineral needs should also be assessed. Gymnasts and other athletes involved in sports that emphasize slimness should be carefully reviewed for vitamin D and calcium status (Lovell, 2008). There is evidence of oxidative damage in athletes. Encouraging all children, but especially athletes, to eat a variety of plant-based foods that increase intake of antioxidant vitamins is warranted. The use of a good multivitamin supplement may be appropriate but should not take the place of a good diet.

Unfortunately, many involved in sports do not meet their nutritional needs and increasingly may rely on unproven athletic performance enhancers. Intense training combined with inadequate nutrition may cause growth delay in elite young athletes. It was found in one school that peer-led teaching in an adolescent sports program helped prevent disordered eating, decreased steroid use, and increased other positive health behaviors (Elliot and colleagues, 2004).

Anabolic steroids and creatine do offer potential gains in body mass and strength but risk adverse effects to multiple organ systems. Anabolic steroids promote muscle growth and protein synthesis. Side effects of anabolic steroids include damage to the heart muscle, atherosclerosis, high risk of clot formation, hepatic dysfunction, and psychiatric and behavioral disturbances and potential for anesthesia risk during

surgical operations (Kam and Yarrow, 2005). Steroids can also lead to breast development in males and testicular shrinkage.

Creatine is a naturally occurring nitrogen compound found primarily in skeletal muscle. It is believed that increasing creatine levels may prolong skeletal muscle activity, enhancing work output. Using supplemental creatine is recognized to prevent the depletion of ATP, which is the substance that provides energy in our body cells. However, it is advised that young athletes be cautious about taking creatine because its effects on growth and development are unknown and long-term safety and efficacy have not been adequately established. This is, in part, due to potential concerns of mad cow disease, since creatine is obtained from bovine sources.

Many so-called **ergogenic** aids have not been proven to enhance athletic performance, especially for youth, but have potential for many adverse effects (Nemet and Eliakim, 2007). Recent changes in the legal status of several substances, new rules for athletic children and adolescents including drug testing of high school students, and educational initiatives designed for the young athlete are aimed at reducing use of harmful substances in athletics (Calfee and Fadale, 2006).

Fact & Fallacy

FALLACY Protein supplements are needed to enhance athletic performance.

FACT It is easy to get enough protein from foods. An adolescent athlete weighing 180 lb requires about 120 g of protein. The maximum number of servings in the MyPyramid Food Guidance System provides this amount of protein. ■

Research on the impact of increasing physical activity levels in children is limited with guidelines being generally based on research in adults. There is evidence that children preferentially use fats as a fuel substrate more efficiently than adults. This is likely due to a limited reserve of muscle glycogen, as well as hormonal differences from adults. With the onset of puberty, the hormonal changes appear to alter fuel substrate use toward preferential use of glucose (Aucouturier, Baker, and Duché, 2008).

Generally speaking, carbohydrate in the form of glucose in the blood is used initially as a fuel source, followed by the storage form, glycogen, found in the liver and muscle. Postexercise glycogen stores are replenished from glucose levels in the blood. This can lead to late-onset hypoglycemia with insufficient carbohydrate intake. This can be particularly problematic for children with diabetes and insulin management (Corigliano and colleagues, 2006). A daily carbohydrate intake of at least 6 g/kg of body weight and intake of 30 to 60 g of carbohydrate during each hour of exercise delays the onset of fatigue (Lambert and Goedecke, 2003). Because there is the equivalent of ½ lb of sugar stored in the liver as glycogen, at least 200 g of carbohydrates are required to replenish glycogen stores. Additional carbohydrates beyond this amount are needed to replenish blood glucose levels and muscle glycogen stores. Fruit juice can be easily consumed and provides the needed carbohy-

drates, as well as being a fluid and electrolyte source. Drinking 1 cup of juice or the equivalent of 30 g of carbohydrates every 15 minutes for about 4 or 5 hours after the sports event may be required.

THE FEMALE ATHLETE TRIAD

The term **female athlete triad** has been coined to describe the combination of menstrual irregularity due to altered hormonal balance, disordered eating, and premature osteoporosis seen in some female athletes. The definition of the female athlete triad includes eating disorders or a milder form of disordered eating behavior, **amenorrhea** (no menstrual cycle) or **oligomenorrhea** (scanty or infrequent menstruation), and decreased bone mineral density—osteopenia or osteoporosis. The risk of stress fractures is increased among whites who have low bone-mineral density, history of stress fractures, or both conditions.

Girls who are involved with sports that emphasize leanness and restrictive eating behaviors are at greatest risk. Girls in these sports and their adult trainers and mentors need to be educated about the dangers. There is no simple approach to managing the female athlete triad. Improved nutritional intake, however, is paramount to preserve bone mass. Adequate intake of calcium and other nutrients needed to prevent osteoporosis is essential. This includes an adequate intake of protein and kcalories with vitamin D, magnesium, and potassium at a minimum. Calcium supplementation and hormone replacement therapy may be needed in adolescent girls with amenorrhea and low levels of estrogen production to help prevent the early onset of osteoporosis.

Promotion of the menstrual cycle is important due to the benefit of estrogen to help preserve bone mass. This is best addressed by prevention of loss of excess body weight and by adequate intake of kcalories for expected kcalorie expenditures. It has been found that most adverse effects appear to occur at less than 30 kcal/kg of fat-free body mass per day (Nattiv and colleagues, 2007).

RISK OF DEHYDRATION

Over 50 high schools in 26 states were surveyed regarding the number of heat injuries sustained in their football programs. Not unexpectedly there were more heat injuries preseason. On average there were just under 1.5 incidents per program preseason and about 1 incident per season of football. It is advised that schools provide better education and oversight for reducing incidents of heat strain and dehydration with an emergency action plan for effective management of heat injuries (Luke, Bergeron, and Roberts, 2007). A study of American football players found that 24-hour fluid requirements ranged from 8.8 to 19 L based on high sweat losses (Godek, Bartolozzi, and Godek, 2005).

Two cups (16 oz) of water equals 1 lb of water loss from sweating. The need for fluid replacement is based on weight loss during a sporting event or training. In general, it is recommended that athletes drink about 16 oz of fluid 1 to 2 hours before an event, and for intense prolonged exercise lasting longer than 1 hour, athletes should consume between 20 and 40 oz per hour of a solution containing 30 to 60 g

Box 12-4 Fluid Replacement and Goals for Carbohydrate and Sodium for Endurance Athletics (per 20 oz)

- 6 oz commercial broth diluted with 14 oz water and 2 oranges cut into quarters
- Just under ¼ tsp salt and 2 tbsp sugar dissolved in 20 oz water
- Just under ¼ tsp salt dissolved in 8 oz fruit juice* diluted with 12 oz water
- 16 oz commercial sports drink containing 500-700 mg sodium and 30 g carbohydrates with additional 4 oz water

*Orange juice, grapefruit juice, or lemonade will provide potassium.

of carbohydrates with 500 to 700 mg of sodium per liter of fluid or the equivalent (see Box 12-4 for alternatives). This will allow for proper hydration, maintain performance, lower submaximal exercise heart rate, maintain plasma volume, and reduce heat stress, heat exhaustion, and possibly heat stroke (Von Duvillard and colleagues, 2004).

General signs of thirst should not be relied on to determine when fluids should be consumed during athletic events. The warning signals that occur during severe dehydration are the following:

- Pronounced thirst
- Loss of coordination
- Mental confusion with irritability
- Dry skin
- Decreased urine output

Teaching Pearl

"A pint's a pound the world around." This old saying can help you to remember that 1 pt (16 oz) of fluid is needed to replace 1 lb (16 oz) of fluid loss through exercise as noted on a weight scale. ■

WHAT IS THE ROLE OF THE NURSE OR OTHER HEALTH CARE PROFESSIONALS IN PROMOTING GOOD NUTRITION DURING CHILDHOOD?

FOR CHILDREN

The terminology used with children needs to be concrete and nonscientific. Children cannot understand abstract concepts, such as the role of nutrients in foods, even though a young child can pronounce the words. Therefore it is more appropriate to focus on promoting positive attitudes toward eating nutritious foods. Children can appreciate the concept that eating is fun, and this concept should be applied to nutritious foods. One method that strongly appeals to children (and even to the parents who may be present) is the use of puppet shows. Stick puppets are made easily with food pictures, and with the addition of paper eyes and mouths they "come alive." Children's books such as *Green Eggs and Ham* or *Stone Soup* can also favorably influence a child's willingness to try new foods.

The importance of good dental care spans all ages, from infancy to very old age. Emphasizing good oral hygiene with regular dental checkups for plaque removal is in order. Infants can have their teeth cleaned with a wet washcloth. Young children can be taught to brush their teeth or have their parents do it for them. The use of fluoride tablets should be promoted for children under 12 years of age if it is not in the local water supply. Assessment of dietary practices is important, especially that of between-meal snacking habits. Sugar is a known cariogenic food. If sweetened foods are eaten at mealtimes, they are less cariogenic. Cheese as part of a snack can help prevent dental decay, possibly because of the calcium and phosphate content, but certainly because of the protein and fat content. However, in the attempt to prevent dental caries we do not want to promote heart disease. To avoid excess intake of fat, food models might be used to show what 1 oz of cheese looks like. Local educational programs on dental health are usually offered by the health department or the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC program) (see Chapter 14). These programs generally focus on children's dental health. The health care professional should be aware of local programs to make referrals.

FOR TEENAGERS

A sensitive approach to teenagers' needs, recognizing their need for independence and acceptance by their peers, should be used in counseling or educational settings. The use of appropriate humor can help the teenager recognize that the health care professional is a caring human being, not merely an authority figure. Comments should be positive ones that help promote positive self-worth and do not undermine a teenager's already fragile self-image. Teenagers should be told about realistic body perceptions and eating patterns such as those represented in growth charts and the Dietary Guidelines.

Nutrition counseling is especially important for the teenager who has failed to develop good food habits up to this point and for the teenager who has strayed from previously good habits. Information should be presented in an interesting and motivating manner. Because teenagers are very interested in their physical appearance, it should be emphasized that adequate nutrients allow for optimal growth and development of their bodies. A teenage girl who believes that she is overweight and starts to lose weight too rapidly can use a growth chart to gain a better sense of normalcy. This tool can be particularly helpful to a teenager with anorexia or bulimia by illustrating the growth fall from the normal curve (see Figure 12-4). Health care professionals need to be aware of the existence of bulimia and its detrimental effect on dental health. A health care team approach is advised for bulimia.

It is important that the counselor respect the teenager's independence. Presenting the adolescent with flexible eating styles instead of a rigid eating pattern will increase the effectiveness of counseling. Special problems of teenagers, such as obesity, alcoholism, anorexia nervosa, and pregnancy, should be an important focus of nutrition counseling. Sports nutrition and appropriate use of supplements are issues increasingly facing American teens. Prevention of heart disease, cancer, diabetes, osteoporosis, and other diseases that may occur later in life needs to be addressed with this population.

Chapter Challenge Questions & Classroom Activities

1. How would you explain the terms *growth* and *development?*
2. What effects might be expected later in life from foods inadequate in quantity and quality during the growing period?
3. Why is it important to prevent baby-bottle tooth decay?
4. What would you advise parents who insist their toddler needs a bedtime bottle?
5. Why is it particularly important for an adolescent girl to have a nutritious diet?
6. What are the characteristics of anorexia nervosa and bulimia?
7. Why are persons with bulimia at high risk for dental erosion? What steps should be taken by one's dental hygienist if bulimia-induced dental caries are suspected?
8. What are some strategies to make snacking less harmful to dental health?
9. What advice would you provide to a high school sports team?

Case Study

Gina Louise looked at her plate and added up the carbs, and then punched in the numbers on her insulin pump. She used a 1:8 insulin-to-carbohydrate ratio, which had been increased because of an A1c of 8.8%. Her diabetes educator had recommended the increased use of insulin to help meet her A1c target. The educator had said an increased need for insulin was due to her maternal grandfather's having type 2 diabetes and her father having been diagnosed with the metabolic syndrome, along with her teenage growth spurt. But she hadn't told the educator that she would punch in a lower amount of carbohydrate grams into the pump so that she didn't have to worry about low blood glucose levels. She added up her meal carbs to 60 g but told the pump she had 30 g because she planned to swim at the school pool later. She also had found by running higher blood glucose levels that she didn't put weight on. She didn't want to look like her mother. She planned to write in her blood glucose log that her sugar reading was 119—it sounded like a good number to her.

Critical Thinking Applications

1. Refer back to Chapter 8; what is an optimal A1c number; what are optimal blood glucose readings?
2. If Gina Louise needs a 1:8 insulin-to-carbohydrate ratio, how much insulin would she need for 60 g of carbohydrates?
3. If the diabetes educator sees a blood glucose log with numbers in the 120s on average but there is an A1c of 8.8%, what should be considered; what assessment questions should Gina Louise be asked?
4. What health problems is Gina Louise at risk for?

REFERENCES

Adams JB, Holloway CE, George F, Quig D: Analyses of toxic metals and essential minerals in the hair of Arizona children with autism and associated conditions, and their mothers, *Biol Trace Elem Res* 110(3):193-209, 2006.

Adams JB, Romdalvik J, Ramanujam VM, Legator MS: Mercury, lead, and zinc in baby teeth of children with autism versus controls, *J Toxicol Environ Health A* 70(12):1046-1051, 2007.

Alhaj E, Alhaj N, Alhaj NE: Diffuse alopecia in a child due to dietary zinc deficiency, *Skinmed* 6(4):199-200, 2007.

Amiet C, Gourfinkel-An I, Bouzamondo A, Tordjman S, Baulac M, Lechat P, Mottron L, Cohen D: Epilepsy in

autism is associated with intellectual disability and gender: evidence from a meta-analysis, *Biol Psychiatry* 64(7):577-582, 2008.

Arnold GL, Hyman SL, Mooney RA, Kirby RS: Plasma amino acids profiles in children with autism: potential risk of nutritional deficiencies, *J Autism Dev Disord* 33(4):449-454, 2003.

Aucouturier J, Baker JS, Duché P: Fat and carbohydrate metabolism during submaximal exercise in children, *Sports Med* 38(3):213-238, 2008.

Banerjee TD, Middleton F, Faraone SV: Environmental risk factors for attention-deficit hyperactivity disorder, *Acta Paediatr* 96(9):1269-1274, 2007.

Bede O, Suranyi A, Pinter K, Szlavik M, Gyurkovits K: Urinary magnesium excretion in asthmatic children receiving magnesium supplementation: a randomized, placebo-controlled, double-blind study, *Magnes Res* 16(4):262-270, 2003.

Boisseau N, Vermorel M, Rance M, Duché P, Patureau-Mirand P: Protein requirements in male adolescent soccer players, *Eur J Appl Physiol* 100(1):27-33, 2007.

Bolte G, Kompauer I, Fobker M, Cullen P, Keil U, Mutius E, Weiland SK: Fatty acids in serum cholesteryl esters in relation to asthma and lung function in children, *Clin Exp Allergy* 36(3):293-302, 2006.

Borowitz SM, Cox DJ, Kovatchev B, Ritterband LM, Sheen J, Sutphen J: Treatment of childhood constipation by primary care physicians: efficacy and predictors of outcome, *Pediatrics* 115(4):873-877, 2005.

Bounds W, Skinner J, Carruth BR, Ziegler P: The relationship of dietary and lifestyle factors to bone mineral indexes in children, *J Am Diet Assoc* 105(5):735-741, 2005.

Bourre JM: Effects of nutrients (in food) on the structure and function of the nervous system: update on dietary requirements for brain. I. Micronutrients, *J Nutr Health Aging* 10(5):377-385, 2006.

Breakey J: Is food intolerance due to an inborn error of metabolism? *Asia Pac J Clin Nutr* 13(Suppl):S175, 2004.

Briefel R, Ziegler P, Novak T, Ponza M: Feeding Infants and Toddlers Study: characteristics and usual nutrient intake of Hispanic and non-Hispanic infants and toddlers, *J Am Diet Assoc* 106(1 Suppl 1):S84-95, 2006.

Burk CJ, Molodow R: Infantile scurvy: an old diagnosis revisited with a modern dietary twist, *Am J Clin Dermatol* 8(2):103-106, 2007.

Calfee R, Fadale P: Popular ergogenic drugs and supplements in young athletes, *Pediatrics* 117(3):e577-e589, 2006.

Caraballo R, Garro F, Cersosimo R, Buompadre C, Ganez LA, Fejerman N: Pyridoxine dependence: the importance of the clinical diagnosis and early treatment, *Rev Neurol* 38(1):49-52, 2004.

Carr RR, Nahata MC: Complementary and alternative medicine for upper-respiratory-tract infection in children, *Am J Health Syst Pharm* 63(1):33-39, 2006.

Centers for Disease Control and Prevention: Blood lead levels—United States, 1999-2002, *MMWR Morb Mortal Wkly Rep* 54(20):513-516, 2005.

Clauson KA, Shields KM, McQueen CE, Persad N: Safety issues associated with commercially available energy drinks, *J Am Pharm Assoc (2003)* 48(3):e55-e67, 2008.

Cluskey M, Edlefsen M, Olson B, Reicks M, Auld G, Bock MA, Boushey CJ, Bruhn C, Goldberg D, Misner S, Wang C, Zaghloul S: At-home and away-from-home eating patterns influencing preadolescents' intake of calcium-rich food as perceived by Asian, Hispanic and non-Hispanic white parents, *J Nutr Educ Behav* 40(2):72-79, 2008.

Cole CR, Lifshitz F: Zinc nutrition and growth retardation, *Pediatr Endocrinol Rev* 5(4):889-896, 2008.

Colter AL, Cutler C, Meckling KA: Fatty acid status and behavioural symptoms of attention deficit hyperactivity disorder in adolescents: a case-control study, *Nutr J* 7:8, 2008.

Comas Vives A, Polanco Allue I: Case-control study of risk factors associated with constipation. The FREI Study, *An Pediatr (Barc)* 62(4):340-345, 2005.

Corigliano G, Iazzetta N, Corigliano M, Strollo F: Blood glucose changes in diabetic children and adolescents engaged in most common sports activities, *Acta Biomed* 77(Suppl 1):26-33, 2006.

Cullen KW, Baranowski T, Klesges LM, Watson K, Sherwood NE, Story M, Zakeri I, Leachman-Slawson D, Pratt C: Anthropometric, parental, and psychosocial correlates of dietary intake of African-American girls, *Obes Res* 12(Suppl):20S-31S, 2004.

Dalbey M: Implementing smart growth strategies in rural America: development patterns that support public health goals, *J Public Health Manag Pract* 14(3):238-343, 2008.

Daniels SR: Regulation of body mass and management of childhood overweight, *Pediatr Blood Cancer* 44(7):589-594, 2005.

Desoto MC, Hitlan RT: Blood levels of mercury are related to diagnosis of autism: a reanalysis of an important data set, *J Child Neurol* 22(11):1308-1311, 2007.

Deth R, Muratore C, Benzecry J, Power-Charnitsky VA, Waly M: How environmental and genetic factors combine to cause autism: a redox/methylation hypothesis, *Neurotoxicology* 29(1):190-201, 2008.

Dettmer K, Hanna D, Whetstone P, Hansen R, Hammock BD: Autism and urinary exogenous neuropeptides: development of an on-line SPE-HPLC-tandem mass spectrometry method to test the opioid excess theory, *Anal Bioanal Chem* 388(8):1643-1651, 2007.

Dhonukshe-Rutten RA, van Dusseldorp M, Schneede J, de Groot LC, van Staveren WA: Low bone mineral density and bone mineral content are associated with low cobalamin status in adolescents, *Eur J Nutr* 44(6):341-347, 2005.

Diaz RM, Gonzalez-Rabelino G, Delfino A: Epilepsy, cerebral calcifications and coeliac disease: the importance of an early diagnosis, *Rev Neurol* 40(7):417-420, 2005.

Eichenberger Gilmore JM, Hong L, Broffitt B, Levy SM: Longitudinal patterns of vitamin and mineral supplement use in young white children, *J Am Diet Assoc* 105(5):763-772, 2005.

Elliot DL, Goldberg L, Moe EL, Defrancesco CA, Durham MB, Hix-Small H: Preventing substance use and disordered eating: initial outcomes of the ATHENA (Athletes Targeting Healthy Exercise and Nutrition Alternatives) program, *Arch Pediatr Adolesc Med* 158(11):1043-1049, 2004.

Falk B, Braid S, Moore M, O'Leary D, Sullivan P, Klentrou P: Bone properties in overweight pre- and early-pubertal boys, *Pediatr Exerc Sci* 20(1):50-61, 2008.

Fanjiang G, Kleinman RE: Nutrition and performance in children, *Curr Opin Clin Nutr Metab Care* 10(3):342-347, 2007.

Fayed SB, Aref MI, Fathy HM, Dayem SM, Emara NA, Maklof A, Shafik A: Prevalence of celiac disease, *Helicobacter pylori* and gastroesophageal reflux in patients with refractory iron deficiency anemia, *J Trop Pediatr* 54(1):43-53, 2008.

Fox MK, Reidy K, Novak T, Ziegler P: Sources of energy and nutrients in the diets of infants and toddlers, *J Am Diet Assoc* 106(1 Suppl 1):S28-S42, 2006.

Freedman DS, Khan LK, Serdula MK, Dietz WH, Srinivasan SR, Berenson GS: The relation of childhood BMI to adult adiposity: the Bogalusa Heart Study, *Pediatrics* 115(1):22-27, 2005.

Fu ML, Cheng L, Tu SH, Pan WH: Association between unhealthful eating patterns and unfavorable overall school performance in children, *J Am Diet Assoc* 107(11): 1935-1943, 2007.

Galloway AT, Fiorito L, Lee Y, Birch LL: Parental pressure, dietary patterns, and weight status among girls who are "picky eaters," *J Am Diet Assoc* 105(4):541-548, 2005.

Godek SF, Bartolozzi AR, Godek JJ: Sweat rate and fluid turnover in American football players compared with runners in a hot and humid environment, *Br J Sports Med* 39(4):205-211, 2005.

Gonzalez VM, Vitousek KM: Feared food in dieting and nondieting young women: a preliminary validation of the Food Phobia Survey, *Appetite* 43(2):155-173, 2004.

Hakim F, Kerem E, Rivlin J, Bentur L, Stankiewicz H, Bdolach-Abram T, Wilschanski M: Vitamins A and E and pulmonary exacerbations in patients with cystic fibrosis, *J Pediatr Gastroenterol Nutr* 45(3):347-353, 2007.

Hauk PJ: The role of food allergy in atopic dermatitis, *Curr Allergy Asthma Rep* 8(3):188-194, 2008.

Hill ID, Dirks MH, Liptak GS, Colletti RB, Fasano A, Guandalini S, Hoffenberg EJ, Horvath K, Murray JA, Pivor M, Seidman EG: Guideline for the diagnosis and treatment of celiac disease in children: recommendations of the North American Society for Pediatric Gastroenterology, Hepatology and Nutrition, *J Pediatr Gastroenterol Nutr* 40(1):1-19, 2005.

Hillesund E, Skranes J, Trygg KU, Bøhmer T: Micronutrient status in children with cerebral palsy, *Acta Paediatr* 96(8):1195-1198, 2007.

Horton S, Barker JC: Rural Latino immigrant caregivers' conceptions of their children's oral disease, *J Public Health Dent* 68(1):22-29, 2008.

Huerta MG, Roemmich JN, Kington ML, Bovbjerg VE, Weltman AL, Holmes VF, Patrie JT, Rogol AD, Nadler JL: Magnesium deficiency is associated with insulin resistance in obese children, *Diabetes Care* 28(5):1175-1181, 2005.

Iyadurai SJ, Chung SS: New-onset seizures in adults: possible association with consumption of popular energy drinks, *Epilepsy Behav* 10(3):504-508, 2007.

Janssen I, Katzmarzyk PT, Boyce WF, Vereecken C, Mulvihill C, Roberts C, Currie C, Pickett W; Health Behaviour in School-Aged Children Obesity Working Group: Comparison of overweight and obesity prevalence in school-aged youth from 34 countries and their relationships with physical activity and dietary patterns, *Obes Rev* 6(2):123-132, 2005.

Kaiser LL, Martinez NM, Harwood JO, Garcia LC: Child-parent feeding relationships in low-income Latino households, *J Am Diet Assoc* 99(5):601-603, 1999.

Kam PC, Yarrow M: Anabolic steroid abuse: physiological and anaesthetic considerations, *Anaesthesia* 60(7):685-692, 2005.

Kim DW, Kang HC, Park JC, Kim HD: Benefits of the nonfasting ketogenic diet compared with the initial fasting ketogenic diet, *Pediatrics* 114(6):1627-1630, 2004.

Kim YN, Lora KR, Giraud DW, Driskell JA: Nonsupplemented children of Latino immigrants have low vitamin E intakes and plasma concentrations and normal vitamin C, selenium, and carotenoid intakes and plasma concentrations, *J Am Diet Assoc* 106(3):385-391, 2006.

Knight CA, Knight I, Mitchell DC, Zepp JE: Beverage caffeine intake in U.S. consumers and subpopulations of interest: estimates from the Share of Intake Panel Survey, *Food Chem Toxicol* 42(12):1923-1930, 2004.

Komlos J, Breitfelder A: Height of US-born non-Hispanic children and adolescents ages 2-19, born 1942-2002 in the NHANES samples, *Am J Hum Biol* 20(1):66-71, 2008.

Koscik RL, Farrell PM, Kosorok MR, Zaremba KM, Laxova A, Lai HC, Douglas JA, Rock MJ, Splaingard ML: Cognitive function of children with cystic fibrosis: deleterious effect of early malnutrition, *Pediatrics* 113(6):1549-1558, 2004.

Kranz S, Lin PJ, Wagstaff DA: Children's dairy intake in the United States: too little, too fat? *J Pediatr* 151(6):642-646, 2007.

Kranz S, Mitchell DC, Siega-Riz AM, Smiciklas-Wright H: Dietary fiber intake by American preschoolers is associated with more nutrient-dense diets, *J Am Diet Assoc* 105(2):221-225, 2005.

Kranz S, Siega-Riz AM, Herring AH: Changes in diet quality of American preschoolers between 1977 and 1998, *Am J Public Health* 94(9):1525-1530, 2004.

Kwiecien J, Karczewska K, Lukasik M, Kasner J, Dyduch A, Zabka A, Sulej J, Ronczkowski S: Negative results of

antiendomysial antibodies: long term follow up, *Arch Dis Child* 90(1):41-42, 2005.

Lambert EV, Goedecke JH: The role of dietary macronutrients in optimizing endurance performance, *Curr Sports Med Rep* 2(4):194-201, 2003.

Lang C, Murgia C, Leong M, Tan LW, Perozzi G, Knight D, Ruffin R, Zalewski P: Anti-inflammatory effects of zinc and alterations in zinc transporter mRNA in mouse models of allergic inflammation, *Am J Physiol Lung Cell Mol Physiol* 292(2):L577-L584, 2007.

Lee SY, Hoerr SL, Schiffman RF: Screening for infants' and toddlers' dietary quality through maternal diet, *MCN Am J Matern Child Nurs* 30(1):60-66, 2005.

Liptak GS, Benzoni LB, Mruzek DW, Nolan KW, Thingvoll MA, Wade CM, Fryer GE: Disparities in diagnosis and access to health services for children with autism: data from the National Survey of Children's Health, *J Dev Behav Pediatr* 29(3):152-160, 2008.

Lovell G: Vitamin D status of females in an elite gymnastics program, *Clin J Sport Med* 18(2):159-161, 2008.

Luke AC, Bergeron MF, Roberts WO: Heat injury prevention practices in high school football, *Clin J Sport Med* 17(6):488-493, 2007.

Mackay MT, Bicknell-Royle J, Nation J, Humphrey M, Harvey AS: The ketogenic diet in refractory childhood epilepsy, *J Paediatr Child Health* 41(7):353-357, 2005.

Millward C, Ferriter M, Calver S, Connell-Jones G: Gluten- and casein-free diets for autistic spectrum disorder, *Cochrane Database Syst Rev* (2):CD003498, 2008.

Mousain-Bosc M, Roche M, Polge A, Pradal-Prat D, Rapin J, Bali JP: Improvement of neurobehavioral disorders in children supplemented with magnesium-vitamin B_6. I. Attention deficit hyperactivity disorders, *Magnes Res* 19(1):46-52, 2006.

Murphy MM, Douglass JS, Johnson RK, Spence LA: Drinking flavored or plain milk is positively associated with nutrient intake and is not associated with adverse effects on weight status in US children and adolescents, *J Am Diet Assoc* 108(4):631-639, 2008.

Nattiv A, Loucks AB, Manore MM, Sanborn CF, Sundgot-Borgen J, Warren MP; American College of Sports Medicine: American College of Sports Medicine position stand: the female athlete triad, *Med Sci Sports Exerc* 39(10):1867-1882, 2007.

Nemet D, Eliakim A: [Banned performance enhancing ergogenic aids in children and adolescent athletes], *Harefuah* 146(10):794-799, 812, 2007.

Nicklaus S, Boggio V, Chabanet C, Issanchou S: A prospective study of food variety seeking in childhood, adolescence and early adult life, *Appetite* 44(3):289-297, 2005a.

Nicklaus S, Boggio V, Issanchou S: Gustatory perceptions in children, *Arch Pediatr* 12(5):579-584, 2005b.

Nja F, Nystad W, Lodrup Carlsen KC, Hetlevik O, Carlsen KH: Effects of early intake of fruit or vegetables in relation to later asthma and allergic sensitization in school-age children, *Acta Paediatr* 94(2):147-154, 2005.

Noble JM, Mandel A, Patterson MC: Scurvy and rickets masked by chronic neurologic illness: revisiting "psychologic malnutrition," *Pediatrics* 119(3):e783-e790, 2007.

Nogovitsina OR, Levitina EV: Diagnostic value of examination of the magnesium homeostasis in children with attention deficit syndrome with hyperactivity, *Klin Lab Diagn* (5):17-19, 2005.

Novotny R, Daida YG, Acharya S, Grove JS, Vogt TM: Dairy intake is associated with lower body fat and soda intake with greater weight in adolescent girls, *J Nutr* 134(8):1905-1909, 2004.

O'Connor TM, Yang SJ, Nicklas TA: Beverage intake among preschool children and its effect on weight status, *Pediatrics* 118(4):e1010-e1018, 2006.

Ostblom E, Lilja G, Pershagen G, van Hage M, Wickman M: Phenotypes of food hypersensitivity and development of allergic diseases during the first 8 years of life, *Clin Exp Allergy* 38(8):1325-1332, 2008.

Padget A, Briley ME: Dietary intakes at child-care centers in central Texas fail to meet Food Guide Pyramid recommendations, *J Am Diet Assoc* 105(5):790-793, 2005.

Palmer RF, Blanchard S, Wood R: Proximity to point sources of environmental mercury release as a predictor of autism prevalence, *Health Place* 15(1):18-24, 2009.

Palmieri L, Papaleo V, Porcelli V, Scarcia P, Gaita L, Sacco R, Hager J, Rousseau F, Curatolo P, Manzi B, Militerni R, Bravaccio C, Trillo S, Schneider C, Melmed R, Elia M, Lenti C, Saccani M, Pascucci T, Puglisi-Allegra S, Reichelt KL, Persico AM: Altered calcium homeostasis in autism-spectrum disorders: evidence from biochemical and genetic studies of the mitochondrial aspartate/glutamate carrier AGC1, *Mol Psychiatry*, July 8, 2008 (Epub ahead of print).

Pardo Lozano R, Alvarez García Y, Barral Tafalla D, Farré Albaladejo M: [Caffeine: a nutrient, a drug or a drug of abuse], *Adicciones* 19(3):225-238, 2007.

Patrick H, Nicklas TA, Hughes SO, Morales M: The benefits of authoritative feeding style: caregiver feeding styles and children's food consumption patterns, *Appetite* 44(2):243-249, 2005.

Peterson SJ, Tangney CC, Pimentel-Zablah EM, Hjelmgren B, Booth G, Berry-Kravis E: Changes in growth and seizure reduction in children on the ketogenic diet as a treatment for intractable epilepsy, *J Am Diet Assoc* 105(5):718-725, 2005.

Polley DC, Spicer MT, Knight AP, Hartley BL: Intrafamilial correlates of overweight and obesity in African-American and Native-American grandparents, parents, and children in rural Oklahoma, *J Am Diet Assoc* 105(2):262-265, 2005.

Pothmann R, Danesch U: Migraine prevention in children and adolescents: results of an open study with a special butterbur root extract, *Headache* 45(3):196-203, 2005.

Powers SW, Mitchell MJ, Patton SR, Byars KC, Jelalian E, Mulvihill MM, Hovell MF, Stark LJ: Mealtime behaviors in families of infants and toddlers with cystic fibrosis, *J Cyst Fibros* 4(3):175-182, 2005.

Rogers EJ: Has enhanced folate status during pregnancy altered natural selection and possibly autism prevalence? A closer look at a possible link, *Med Hypotheses* 71(3):406-410, 2008.

Rowe BH, Camargo CA Jr: The role of magnesium sulfate in the acute and chronic management of asthma, *Curr Opin Pulm Med* 14(1):70-76, 2008.

Rubenstein JE, Kossoff EH, Pyzik PL, Vining EP, McGrogan JR, Freeman JM: Experience in the use of the ketogenic diet as early therapy, *J Child Neurol* 20(1):31-34, 2005.

Sackesen C, Ercan H, Dizdar E, Soyer O, Gumus P, Tosun BN, Büyüktuncer Z, Karabulut E, Besler T, Kalayci O: A comprehensive evaluation of the enzymatic and nonenzymatic antioxidant systems in childhood asthma, *J Allergy Clin Immunol* 122(1):78-85, 2008.

Schebendach JE, Mayer LE, Devlin MJ, Attia E, Contento IR, Wolf RL, Walsh BT: Dietary energy density and diet variety as predictors of outcome in anorexia nervosa, *Am J Clin Nutr* 87(4):810-816, 2008.

Schechter R, Grether JK: Continuing increases in autism reported to California's Developmental Services System: mercury in retrograde, *Arch Gen Psychiatry* 65(1):19-24, 2008.

Singh GK, Kogan MD, van Dyck PC: A multilevel analysis of state and regional disparities in childhood and adolescent obesity in the United States, *J Community Health* 33(2):90-102, 2008.

Smith AM, Roux S, Naidoo NT, Venter DJ: Food choice of tactile defensive children, *Nutrition* 21(1):14-19, 2005.

Strambi M, Longini M, Hayek J, Berni S, Macucci F, Scalacci E, Vezzosi P: Magnesium profile in autism, *Biol Trace Elem Res* 109(2):97-104, 2006.

Strumia R: Dermatologic signs in patients with eating disorders, *Am J Clin Dermatol* 6(3):165-173, 2005.

Syme C, Abrahamowicz M, Leonard GT, Perron M, Pitiot A, Qiu X, Richer L, Totman J, Veillette S, Xiao Y, Gaudet D, Paus T, Pausova Z: Intra-abdominal adiposity and individual components of the metabolic syndrome in adolescence: sex differences and underlying mechanisms, *Arch Pediatr Adolesc Med* 162(5):453-461, 2008.

Takeda A, Yamada K, Minami A, Nagano T, Oku N: Enhanced excitability of hippocampal mossy fibers and CA3 neurons under dietary zinc deficiency, *Epilepsy Res* 63(2-3):77-84, 2005.

Tofil NM, Benner KW, Winkler MK: Fatal hypermagnesemia caused by an Epsom salt enema: a case illustration, *South Med J* 98(2):253-256, 2005.

Umemura T, Ueda K, Nishioka K, Hidaka T, Takemoto H, Nakamura S, Jitsuiki D, Soga J, Goto C, Chayama K, Yoshizumi M, Higashi Y: Effects of acute administration of caffeine on vascular function, *Am J Cardiol* 98(11):1538-1541, 2006.

Van Biervliet S, Van Biervliet JP, Robberecht E: Serum zinc in patients with cystic fibrosis at diagnosis and after one year of therapy, *Biol Trace Elem Res* 112(3):205-211, 2006.

Van Horn L, Obarzanek E, Friedman LA, Gernhofer N, Barton B: Children's adaptations to a fat-reduced diet: the Dietary Intervention Study in Children (DISC), *Pediatrics* 115(6):1723-1733, 2005.

Vojdani A, O'Bryan T, Green JA, Mccandless J, Woeller KN, Vojdani E, Nourian AA, Cooper EL: Immune response to dietary proteins, gliadin and cerebellar peptides in children with autism, *Nutr Neurosci* 7(3):151-161, 2004.

Von Duvillard SP, Braun WA, Markofski M, Beneke R, Leithauser R: Fluids and hydration in prolonged endurance performance, *Nutrition* 20(7-8):651-656, 2004.

Wang F, Van Den Eeden SK, Ackerson LM, Salk SE, Reince RH, Elin RJ: Oral magnesium oxide prophylaxis of frequent migrainous headache in children: a randomized, double-blind, placebo-controlled trial, *Headache* 43(6):601-610, 2003.

Wang HS, Kuo MF, Chou ML, Hung PC, Lin KL, Hsieh MY, Chang MY: Pyridoxal phosphate is better than pyridoxine for controlling idiopathic intractable epilepsy, *Arch Dis Child* 90(5):512-515, 2005.

Wang J, Visness CM, Sampson HA: Food allergen sensitization in inner-city children with asthma, *J Allergy Clin Immunol* 115(5):1076-1080, 2005.

Wei J, Hemmings GP: Gene, gut and schizophrenia: the meeting point for the gene-environment interaction in developing schizophrenia, *Med Hypotheses* 64(3):547-552, 2005.

White KC: Anemia is a poor predictor of iron deficiency among toddlers in the United States: for heme the bell tolls, *Pediatrics* 115(2):315-320, 2005.

Wiley AS: Does milk make children grow? Relationships between milk consumption and height in NHANES 1999-2002, *Am J Hum Biol* 17(4):425-441, 2005.

Williams KJ, Taylor CA, Wolf KN, Lawson RF, Crespo R: Cultural perceptions of healthy weight in rural Appalachian youth, *Rural Remote Health* 8(2):932, 2008.

Wood LG, Gibson PG, Garg ML: Circulating markers to assess nutritional therapy in cystic fibrosis, *Clin Chim Acta* 353(1-2):13-29, 2005.

Young WG: Tooth wear: diet analysis and advice, *Int Dent J* 55(2):68-72, 2005.

Ziegler P, Briefel R, Ponza M, Novak T, Hendricks K: Nutrient intakes and food patterns of toddlers' lunches and snacks: influence of location, *J Am Diet Assoc* 106(1 Suppl 1):S124-S134, 2006.

chapter

13

Nutrition Over the Adult Life Span

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Chapter Topics

Nutritional Concerns of Young Adulthood
Life Cycle Issues and Impact on Nutritional Status
Nutrient Needs Over the Life Span
Nutrition Issues for Women
Nutritional Needs for Physical Endurance, Strength, and Health in Sports and the Military
Common Medical Conditions in the Older Adult
Food and Drug Interactions
Nutrition Screening Initiative for Adults
The Role of the Nurse and Other Health Care Professionals in Promoting Nutritional Health of the Adult

Objectives

After completing this chapter, you should be able to:

- Explain how social, economic, and physiologic changes affect nutritional status over the adult life span.
- Discuss nutrient needs over the adult life span.
- Discuss common nutrition-related medical problems of the older adult.

Terms to Identify

Acetylcholine
Aging
Alzheimer's disease
Amyotrophic lateral sclerosis (ALS)
Anemia of chronic disease
Arthritis
Ascites
Dementia
DETERMINE Checklist
Gerontology
Huntington's disease
Hyponatremia
Intracellular hypoxia
Intrinsic factor
Lou Gehrig disease
Macular degeneration
Multiple sclerosis (MS)
Nutrition Screening Initiative
Over-the-counter medications (OTCs)
Overtraining syndrome
Parkinson's disease
Perimenopause
Polypharmacy
Pouching
Premenstrual dysphoric disorder (PMDD)
Probiotics
Psoriasis
Sarcopenia
Sports anemia

INTRODUCTION

The transition from adolescence to young adulthood brings its own set of challenges. Learning how to plan meals, eating within the workplace, or having late-night snacks in college dorms can have lasting health implications for the later years. Many chronic health problems have their roots in the habits of childhood and young adulthood. The promotion of good nutrition is an ongoing process through the life cycle.

The sense of immortality in adolescence slowly evolves into an awareness of how our actions affect our eventual mortality. The causes of mortality have changed since the beginning of the twentieth century. At that time average life expectancy was only 47 years, and infectious agents were central as the cause of death. In 2003, according to the Centers for Disease Control and Prevention, life expectancy rose to a record high of 77.6 years, largely because of improved health care and diet. Lifelong health and nutrition habits have profound effects on longevity and level of physical functioning in the elder years.

Goals of health over the life span may differ somewhat, but one element of commonality is how to delay the aging process. Current research suggests avoiding excess kilocalories for the goal of maintaining a stable, lean body weight, avoiding saturated fat, and emphasizing high-fiber foods are key components of healthy **aging** (the process of getting older, which is influenced by genetics and environmental factors). A healthy lifestyle during adulthood that follows one beginning in utero can best optimize one's genetic potential for longevity (Everitt and colleagues, 2006).

The extension of life expectancy has had and will continue to have a profound effect on society and the health care system. This is particularly true for adults who did not follow healthy guidelines during their youth or young adulthood and have to contend with chronic disease related to obesity. It is expected that the younger generations today will actually see a shortened life span due to cardiovascular disease, diabetes, renal disease, and cancer, all related to obesity and the metabolic syndrome. On the other hand, there are many health conscious and physically active individuals, who are in many ways healthier than their earlier counterparts.

Many of today's older adults are very different from those of past generations. It has been said that 50 is the new 30, and for many 50-year-olds, being labeled "middle-aged" does not have the same connotation as it once did. Increasingly, older adults are working far past the traditional retirement age of 65 years. Older adults in their 60s and 70s may even be more physically fit than in their younger years because they have increased time for physical activity (Figure 13-1). Other, relatively young adults may already be frail and in poor health because of chronic health problems or a lifetime of poor nutritional intake and substance abuse.

After the age of 80 there are physical declines for all. However, this elder population may still have much to contribute to society, such as being surrogate parents for grandchildren or even great-grandchildren. Even into the 90s more and more elder adults are maintaining their independence and are providing a unique perspective on life for the younger generations. Increasing numbers of adults are living past 100 years of age. The nutritional needs of centenarians are generally

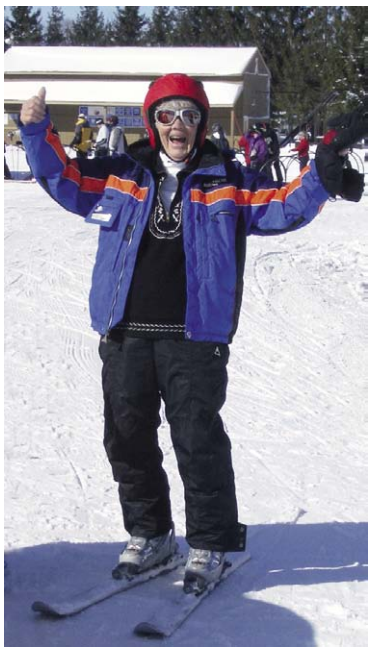


FIGURE 13-1 Older adults are increasingly staying active and involved in sports.

unknown, but research is developing for the very old and the frail elderly population.

Food and meal choices by adults generally stem from earlier life experiences. The older population who lived through the Great Depression of the 1930s often have a difficult time wasting food. This can lead to food poisoning from eating food that has been in the refrigerator too long or to obesity from trying to clean the plate, especially with the large portions now served in restaurants. On the other hand, older adults may have greater willingness to eat a variety of foods because of childhood consumption. Most older adults lived on farms at some point in their lives and were generally exposed to a wide variety of garden produce and fresh meat slaughtered on their land. Many lived in rural areas where it was common to hunt wild game and consume rabbit, squirrel, and woodchuck. Many of the elder population are first- or second-generation Americans and continue to follow more traditional ethnic eating. Such foods as sardines and herring may be considered a treat to the older adult, whereas a younger adult may not dream of eating fish at all. Not all adults ate well as children. They may have had severe limitations on the variety available or may have had negative meal environments and still refuse to eat vegetables because they were forced to do so as children. The complexity of cultural food values, diversity of health requirements, effects of aging on digestion and metabolism, and the array of meal options makes working with adults fascinating yet challenging. The field of **gerontology** (the study of the needs of older adults) continues to grow and develop.

Fact & Fallacy

FALLACY Amino acid supplements will promote longevity.

FACT The older adult's protein requirement is essentially the same as that of a younger person, and there is no truth to the notion that amino acid supplements have any effect on the aging process. A wide variety of good protein sources are available, even for individuals who have poor dentition. ■

WHAT ARE NUTRITIONAL CONCERNS OF THE YOUNG ADULT?

College is a time of weight gain for many students, especially freshman year. A variety of factors play into this, including the "all-you-can-eat" dining halls, late-night snacking (Figure 13-2), convenience of high-fat snack foods, drinking sugar-based beverages, refrigerators in dorm rooms, eating quickly, and reduced physical activity from sitting in classes along with studying in the library. The freshman 10 (pounds) has increased over time to the freshman 15, and many college students gain far more weight than this.

Entering the workforce also alters food habits and may reduce kcalorie expenditure. Once-athletic adolescents or former military personnel who now find themselves in desk jobs 40 hours weekly may soon realize that their food habits need to change to curb weight gain.

Other changes occur to transform eating habits, from living on one's own to eating at restaurants on dates and blending food preferences in a marriage or partnership. Social occasions contribute to overeating high-fat, high-sugar foods, some of which are entrenched in society (Figure 13-3). Becoming parents can dramatically affect mealtimes (e.g., contending with a crying baby during dinner).

If young adults were exposed to a positive meal environment throughout their own childhood, and learned to accept a variety of foods, the transitions will be easier and a positive nutritional status can still be maintained. For the young adult who

FIGURE 13-2 Late-night snacking is a common social experience in college dormitories.

FIGURE 13-3 Marriage has many influences on food choices.

has not yet learned how to accept a variety of foods, it is still possible. Just as a child needs to try a new food 10 times before a preference is developed, the same seems to hold true for adults. The fear of new foods can still be a major obstacle, but with motivation can be overcome.

HOW DO LIFE CYCLE ISSUES AFFECT NUTRITIONAL STATUS?

SOCIAL CHANGES

Various changes incurred during the early adult years will influence food habits. This includes food availability at college and work settings, new relationships with blending of food preferences, and marriage status. A study of married individuals found widowed men and women were at the greatest risk of low carotenoid levels (Stimpson and Lackan, 2007). Even the empty nest can alter food habits for older couples. Older adults may stop cooking after children leave home, or increased intake may result because of an inability to decrease amounts of food prepared. Elder adults who are cared for by an adult son or daughter may have their usual intake altered with fewer choices available. Loss of mobility to shop for food occurs when physical impairments make driving a car or using public transportation difficult. Isolation from others will result unless there are friends or family members on whom the elder person can rely. Entering a nursing home profoundly changes eating habits. It is human nature not to deal well with change. Any change in the social environment can trigger depression, which can lead to overeating or undereating with concomitant changes in weight and nutritional status.

Alcohol plays a role in many adult lives. In college, binge drinking is common. One study found almost one quarter of college student current drinkers reported mixing alcohol with energy drinks. The combination of caffeine in the energy drinks with the alcohol can further impair judgment (O'Brien and colleagues, 2008). Older

adults lose their ability to metabolize alcohol as efficiently as when they were younger, leading to alcohol-related problems such as falls.

Caffeine plays a central role in most adults' lives. The older adult is most likely to drink black coffee or tea, whereas young to middle-age adults have designer coffees or caffeinated soft drinks and the younger adults may eat coffee beans or consume energy drinks that are marketed to this population. Most are not drinking the caffeinated beverages intentionally as a fluid source, although they do contribute fluid for bodily needs. A study of consumers of energy drinks found two thirds drank one container due to lack of sleep or energy provided, whereas about half drank three or more with alcohol while partying. About one out of five consumers of energy drinks reported they caused headaches and heart palpitations (Malinauskas and colleagues, 2007).

ECONOMIC CHANGES

A young adult, often earning minimum wage, may find it difficult to purchase nutritious foods. Learning how to budget to include the essentials is an important step in maintaining health throughout life. With advancing age, retirement from work usually results in a decrease in income at a time when an increased amount of money is being spent on medical care. As a result, less money may be available for food. High-protein foods may be consumed in lesser amounts because they are expensive and require preparation and many are difficult to chew and swallow. Young and old alike may consume excessive amounts of high-carbohydrate foods, which are inexpensive, easily stored without refrigeration, and simple to prepare.

PHYSICAL CHANGES

Once the growth spurt of adolescence is past, the need for kcalories decreases. During the aging process the basal metabolic rate begins to slow during the early adult years. By the middle adult years the amount of lean body mass (muscle tissue) begins to reduce. Exercise needs to be part of daily activities and will help to maintain muscle strength and tone throughout the adult years. Even bedridden older adults can exercise (Figure 13-4).

FIGURE 13-4 Exercise is possible even for bedridden adults.

During the later years, perceptual changes may affect eating behavior. Taste may be altered because of a decrease in the number of taste buds that occurs either as part of the aging process or as an effect of disease states, nutritional deficiencies, or medications. A reduced ability to detect odors and impaired hearing and sight may reduce the enjoyment of the social aspects of eating. All these perceptual changes may contribute to reduced food consumption. Reduced senses also increase the risk of food poisoning for the older adult who has impaired vision, taste, and smell (see Chapter 14 for guidelines on food safety).

Loss of teeth, found even with young adults and prevalent in the elder population, may lead to altered food choices that decrease the nutritive value of the diet. Ill-fitting dentures will also affect food choices. If refined foodstuffs are eaten instead of raw fruits and vegetables, alterations in gastrointestinal function may lead to constipation, especially at older ages, because of a decrease in the body's ability to move waste products through the gastrointestinal tract. Increasing the fiber content of the diet and maintaining an adequate fluid intake and exercise are important for gastrointestinal functioning.

With decline in function of organs such as the liver and kidneys, the metabolism and excretion of food nutrients are altered. Use of protein is altered with liver disease, and buildup of toxins can occur when the kidneys lose their ability to filter harmful substances. These health declines may be apparent with younger adults who have had chronic illness since childhood.

Because the sense of thirst diminishes with older adults, it is especially important for such individuals to be aware of the need for fluids to prevent dehydration. This is particularly true for a person taking diuretics to promote loss of excess fluid. However, for an individual with advanced renal disease or **ascites** (fluid buildup in the abdomen) from liver digease, fluid restrictions may be imposed.

Decreases in body secretions also occur with the older adult. For example, swallowing may become more difficult because of decreased saliva production, and protein digestion is less efficient because of decreased hydrochloric acid secretion. The body's production of digestive enzymes decreases with aging as well. Table 13-1 summarizes the effect of the physiologic changes in the older adult.

Even though little is known about an elder person's nutritional needs, meals should be planned according to the five-food-group system of the MyPyramid Food Guidance System, as discussed in Chapter 1. Six small meals per day are often more appropriate than three full-size meals for someone with a small appetite.

Teaching Pearl

The elder population was raised to respect authority figures. Consequently, many will adhere to advice given by health care providers, even if the advice is not in their best interest. Thorough assessment of nutritional habits, including fluid intake and other factors influencing eating habits and health requirements, needs to be conducted before any nutritional guidance is given, in order to avoid unintentional harm to the elder population. Manners and showing respect, including appropriate attire, are very important to many of the elder population and include being addressed as Mr., Mrs., or Miss, unless the individual states otherwise. Middle-age and younger adults generally prefer being called by their first name. ■

Table 13-1 Physiologic Changes in the Older Adult

COMPONENT	FUNCTIONAL CHANGE	OUTCOME
Body composition	↓ Muscle mass	↑ Fat tissue in muscle size and strength
	↓ Basal metabolic rate	↓ Caloric requirements
	↓ Bone density	↑ Risk of osteoporosis
Perceptions	↓ Hearing	Feeling of isolation
	Slowing of adaptation to darkness	Reluctance to eat in public places or at large social affairs
		Need for brighter light to perform tasks
	↓ Number of taste buds	↓ Ability to taste salt, sweet
		↑ Ability to taste bitter and sour
Gastrointestinal tract	↓ Smell	↑ Threshold for odors
	↓ Motility	Constipation
	↓ Hydrochloric acid	↓ Efficiency of protein digestion
		More prone to food poisoning
	↓ Saliva production	Difficulty swallowing
Heart	↑ Blood pressure	↓ Ability to handle physical work and stress
Lungs	↓ Ability to use oxygen	↑ Fatigue
	↓ Capacity to oxygenate blood	↓ Capacity for exercise
Endocrine	↓ Number of secretory cells	↓ Blood hormone levels
	↓ Insulin production	↑ Blood glucose level
Kidney	↓ Renal blood flow	↓ Capacity for filtration and absorption

WHAT ARE THE NUTRIENT NEEDS OVER THE LIFE SPAN?

ENERGY

Younger adults typically require 2000 to 2500 kcal daily. For this reason, the Daily Values found on food labels list the amounts of fat, carbohydrate, and protein based on these levels (see Figure 1-4). There is, however, a wide range in caloric needs for individuals, based on body composition, level of physical activity, age, and metabolism. For any adult, generally a minimum of 1200 to 1500 kcal is required to have an adequate nutritional intake, and most young adults will lose weight at these levels. For athletic adults the minimum kcalorie needs are generally at least 2000 kcal.

We know that energy needs are lower for the older adult because basal metabolism decreases gradually with aging owing to a decrease in lean body tissue. Older adults generally have the same minimum needs for micronutrients and protein as younger adults, with the minimum number of servings of the MyPyramid being necessary throughout the adult life span.

PROTEIN

Protein requirements do not decrease with age. It is now generally believed that a slightly higher need for protein exists for the elder population at 1.0 g/kg of body weight—versus 0.8 g/kg for the younger adult—because of the diminishing efficiency of protein use in the older adult. Athletic adults need a higher protein intake

of up to 1.5 g/kg of body weight to a maximum of 2.0 g/kg of body weight. Factors such as renal health and serum albumin levels help determine individual protein needs. Also, for people of any age, protein requirements increase in response to certain types of physiologic stress, such as infection, bone fractures, surgery, and burns. The minimum number of servings of the MyPyramid easily meets the basic protein needs of most adults. Exceptions exist mainly for pregnant women, athletes, and those who have more immediate needs, such as for healing from trauma.

With aging there is loss in both muscle mass and strength. This is called **sarcopenia**. There is some evidence that protein intake, especially from animal sources, may help reduce the risk of sarcopenia (Lord and colleagues, 2007). Milk, with its high protein content, has been found to promote increased muscle mass, especially along with resistance exercise (Wilkinson and colleagues, 2007).

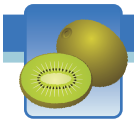
VITAMINS AND MINERALS

The Dietary Reference Intakes (DRIs) for vitamins and minerals are similar in older and younger adults. Eating a healthy, well-balanced diet continues its importance throughout the life span. Women living in the community who have higher serum selenium and carotenoid levels are at a lower risk of death (Ray and colleagues, 2006). On the other hand, low serum micronutrient (carotenoids, vitamins E and D) levels have been shown to increase the risk for frailty in older women. The more micronutrient deficiencies, the greater the risk of frailty (Semba and colleagues, 2006). Maintaining adequate intake of foods high in folate is important throughout the life span for its role in cell division and protein metabolism. Folate is important to help prevent cardiovascular disease in individuals who have hyperhomocysteinemia (see Chapter 7).

Taking a multivitamin and mineral supplement may be helpful for the older adult who has nutrient deficiencies. However, there can be problems with excess nutrients from multivitamins such as if the person has renal insufficiency, in which a buildup of vitamin A can occur, and especially if fortified foods also are consumed in large amounts such as with fortified cereals that may be eaten more than just at breakfast. Iron is another micronutrient that can be consumed in excess with supplements. Although the need continues to be high for the young adult woman due to losses incurred from menstruation and pregnancy, this is not the case with the older adult. The DRI of iron for women over 50 years old matches men's need. This is the approximate time of menopause for most women. This is reflected in the lower amounts of iron found in multivitamin and mineral supplements designed for the older adult, such as Centrum Silver or men's preparations. An increased need for iron, however, may develop after surgery, as a result of blood loss. Worsening iron deficiency anemia in an older adult may be a result of gastrointestinal blood loss from a medical condition, and the cause of the anemia needs to be determined.

Maintaining appropriate intake of calcium and vitamin D from the diet alone can be a challenge for a variety of reasons such as allergies or dislike of milk. Generally 1200 mg calcium and 400 International Units of vitamin D (1 mcg of vitamin D equals 40 International Units) is required daily for most adults (see differences as noted in the DRIs at the back of the book). For persons who can drink 1 quart (4 cups) of vitamin D–fortified milk, this will provide the recommended 1200 mg of calcium and 400 International Units of vitamin D. Equivalent amounts of cheese and

yogurt will provide calcium but are generally low in vitamin D. As previously reviewed, a higher intake of vitamin D may be advisable in areas with limited sunshine such as in Northern areas of the world. Adults with limited sunshine, such as those who remain indoors, are advised to take increased amounts of vitamin D. A supplement of 800 International Units of vitamin D per day in combination with calcium has been shown to reduce the risk of falls and fractures (Mosekilde, 2005). Others have recommended up to 1000 International Units of vitamin D in the elder years, in conjunction with a healthy diet that provides a variety of vitamins and minerals for optimal bone health (Nieves, 2005). Total calcium and vitamin intake needs to be considered by health care professionals before supplementation is advised. Serum vitamin D levels (25[OH]D—see Chapter 3) can be monitored. The nutrient needs of the elder population over 80 years of age are not as well known. The DRI guidelines currently provide only for greater than 70 years (see the back of the book). Identification of possible unique needs of the elder population will be determined through further research.



Cultural Considerations

The older generation who lived on farms would have had liver at slaughtering times. It appears that the message, beginning in the 1970s, to reduce cholesterol intake resulted in many adults who not only don't eat eggs, but also don't eat liver. Although liver is high in cholesterol, it is low in total fat and saturated fat and is extremely high in a number of micronutrients (see Tables 3-1, 3-2, 3-3, and 3-4). Encouraging the reintroduction of liver into the diet of an older adult can greatly round out the nutritional quality of his or her diet. ■

HYDRATION

Adequate fluid intake is important throughout life. Adults generally require an intake of 1 mL/kcal or 30 to 35 mL/kg of body weight. This generally equates to at least 2 L or 8 cups of total fluids daily for most adults. Adults involved in athletics may have special needs (see section below). Any adult who has excess loss of sweat from work or leisure activities will need increased amounts of fluids. Fluid needs will increase for lactating women. Excess fluid intake can also occur but is usually not dangerous unless fluid is being pushed beyond the thirst mechanism.

For older adults or those involved in strenuous sports the sense of thirst is not an adequate indicator of fluid need. In athletic sports, rapid loss of fluid from sweat may occur that needs to be replenished before the recognition of thirst is apparent. With age, the sense of thirst diminishes. Dehydration in the older adult is associated with increased risk for falls because dehydration adversely affects the sense of balance. Other health issues with chronic dehydration include dental decay and impaired swallowing because of reduced saliva flow, very low blood pressure, and increased risk for urinary tract infections (UTIs). Signs of dehydration include fatigue, mental confusion, poor skin tone, loss of ability to sweat, and constipation.

Adults who take diuretics are at increased risk for dehydration. Excess alcohol intake, without intake of other sources of liquids, may cause dehydration because alcohol is a diuretic. With renal impairment, the ability to concentrate urine becomes

impaired and increases the risk of dehydration. Adults with heart failure or edema may need to follow fluid restriction, generally about 25 mL/kg of body weight.

Teaching Pearl

A graphic description of the color of normal urine can help adults recognize hydration. Urine that is dark yellow or amber generally reflects dehydration. An adult who is trying too aggressively to increase fluid intake may note clear urine. Normal urine color is pale yellow. Comparing amount of fluid intake to the color of urine excreted can help to recognize a need for greater or lesser intake. The message that anything that melts or is a liquid is considered a fluid source may be helpful (with the exception of alcohol and fats). Caffeinated beverages are not as able to be used as a fluid source because of their weak diuretic effect but do contribute to hydration status. ■

FIBER

Fiber is also important throughout life. It serves as a marker at any age for intake of a variety of trace minerals. Minerals are essential for the numerous metabolic activities that occur within the body cells.

In older adults, low fiber intake is related to chronic disorders such as diverticulosis and constipation. The recommended amount is about 25 g/day, which is reflected in the U.S. Department of Agriculture (USDA) MyPyramid minimum number of servings of fruits, vegetables, and whole grains. It is particularly easy to meet the fiber and mineral goals through the consumption of legumes, which on average contain three to four times the fiber content of any other plant-based food.

When providing advice on increasing fiber intake, it also is important to emphasize fluids. A high fiber intake with insufficient fluids can lead to bowel impaction. This is particularly important for the older population, who may not recognize when they are becoming dehydrated. Inadequate hydration status should be suspected whenever reduced bowel function or constipation develop.

Teaching Pearl

The correlation of fiber and mineral content of food can be related through the description of plant growth. Minerals are microscopic rocks (refer back to Chapter 3) that are drawn from the soil by the roots of various plants (whole grains, vegetables, fruits, and so on). The minerals are tied up with the fiber in plant-based foods. ■

WHAT ARE SOME NUTRITION ISSUES FOR WOMEN?

PREMENSTRUAL SYNDROME

Premenstrual syndrome (PMS) occurs the first few days before the onset of the monthly menstrual cycle and disappears after menstruation. A high intake of calcium (1300 mg) and vitamin D (700 International Units) may reduce the risk of PMS (Bertone-Johnson and colleagues, 2005).

The majority of American women experience some degree of PMS with increased appetite, anxiety, irritability, and headaches. Although these symptoms are similar to ones indicating hypoglycemia, eating does not always relieve these symptoms as

would be expected in treating hypoglycemia. Nutrition has no known affect on PMS. Eating small, frequent meals may help with control of hunger without resulting in weight gain of adipose tissue. Including dairy foods and a variety of whole grains, legumes, and nuts can help provide the minerals as discussed previously.

Premenstrual dysphoric disorder (PMDD) is the more severe and disabling form of PMS. This condition is estimated to occur in 2% to 9% of menstruating women. The selective serotonin reuptake inhibitor (SSRI) antidepressants, used either continuously or only during the luteal phase, lead to rapid improvement in symptoms and functioning (Freeman and Sondheimer, 2003).

MENSTRUAL MIGRAINES

Migraine incidence is similar between the sexes before puberty and after age 50 with the onset of menopause. About one out of four women of reproductive age experience migraines, three times the incidence of males (Raña-Martínez, 2008). Pregnancy allows for temporary cessation of menstrual migraines. Menstrual migraine attacks are more severe, of longer duration (potentially lasting more than 3 days), and are typically difficult to treat (Pringsheim, Davenport, and Dodick, 2008). Triptan medications, in particular sumatriptan, are the most effective in the management of acute menstrual migraine attack (Allais and Benedetto, 2004). See section below for dietary factors in the prevention of migraine.

Although the pathogenesis of menstrual-related pain conditions is not fully understood, menstrual-related overproduction of prostaglandins is implicated in the pathophysiology of both menstrual migraine and dysmenorrhea (Mannix, 2008).

MENOPAUSE

Menopause is the permanent cessation of ovarian activity. Women have symptoms of menopause for a number of years before complete onset. This period is referred to as **perimenopause**, or the time around menopause. These symptoms can consist of weight gain, mood swings, increased serum cholesterol levels, and hot flashes. The physical changes associated with hot flashes consist of increased peripheral blood flow with a feeling of heat that is not registered as body temperature, increased heart rate, and profuse sweating. It is believed this is a disturbance of the temperature-regulating mechanism found in the hypothalamus. Asian women have lower incidence of hot flashes, which has been thought to be due to higher intake of soy products and their natural phytoestrogen content. However, dietary supplementation with phytoestrogens has not provided the same effect as hormone replacement therapy (Sturdee, 2008). Consuming soy products, rather than supplements, may be of benefit.

Questions of safety and efficacy continue with herbal products. Black cohosh has been reported to be useful in the treatment of menopausal symptoms; however, the research on this herb is limited. Adverse events such as nausea, vomiting, headaches, dizziness, breast pain, and weight gain have been observed in clinical trials. A few cases of hepatotoxicity have been reported, but a direct link has not been made with black cohosh. Black cohosh does not appear to act like estrogen, a concern for women at risk for estrogen-dependent breast cancer (Mahady, 2005). Because there are few studies on the impact of herbs for control of hot flashes, and the supplement industry is largely unregulated, herbs cannot yet be widely recommended. Because women

may seek their own alternatives, health professionals need to be aware of possible side effects from over-the-counter herbal products.

WHAT ARE NUTRITIONAL NEEDS FOR PHYSICAL ENDURANCE, STRENGTH, AND HEALTH IN SPORTS AND PHYSICALLY DEMANDING OCCUPATIONS?

SPORTS NUTRITION ISSUES

Increasingly, adults of all ages are engaging in sports (see Figure 13-1). There are a variety of reasons from simple pleasure to body building or health reasons. There are many positive reasons to maintain a high level of physical activity throughout the adult life span.

In regard to decreasing insulin resistance to help manage diabetes, it has been observed that high-intensity exercise is more effective than moderate intensity. With the equivalent of 1000 kcal per week of high-intensity exercise, insulin sensitivity and metabolism of glucose increased 20% (Coker and colleagues, 2006). Aerobic and resistance exercise have been found to be comparable in improving glucose metabolism in older men (Ferrara and colleagues, 2006).

In helping to maintain muscle mass in older ages, a higher level of physical activity also is needed. Leisure type activities were found to be insufficient in preventing sarcopenia in persons greater than 65 years of age (Raguso and colleagues, 2006). Minimizing inflammatory conditions among older adults also appears necessary to minimize loss of muscle strength (Schaap and colleagues, 2006). Adequate protein intake is further important, with some evidence that older adults require a higher intake of protein beyond the DRI of 0.8 g/kg of body weight to maintain muscle mass. Goals for protein need to be evaluated in terms of preexisting renal or liver disease that precludes an increased intake.

The foundation of a nutritious diet with appropriate amounts of kcalories, protein, and fluids is essential for all adults. Individual needs are dictated by body size, age, and type of sports in which one is involved.

An elite athletic adult who is involved with endurance sports will have different needs than an adult who is focusing primarily on increasing muscle strength or is engaged in leisure activities. Although many athletes choose to take performance-enhancing supplements, sound nutritional status is still fundamental for peak performance.

For the health professional working with athletes, understanding the fundamental nutritional needs and interventions is essential. Being able to help prevent and correctly identify the cause of exercise-induced problems is paramount in preventing physical injury or mortality of athletes. Resistance training is not without potential harm. It is associated with periods of acute **intracellular hypoxia** (lack of oxygen within the body cells) and low intramuscular pH levels. Rhabdomyolysis (a condition resulting from muscle injury with release of cell contents into the plasma) can be caused by overly aggressive resistance training such as excessive weight lifting. Excess physical tension on the muscle fibers and lowered levels of adenosine triphosphate (ATP) with altered electrolyte levels in the cell can induce this condition. Symptoms of rhabdomyolysis include muscle soreness, reduction in the range of motion, decreased muscle strength, black urine, and, in severe cases, acute renal

failure. A gradual training program with maintenance of appropriate hydration is advised to prevent this condition (Heled and colleagues, 2005).

Being able to distinguish the relatively benign exercise-associated hypotensive collapse caused by events such as marathon runs or triathlons from potentially fatal conditions is essential for proper treatment. **Hyponatremia** (low serum sodium levels less than 135 mEq/L), dehydration, hyperthermia, and diabetes-related hypoglycemia are all potentially lethal conditions that require different nutritional interventions.

PROTEIN NEEDS

Most adults easily meet their protein requirements. With adequate kcalorie intake, protein needs are only slightly increased for low- to moderate-intensity endurance at an estimated 1.0 g of protein per kilogram of body weight. Results suggest that a protein intake of 1.2 g/kg or 10% of total energy intake is needed to achieve a positive nitrogen balance for higher levels of physical activity. This is not a concern for most endurance athletes who routinely consume protein at or above this level (Gaine and colleagues, 2006). For the elite athlete the maximum protein requirement has been estimated at 1.6 g/kg of body weight (Tarnopolsky, 2004).

Diet plays a role in promotion of muscle mass with adequate kcalories and protein required. Protein requirements for novice weightlifters are not elevated (Moore and colleagues, 2007). This is due to the beneficial effect of resistance training that lowers requirements for protein initially (Hartman, Moore, and Phillips, 2006). Ultimately, increased dietary protein intake (up to 1.6 g of protein per kilogram of body weight daily) may best promote increased muscle development in response to resistance exercise. Adequate protein and kcalories is particularly important for the elder population in this quest (Evans, 2004). Including milk after resistance exercise has been shown to improve the body's uptake of amino acids needed in muscle protein production. Evidence suggests whole milk may be more efficient at protein synthesis than low-fat milk (Elliot and colleagues, 2006). The benefit of milk may be more important in groups of persons with low levels of lean mass and strength such as the elderly (Phillips, Hartman, and Wilkinson, 2005). Healthy young men who routinely include milk after exercise were shown to have greater muscle growth during early stages of resistance training when compared with soy or carbohydrate sources (Hartman and colleagues, 2007). The optimal amount of the milk proteins, casein and whey, has been observed at 40 g/day of whey protein plus 8 g/day of casein for the greatest increase in lean tissue development (Kerksick and colleagues, 2006). Young adults generally do not need supplemental protein sources beyond that provided by diet to increase lean tissue mass and strength (Candow and colleagues, 2006).

FLUID AND ELECTROLYTE REQUIREMENTS

Fluid and electrolyte balance is also critical to maintain physical energy in an endurance event. As little as 2% weight loss from dehydration will impair endurance and strength. Appropriate hydration is important to prevent both dehydration and overhydration. Dehydration can lead to hyperthermia or heat stroke and renal failure. Adequate hydration is especially important in a hot, dry climate. It is even important to maintain adequate hydration to promote dental health because saliva production neutralizes acid in the oral cavity.

Overhydration can lead to hyponatremia (see later section), which can be fatal if severe due to altered electrical charges. Drinking enough fluid until the urine is clear has been a message promoted by coaches in the past. However, this simple message has resulted in some athletes consuming excess fluids and likely has contributed to the frequent reports of hyponatremia. Maintaining stable serum sodium levels is essential for optimal endurance and avoidance of potential mortality. Providing potassium beverages and foods is also recommended.

ENDURANCE SPORTS AND NEEDS

It is advised that athletes consume at least 30 to 60 g of carbohydrate hourly during sustained intensive exercise in order to maintain adequate glucose levels and glycogen reserves (Gleeson and colleagues, 2004). Some sports, such as cross-country skiing or mountain biking, require about 100 g of carbohydrate hourly. This is particularly important for the nurse or sports trainer to be aware of if an athlete is taking insulin (see Chapter 8).

Exercise training increases free radical production, potentially leading to enhanced muscle injury. Inflammation is known to occur in elite athletes. Vitamins C and E are antioxidants that may help prevent muscle cell damage (Zoppi and colleagues, 2006). Inflammation and oxidative stress have been implicated in the mechanism of eccentric exercise-induced muscle injury. Data suggest that even suboptimal selenium status may lead to chaotic muscle contractions (Milias and colleagues, 2006). Inflammatory conditions related to athletes include a newly recognized one involving the upper respiratory tract, even occurring days after the endurance event. (Nieman and Bishop, 2006).

Football is certainly an endurance sport, whether at the high school level or professional level. Heat stroke needs to be watched for, especially during the preseason period when the sun and level of heat are usually at their highest. Thermal responses of average-size male subjects (mass of approximately 70 kg) may not accurately reflect the rate of heat storage in larger athletes with greater muscle mass. Linemen have shown to be less dehydrated but have higher core body temperatures than the position of backs during practice (Godek and colleagues, 2006). Linemen have been noted to have higher rates and volumes of sweat loss, although more fluids were consumed and had less urine output was produced. Sodium losses could be considerable in players during the preseason because of high daily sweat losses in backs and in linemen (Godek and colleagues, 2008).

PREVENTION AND MANAGEMENT OF HYPONATREMIA

Women have a greater incidence of hyponatremia than men. Hyponatremia can lead to central nervous dysfunction. Most hyponatremic athletes will recover with careful observation while awaiting spontaneous diuresis. Providing fluids to a person with severe hyponatremia can cause fatal cerebral edema. Use of hypertonic saline should be reserved for patients with severe symptoms (Hsieh, 2004).

Risk factors for hyponatremia among nonelite marathon runners include substantial weight gain, an intake of greater than 3 L total of fluids and fluids consumed every mile during the race, a racing time of over 4 hours, female sex, and low body mass index (BMI) (Almond and colleagues, 2005). Vomiting was found to be the only

clinical sign differentiating hyponatremia from other conditions that induce exercise-associated collapse (Hew and colleagues, 2003).

Generally, 16 oz of fluid is needed to replace 1 lb (16 oz) of body weight lost during an athletic event. However, using this guideline may overestimate fluid needs when body mass is lost through high-intensity, prolonged endurance events.

New recommendations for fluid replacement of no more than 400 to 800 mL/hr for marathon runners were promoted during the 2003 Boston Marathon. However, 9% of the runners were subsequently found to have hypernatremia (sodium level greater than 146 mEq/L), and 5% were hyponatremic (sodium level less than 135 mEq/L), suggesting that either the new guidelines were not followed or they are not adequate to prevent abnormalities in fluid balance (Kratz and colleagues, 2005).

SPORTS ANEMIA

Sports anemia, or the **overtraining syndrome**, includes an increased amount of plasma that lowers both plasma viscosity and hematocrit. This is related to an inflammation process caused by overtraining in which the increased amount of plasma artificially lowers the number of red blood cells in a given volume of blood. Iron studies should be undertaken to distinguish low hematocrit resulting from overtraining versus that resulting from a need for iron supplementation.

Sports anemia may be prevented and treated with both a decrease in training intensity and the inclusion of foods containing the antioxidant vitamins A, C, and E. Incorporating antioxidant vitamins has been shown to be effective in preventing the inflammation-like response and subsequent reduced hematocrit level that follow an exhaustive episode of training (Senturk and colleagues, 2005).

NUTRITION ISSUES OF THE MILITARY

Guidelines for sports nutrition apply to military personnel. The need for kcalories, however, can be even higher under combat conditions. Soldiers have further needs beyond physical endurance, such as maintaining cognitive function while being sleep deprived, often with inadequate rations, and being in extreme weather conditions and under tremendous mental stress. With sleep deprivation, caffeine has been noted to promote vigilance and cognitive function. The amino acid tyrosine, as found in protein foods and metabolized from phenylalanine, appears to offset adverse effects of acute stress on cognitive performance and mood. For soldiers engaged in sustained, intense physical activity, adequate carbohydrate intake is necessary to maintain cognitive performance (Lieberman, 2003). When restricted field rations are required, at least 1100 to 1500 kcal, 50 to 70 g of proteins, and a minimum of 100 g of carbohydrates on a daily basis should be consumed for a maximum of 10 days' duration (Montain and Young, 2003).

The overall average daily kcalorie needs for different branches of the military in a variety of settings was found to be about 4600 kcal for male personnel, with a range of 3000 to 7000 kcal depending on level of physical activity and other factors. For female personnel an overall average of 2900 kcal, with a range of 2300 to 5600 is generally required. The highest range of kcalories is needed for combat training in cold temperatures at high altitudes (Tharion and colleagues, 2005). Knowledge of

kcalorie needs does not necessarily bear out into application even on the military base.

The MREs (Meals, Ready-to-Eat Military Field Rations) are required to provide at least 3200 kcal. The standard single-serving Army MRE contains 3600 kcal, with 100 g of protein and approximately 440 g of carbohydrate and 160 g of fat. The MRE provides daily need for vitamins A and C, 80% of calcium needs for men, 100% of iron needs for women, and 5000 to 7000 mg of sodium. The MREs are required to have at least a 2-year shelf life, but most MREs have a shelf life of 5 years at 70° to 85° F.

As with athletes, there are misconceptions among soldiers about the role of nutrients for endurance needs. The majority of a group of Army Special Forces soldiers were found to incorrectly believe that protein is used for energy in short-term endurance events and that vitamins provide energy (Bovill and colleagues, 2003). Appropriate guidance on meal and snack selection beyond basic military provisions is needed for the goal of optimal endurance and mental function by military personnel.

A frequent cause of injury sustained during combat is traumatic brain injury (TBI). Studies have shown that administration of riboflavin and vitamin B_2 significantly reduced development of edema following experimental stroke. Administration of vitamin B_2 following injury helped reference and working memory tests in a rat study. Edema formation following injury also was significantly reduced by vitamin B_2 and may be a therapeutic potential for the treatment of TBI (Hoane, Wolyniak, and Akstulewicz, 2005).

WHAT ARE SOME COMMON NUTRITION-RELATED MEDICAL CONDITIONS IN ADULTS?

Aside from obesity, cardiovascular disease, hypertension, diabetes, renal disease, and cancer, discussed in Section Two, there are many other common medical conditions that have nutrition relevance. These range from neurologic conditions to inflammatory states.

ANEMIA

There are many forms of anemia and many causes. In the elder population, iron deficiency anemia is most likely to occur if there is blood loss such as with a gastrointestinal bleed. Folate and B_{12} deficiencies also are common and are described as macrocytic, meaning the red blood cells are abnormally enlarged. Folate deficiency may be from interactions from medications, whereas B_{12} deficiency generally results from reduced gastric acid secretion from antacid medications or reduced ability to absorb vitamin B_{12} due to lack of a protein called **intrinsic factor**. Such individuals will need intramuscular injections of vitamin B_{12}. Other causes include renal disease, in which the kidneys reduce their ability to produce the hormone erythropoietin (see Chapter 9), or inflammation, often referred to as **anemia of chronic disease** (see Table 13-2 for laboratory values that help distinguish between iron deficiency and macrocytic anemia).

ARTHRITIS AND OTHER INFLAMMATORY CONDITIONS

There are two major forms of **arthritis**: osteoarthritis and rheumatoid arthritis. Gout, with its buildup of uric acid crystals, is one form of arthritis that is found with the

Table 13-2 Laboratory Guide to Anemias With Low Hemoglobin and Hematocrit

LABORATORY TEST	IRON DEFICIENCY	FOLATE DEFICIENCY	VITAMIN B_{12} DEFICIENCY	ANEMIA OF CHRONIC DISEASE
Normal Hgb (g/dL) Women: 12-16 Men: 14-18	Low	Low	Low	Low
Normal Hct % Women: 33-43% Men: 39-49%	Low	Low	Low	Low
MCV Normal 80-95	Low	High	High	Normal
MCH Normal 27-31	Low	High	High	Normal

Hgb, Hemoglobin; *Hct*, hematocrit; *MCH*, mean corpuscular hemoglobin; *MCV*, mean corpuscular volume.

metabolic syndrome (refer back to Chapter 5 for management). Generally arthritis is considered an inflammatory or rheumatic condition. Nutrition is generally felt to play a minor role in prevention and management, except with regard to weight control, which helps decrease strain on joints affected by osteoarthritis. There is some evidence that glucosamine chondroitin has modest benefit for osteoarthritis. This form of treatment, however, is still controversial (Bruyere and Reginster, 2007).

Increasingly, however, the influence of omega-3 fatty acids in reducing inflammation associated with rheumatoid arthritis is being recognized. A dose of at least 3 g of omega-3 fatty acids daily is required to reduce morning stiffness and the number of tender joints found with rheumatoid arthritis (Covington, 2004). An enhanced improvement with fish oil supplements was noted when used in combination with olive oil in the diet (Berbert and colleagues, 2005). Maintaining an active lifestyle with regular exercise is of further importance in maintaining physical function. A proportion of patients who follow a vegetarian or Mediterranean type of diet will experience benefit. All individuals with inflammatory disease should include a good intake of antioxidants such as copper and zinc. Supplementation with selenium and vitamin D may be advisable (Rayman and Pattison, 2008).

Poor vitamin B_6 status and elevated plasma homocysteine concentrations were seen in older women with rheumatoid arthritis. This may contribute to their increased risk of cardiovascular disease (Woolf and Manore, 2008).

BENIGN PROSTATIC HYPERPLASIA

There is a link between nutrient intake, hyperinsulinemia, and risk of benign prostatic hyperplasia (BPH). Lowering insulin production through weight management, high-fiber diet, with low saturated fat reduces growth of prostate cells (Barnard, Kobayashi, and Aronson, 2008). Chapter 10 reviews more on prostate health to prevent or manage prostate cancer.

BOWEL MANAGEMENT

As described previously, adequate fluid and fiber intake is required for normal bowel management and the prevention of constipation. The insoluble fiber provides

the bulk, and the soluble fiber allows for moist fecal material that is easier to pass. Physical activity that uses the abdominal muscles is helpful to maintaining bowel health.

Neurologic damage is a prevalent cause of constipation in the adult who has uncontrolled diabetes or in most older adults. Pain medication can cause constipation. Increasing intake of fiber-based foods and ensuring good hydration are the first-line approaches in correcting constipation. Chronic reliance on laxatives can cause dependency on their use. When dietary approaches are not adequate, use of laxatives is warranted.

The inclusion of yogurt or buttermilk is further helpful to maintaining bowel regularity and optimal bacterial flora. This is primarily because of the bacterial cultures, called **probiotics**, contained in these foods, specifically *Lactobacillus* and *Bifidobacterium.* Probiotics also are now available in pill and powder form. Because bacteria need fuel to survive, a high-fiber diet promotes a healthy bacterial flora in the intestinal system. Fluids need to be increased with a high fiber intake.

For adults taking antibiotics, it is especially important to replace the beneficial bacteria that can be destroyed with these medications. The use of yogurt to control diarrhea associated with antibiotic use is well established. Younger adults are more likely to accept yogurt, whereas many older adults have a preference for buttermilk.

CELIAC DISEASE

As reviewed in Chapter 4, celiac disease is now recognized to be a common medical condition owing to more reliable blood tests. Celiac disease may manifest as vague symptoms. In the majority of the elder population with celiac disease, weight loss, diarrhea, and iron deficiency anemia are present; osteopenia is very common. There is an increased risk of autoimmune diseases such as type 1 diabetes and bowel cancer with untreated celiac disease. Common presenting signs and symptoms with uncontrolled celiac disease include fatigue, abdominal pain, bloating or gas, and anemia. Initial medical diagnoses are often irritable bowel syndrome, psychologic disorders, and fibromyalgia.

A variety of neurologic and psychiatric disorders have been linked with celiac disease, including cerebellar ataxia, peripheral neuropathy, epilepsy, dementia, depression, migraine, and Huntington's disease—see below (Bushara, 2005).

Among a group of persons over the age of 60 who were found to have undiagnosed celiac disease, the most common symptoms were weight loss, iron deficiency anemia, and diarrhea. Other outcomes of untreated celiac disease included severe early osteoporosis, neurologic manifestation, and cognitive decline attributed to Alzheimer's disease. After intervention with a gluten-free diet, cognition improved, one person with peripheral neuropathy improved to normal, and there was significant weight gain with a range of approximately 10 to 20 lb (Lurie and colleagues, 2008).

One case study found a connection between a form of hypoparathyroidism and years later a diagnosis of celiac disease. Some of the health problems included severe microcytic anemia, mild hypoalbuminemia, low calcium and high phosphate levels with a history of bouts of diarrhea and weight loss, and osteopenia. After a gluten-free diet was initiated, laboratory values improved (Isaia and colleagues, 2004).

Secondary hyperparathyroidism is also a potential indicator of celiac disease. All persons with this condition, especially when it is persistent, should be tested for celiac disease (Jorde and colleagues, 2005).

EPILEPSY

One cause of seizures has been noted with vitamin B_6 deficiency (Kuwahara and colleagues, 2008). For cases in which medication is not effective, or an individual wants to lower need for medication, the ketogenic diets (see Chapter 12) have shown effectiveness. This may be due to lowered insulin production resulting in more stable blood glucose levels. Regular meal intake seems to be important, along with regular and adequate sleep habits of 8 to 9 hours daily.

GASTROESOPHAGEAL REFLUX DISORDER

Gastroesophageal reflux disorder, commonly referred to as GERD, is common among older adults. It is also likely to occur at younger ages among those with obesity. Treatment may involve weight loss for reduced pressure on the stomach from excess abdominal adipose tissue. The use of small, frequent meals further helps. Avoiding fatty meals, especially before bedtime, allows for quicker digestion. When the stomach is empty, there is less likelihood that reflux will occur. Avoidance of fatty foods, alcohol, caffeine, and nicotine from smoking cigarettes helps the esophageal sphincter to function better, thereby helping to prevent reflux. Another common condition among older adults is hiatal hernia (see Figure 4-7), which may have symptoms and problems similar to those of GERD. Refer to Chapter 4 for more on GERD.

Weight loss and head of bed elevation are effective lifestyle interventions for GERD. There is no evidence supporting an improvement in GERD measures after cessation of tobacco, alcohol, or other dietary interventions such as avoiding chocolate or other fatty foods (Kaltenbach, Crockett, and Gerson, 2006). However, tolerances and intolerances to these various lifestyle factors may have bearing on specific individuals and may be worth trying. Other lifestyle factors worth trying as needed to lower need for medical management include avoiding caffeine, mint, and carbonated beverages (Csendes and Burdiles, 2007).

HEARING LOSS

Hearing loss is common among older adults. Younger adults are increasingly at risk from listening to loud music. Interesting research suggests that vitamin C may be beneficial in reducing susceptibility to noise-induced hearing loss (McFadden and colleagues, 2005). This may be a result of the antioxidant effect of vitamin C and/or its role in maintaining structural integrity of cellular structures. Refer to Appendix 6 on the Evolve website for vitamin C (ascorbic acid) content of fruits and vegetables. A maximum of 500 mg of vitamin C in supplemental form may be advisable.

MIGRAINES

Migraines are a common malady, often beginning in childhood. They are a frequent cause of physician visits and absences from work. The development of migraine is now believed to start in the brain stem and spread through the trigeminal nerve system. Increasingly, neurologists are recognizing that many forms of headaches are

migrainelike in nature, such as tension type of headaches, and may have a common pathophysiology with migraines.

Migraines are related to a state of hyperexcitability in the brain. This may be a result of a low magnesium level. With a low magnesium level, excess calcium enters cells. Medications that are calcium channel blockers have been used to prevent migraines. Magnesium has a similar calcium channel blocker action and may be helpful in the prevention of migraines. A significant proportion of patients with migraine have celiac disease. Celiac may be implicated owing to impaired absorption of nutrients with increased risk for magnesium deficiency. A gluten-free diet may lead to an improvement in migraine frequency.

Migraines may be related to the production of histamine. Histamine is a known gastrointestinal irritant, but newer evidence shows that it causes the release of nitric oxide from the vascular system, causing spontaneous headache pain (Thomsen and Olesen, 2001). It is known that parenteral histamine and the medication nitroglycerin can induce a severe headache (Holzhammer and Wober, 2006). Histamine may be released during periods of hypoglycemia (see Chapter 8). Therefore small, frequent meals may be helpful in reducing the incidence of some forms of headaches.

There are many potential triggers that induce migraines. Repeated challenges to known food triggers should be undertaken because individuals may not react to all of these. Alcohol, especially red wine, and caffeine withdrawal are well known inducers of headaches. Dehydration can be a factor. Some individuals may trigger a migraine by ingesting chocolate, aged cheese, nitrates and nitrites, monosodium glutamate (MSG), aspartame, citrus fruits, tea, coffee, pork, milk, nuts, and legumes. Lack of sleep and rest after a high-stress interval are nonnutritional factors that may induce migraines.

Low plasma levels of serotonin have been implicated in the development of migraines. With low blood glucose levels, serotonin production is suppressed. Niacin, as used for lipid management (see Chapter 7), has been associated with reduced incidence of migraines. It has been suggested that niacin shunts tryptophan into the serotonin pathway, thus increasing plasma serotonin levels (Velling, Dodick, and Muir, 2003). Other nonmedicinal treatments that have been helpful in reducing the severity or frequency of migraines includes riboflavin, the herbs feverfew and butterbur, and coenzyme Q_{10} (Schürks, Diener, and Goadsby, 2008).

NEURODEGENERATIVE AND COGNITIVE DISEASES

Neurodegenerative diseases are some of the cruelest forms of disease with loss of ability of bodily parts to function. Nerve damage interferes with the ability of muscles to work and can leave a person virtually a prisoner in his or her own body. Loss of brain function with Alzheimer's and other forms of **dementia** are probably hardest on the person's family and friends, who have to contend with "loss" of the person while the body still functions.

Multiple sclerosis (MS) is caused by demyelination of the nerves in the brain and spinal column. This condition can gradually develop and go into remission or may occur rapidly, leaving the person paralyzed while his or her mind continues to function. It is now being associated with vitamin D deficiency as a causal agent. This association, in part, is recognized because the highest populations having MS are Olympic skiers and persons living in northern regions. General decline in cognition

has been attributed to low vitamin D status (Rondanelli and colleagues, 2007). Sun exposure and vitamin D_3 are associated with reduced risk for MS.

Persons with MS in remission have been found to have higher vitamin D status as evidenced by levels of 25(OH)D levels (see Chapter 3) and lower parathyroid hormonal levels (Soilu-Hänninen and colleagues, 2008). It appears that individuals living in northern climates require at least 800 International Units of vitamin D daily from autumn to spring to maintain adequate vitamin D status.

There are many similarities in the neurologic and cognitive issues of **Alzheimer's disease** (the most common form of dementia related to brain atrophy), **Huntington's disease** (a genetic neurodegenerative condition generally noted in middle-age adults that leads to uncontrolled movements, cognitive dysfunction, and inability to swallow), **Parkinson's disease** (a common neurodegenerative condition generally noted in older adults resulting in uncontrolled physical tremors due to altered dopamine level with altered muscle tone that eventually results in cognitive decline), and **amyotrophic lateral sclerosis (ALS)**, (also known as **Lou Gehrig disease**—named after the famous and beloved baseball player who succumbed to this disease with progressive neurodegeneration but retention of cognitive function). Research efforts increasingly are focused on the common pathways of these separate conditions to advance prevention strategies for all neurodegenerative diseases.

Increased need for kcalories occurs with movement disorders such as Parkinson's. Interestingly, two thirds of persons with ALS develop a hypermetabolism of unknown cause with an increased need for kcalories. A higher level of low-density lipoprotein (LDL) cholesterol appears to be protective for individuals with ALS, with an observed increased life span of over 12 months compared with persons with ALS with lower levels of LDL cholesterol. Lipid medications are thus not likely beneficial with ALS (Dupuis and colleagues, 2008). Research is being undertaken with some beginning evidence that a ketogenic diet may have neuroprotective effect.

Mitochondrial dysfunction is increasingly believed to be the commonality of many of the neurodegenerative diseases. Suppressed brain metabolism of glucose and increased oxidative stress is associated with Alzheimer's disease as well as thiamin deficiency that is related to neurologic damage as well. There is growing evidence of abnormality in thiamin-dependent biochemical processes linked to the development of Alzheimer's. Although supplementation with thiamin has not shown dramatic benefits in persons with Alzheimer's, there has been limited research (Gibson and Blass, 2007). Diminished activity of thiamin-dependent enzymes plays a role in other neurodegenerative diseases, including Parkinson's disease and Huntington's disease. Thiamin deficiency in rat pups caused a significant decrease in the voltage-dependent potassium currents across their cellular membranes (Oliveira and colleagues, 2007). Thiamin deficiency is a known cause of dementia from Wernicke's encephalopathy. This may occur for reasons other than alcohol abuse. Malabsorption can be the cause, and certain forms of bariatric surgery have been associated with thiamin deficiency (see Chapter 6). Another form of vitamin B_3, nicotinamide, is showing evidence in helping to preserve neuronal and vascular cells in the brain during injury and may help protect against neurodegenerative diseases (Li, Chong, and Maiese, 2004).

Alzheimer's disease is associated with major impairments in insulin signaling in the brain. The abnormalities are related to reduced energy metabolism and

acetylcholine (a neurotransmitter related to the B vitamin choline) homeostasis. The suggestion is that Alzheimer's may represent a brain-specific form of diabetes that has been called type 3 diabetes (de la Monte and colleagues, 2006).

Other contributors to Alzheimer's disease are believed to include hyperhomocysteinemia that promotes neurodegeneration through abnormal brain methylation activity (Fuso and colleagues, 2008). Higher folate intake may decrease the risk of Alzheimer's and is known to help lower homocysteine levels. However, unexpectedly, vitamins B_6 and B_{12} are not related (Luchsinger and colleagues, 2007). Folic acid supplementation has been shown to improve cognitive function. This may be due to folic acid's ability to facilitate plasma concentrations of the omega-3 fatty acids (Das, 2008). However, medical input should be sought before consuming high-dose folic acid because of potential worsening of the functioning of vitamin B_{12} with a preexisting vitamin B_{12} deficiency (Selhub, Morris, and Jacques, 2007). Because the brain has the highest lipid concentration after adipose tissue, deregulated lipid metabolism may be of particular importance (Adibhatla and Hatcher, 2008).

Zinc deficiency has been linked with degeneration in myelin sheaths of sciatic nerves (Unal and colleagues, 2005). Moderate intake of dietary zinc is showing protection with some forms of Lou Gehrig disease (Ermilova and colleagues, 2005).

There is conflicting data on the role of zinc in neurologic diseases. Certain areas of the brain have increased levels of zinc among persons with Alzheimer's. The same holds true for Parkinson's disease (Ciubotariu and Nechifor, 2007). However, in a study of mice, low dietary zinc caused a significant 25% increase in total plaque volume in Alzheimer's. A similar subclinical zinc deficiency also is felt to be common in older human populations and may contribute to Alzheimer's in humans (Stoltenberg and colleagues, 2007). It may be that either high or low levels of zinc contribute to neurologic damage because it would affect the use of copper. There may be a high requirement for copper in Down syndrome that is associated with increased risk of Alzheimer's disease (Klevay, 2008).

A common and early characteristic of Alzheimer's is altered smell perception. This may be due to zinc deficiency with the olfactory lobe normally being a rich source of zinc (Hipkiss, 2005). It has long been known that zinc deficiency impairs taste perception. Taste perception requires a sense of smell. Individuals taking zinc supplementation need to avoid excess intake because of inhibition of copper with potential for a lethal form of anemia.

Parkinson's disease appears, in part, due to oxidative damage. A high-fiber diet with white meat, fish, and nuts as part of a low–saturated-fat diet and moderate amounts of alcohol is associated with lower risk of Parkinson's disease (Gao and colleagues, 2007). Flavonoids, as found in colorful fruits and vegetables, could provide benefits along with other antioxidant therapies in Parkinson's disease (Mercer and colleagues, 2005). There is evidence that increased homocysteine levels might reduce dopamine levels through neurotoxic effects in Parkinson's disease. Higher dietary intakes of folate, vitamin B_{12}, and vitamin B_6 might decrease the risk of Parkinson's disease through decreasing plasma homocysteine levels (Qureshi and colleagues, 2008). Dietary vitamin B_6 may decrease the risk of Parkinson's disease through mechanisms unrelated to homocysteine metabolism (de Lau and colleagues, 2006). There is some evidence that caffeine helps reduce the risk of Parkinson's disease.

Medical management of Parkinson's disease with levodopa is enhanced with a lower protein intake. It is advised that levodopa be provided at the time of day when

there is low protein intake, such as bedtime. One case of a man with Parkinson's disease required tube feeding that was provided continuously. At a protein provision of 1.4 g/kg of body weight, this individual developed severe rigidity despite being heavily medicated. Once the tube feeding was reduced to a provision of protein at 0.9 g/kg of body weight with bolus feeding and medications given at times of nonfeeding, the rigidity was drastically improved (Cooper, Brock, and McDaniel, 2008).

In recent years, dietary supplementation with creatine has been shown to enhance neuromuscular function in several diseases. Recent studies have suggested that creatine can be beneficial in patients with muscular dystrophy and other mitochondrial dysfunctions and may help prevent sarcopenia (see below). Creatine has been shown to decrease cellular calcium levels and may have a potential role in neuroprotective effects (Pearlman and Fielding, 2006).

The use of creatine supplementation to enhance energy metabolism via the mitochondria has shown some success in the treatment of Huntington's disease. A study using 8 g/day of creatine administered for 4 months was found to be well tolerated and safe. A chemical substance indicative of oxidative injury to DNA and markedly elevated in Huntington's was reduced by the creatine treatment (Hersch and colleagues, 2006). The energy defects in Huntington's also may benefit with the administration of coenzyme Q_{10} or nicotinamide (Kasparová and colleagues, 2006).

Several problems occur with dementia, including forgetfulness and disorientation, pacing, inability to eat independently, weight gain or loss, dysphagia, food behavioral problems, and dehydration issues. Because of disorientation, a person with dementia needs to be reminded to chew, swallow, and drink water. All these problems may affect nutritional status. Responses might include increasing caloric intake to prevent weight loss, increasing fluid intake for better balance and bowel management, or offering finger foods to encourage feeding independence.

Pouching (retaining bits of food between the cheeks and gums) is sometimes observed, especially in nursing home patients or those with developmental delays. If the food retained in the mouth contains fermentable carbohydrates (such as in fruit, candy, and bread), acid production and plaque will occur, resulting in dental decay. Acidic foods such as oranges may cause erosion of tooth enamel if the food is pouched. Caregivers should inspect the mouth of persons known to pouch.

Among persons who have developed Alzheimer's disease, it is common to find decreased food intakes, eating behavior disturbances, and loss of body weight. Suboptimal diet is even evident early in the onset of the disease (Shatenstein and colleagues, 2007). An occupational therapist (OT) can help with practical strategies to maintain independence with eating such as use of built-up utensils or lipped plates when there is reduced hand dexterity (see Figure 15-3).

OSTEOPOROSIS

Osteoporosis is a major health concern for the older adult; an estimated 20 million Americans are affected. Osteoporosis develops gradually over a lifetime, but age-related bone loss usually begins at around the age of 35 to 40 years in both men and women. Current approaches increasingly focus on prevention, but for many older adults, osteoporosis has already been diagnosed. With the diagnosis of osteoporosis comes increased risk of bone fractures.

Including adequate amounts of calcium and vitamin D during adolescence and young adulthood decreases the risk of osteoporosis. If the bone is able to absorb adequate amounts of calcium at this time of life, osteoporosis will be less likely to occur. Vitamin K is also important to maintain bone health. Increasing intake of vegetables and legumes might lead to a decrease in hip fracture incidence (Yaegashi and colleagues, 2008). For adults taking blood thinners, vitamin K intake from dark green, leafy vegetables does not need to be eliminated. Because of the importance of vitamin K foods to health, the current goal is to maintain a consistent intake of vitamin K in order for the health care provider to regulate the dosage of the blood thinner. The B vitamins appear beneficial in maintaining strong bones (Herrmann and colleagues, 2007).

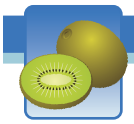
Types of fats in the diet have bearing on bone health and prevention of osteoporosis. A lower intake of omega-6 oils and an increased intake of omega-3 fatty acids help maintain higher bone mass density (Weiss, Barrett-Connor, and von Muhlen, 2005). Olive oil was also shown to help prevent inflammation-induced osteopenia in an animal study (Puel and colleagues, 2004).

Aside from diet, increased levels of weight-bearing physical activity reduce the risk of osteoporosis. Cigarette smoking is known to damage all body cells, including bone. Another cause of osteoporosis includes malabsorption problems such as surgical removal of portions of the small intestine.

Nutritional disorders that cause bone loss in adults include disordered eating behaviors (female athlete triad and anorexia nervosa), gastrointestinal diseases (celiac sprue, inflammatory bowel disease, and other malabsorption syndromes), alcoholism, and hypervitaminosis A.

Hypervitaminosis A from long-term intake of diets high in vitamin A (retinol) stimulates bone resorption and inhibits bone formation. It is found with hypercalcemia and appears to contribute to osteoporosis and hip fractures (Genaro Pde and Martini, 2004).

Once estrogen production ceases in otherwise healthy postmenopausal women, an intake of 1200 mg calcium from a combination of milk and supplements showed diminished bone turnover through reduction in parathyroid hormone (PTH) secretion (Bonjour and colleagues, 2008). Among an elder population with hip fractures, age and female gender were found to be the primary risk factors. In addition, a high PTH level, low 25(OH)D3 levels, and low physical activity were related to fracture risk. Persons with diabetes had a threefold risk for hip fracture (Segal and colleagues, 2008).



Cultural Consideration

A study conducted in Bogalusa, Louisiana, in which about 60% were women and 75% were white, found that almost half of the adults consumed one serving or less of dairy products daily and only about 20% consumed the recommended three or more servings. Average intake of dairy was higher in whites compared with African Americans. Women consumed significantly more servings of cheese and yogurt than men. Not unexpectedly, those who consumed more milk had a higher intake of a wide range of nutrients including the B vitamins, calcium, vitamin D, magnesium, and potassium (Ranganathan and colleagues, 2005). ■

Some medications are known to adversely affect bone density, especially steroids as used with inflammatory conditions. Medications used to lower androgen levels in the treatment of prostate cancer increase the risk of osteoporosis in men. Currently there is inadequate emphasis on the prevention of osteoporosis in men being treated to lower androgen levels. Interventions for such men include undergoing a dual-energy x-ray absorptiometry (DXA) scan to assess bone density, with supplementation with calcium and vitamin D and osteoporosis medications as warranted (Tanvetyanon, 2004).

The DRIs for calcium were set at levels associated with retention of body calcium. The recommended intake for adults is 1000 to 1200 mg/day (see the back of the book). The upper tolerable limit for calcium was set at 2500 mg. A calcium intake in the range of 1300 to 1700 mg stops age-related bone loss and reduces fracture risk in individuals 65 and older. Intakes of 2400 mg daily restore the functioning of the parathyroid glands (glands integral in maintaining serum calcium levels) to young adult values. Milk is probably the most nutritional and cost-effective means of meeting the calcium need in the elderly (Heaney, 2001).

Fact & Fallacy

FALLACY Calcium-based antacid tablets and calcium-fortified foods will prevent osteoporosis.

FACT Although this message may be advertised as an appropriate strategy to prevent osteoporosis, it is oversimplified and potentially harmful. Individuals who have consumed adequate quantities of milk and milk products throughout their lives are less prone to the development of osteoporosis in their later years. However, it is still not clear whether the calcium in milk or other combinations of nutrients (such as magnesium) in the milk are of the most benefit. The best approach is to eat or drink foods that are naturally rich in calcium and vitamin D, such as fortified milk. Moderate sun exposure will help the kidneys to produce the active form of vitamin D required for efficient use of calcium. Weight-bearing exercise, avoidance of excess alcohol, and consuming a well-balanced diet containing a variety of vitamins and minerals are all important in maintaining bone health and strength. ■

PANIC ATTACKS

There appears to be a genetic connection with panic attacks with environmental implications. It was found that persons with panic attacks or their close relatives were adversely affected with caffeine intake greater than 480 mg (Nardi and colleagues, 2008). There is evidence of altered brain metabolism among persons with panic attacks with increased activity in the area where fear is produced. Other areas of the brain have been shown to have hypometabolism. There is limited research on diet and panic attacks, but a steady supply of glucose, without hyperglycemia or hypoglycemia, may be important to reduce panic attacks.

PSORIASIS

The well-known author John Updike suffered with the skin condition **psoriasis**. This noncontagious disease is an inflammatory skin disease characterized by rapid

skin turnover that results in large red patches, generally on truncal locations and extremities. Adequate vitamin D status appears to be particularly beneficial, but avoidance of arachidonic acid through fasting, vegetarian diets, and high intake of omega-3 fatty acids via fatty fish all help to a degree. Some psoriasis cases are gluten sensitive and may benefit from a gluten-free diet (Wolters, 2006).

PSYCHIATRIC CONCERNS

Mental disorders are causes of disability in the United States and other developed countries. Major depression, bipolar disorder, schizophrenia, and obsessive-compulsive disorder (OCD) are among the most common mental disorders.

Research on the impact of diet on prevention or management of psychiatric illness is just beginning. Some evidence suggests diet is related to a much higher incidence rate in the United States than in China. Several essential vitamins, minerals, and omega-3 fatty acids are often deficient in the general population in America and other developed countries and in patients suffering from mental disorders (Lakhan and Vieira, 2008). This may be a consequence, not a cause of mental illness.

Schizophrenia is now being linked with the metabolic syndrome (Hagg and colleagues, 2006). Although promoting nutritional advice aimed at lowering risk of or managing the metabolic syndrome (see Chapter 5) may not prevent symptoms of schizophrenia, it remains healthy advice that may be beneficial. This is, in part, to help reduce comorbidities such as diabetes. Among a white population with schizophrenia the prevalence of diabetes was found to be significantly greater than the general population. Assessing fasting blood glucose levels among persons with schizophrenia is advised with appropriate management as needed (Cohen and colleagues, 2006). A subgroup of persons with schizophrenia have an essential fatty acid deficiency, low omega-3/docosahexaenoic acid (DHA) levels, moderate hyperhomocysteinemia, or combinations (Kemperman and colleagues, 2006).

There is a body of research suggesting persons who eat the most fish have the lowest rates of depression. Incorporating fish into the diet has many other health benefits such as reduced heart disease. Use of supplements of fish oil generally should be left to the discretion of the person's physician or health provider. A decreased intake of saturated fat and an increased intake of vitamin B_6 has been associated with a decrease in depression (Merrill, Taylor, and Aldana, 2008).

A low intake of fruits and vegetables has been observed in persons with psychiatric disorders. A history of attempted suicide is associated with low levels of antioxidant vitamins and lycopene and total carotenoids (Li and Zhang, 2007). This may be a consequence and not a cause. Psychiatric issues, such as the belief that caretakers are poisoning the food, can lead to impaired eating. Nurses and other health care professionals working with individuals suffering from paranoia need to develop strategies to encourage eating. This may include providing foods in unopened containers. Deficits in odor identification and detection threshold sensitivity have been observed in schizophrenia (Moberg and colleagues, 2006). Advice on food safety may be needed (see Chapter 14).

One treatable psychiatric issue that may be found in adults is related to altered levels of the thyroid hormone. Thyroid screening in persons with mood and psychotic disorders is advised (Stowell and Barnhill, 2005).

SARCOPENIA

Sarcopenia is a condition of muscular weakness. With age there is loss of both muscle mass and muscle strength. Theoretically correction of obesity reduces inflammation, which can help preserve lean muscle mass. However, the reduction in kcalories to attain weight loss inherently increases risk of muscle loss and is not advised among the elderly population (Miller and Wolfe, 2008).

URINARY TRACT INFECTIONS

Women who are sexually active are especially prone to UTIs. Older men and women also are at increased risk because of depressed immune systems and impaired bladder function. Cranberry juice is considered a preventive factor against UTI caused by *Escherichia coli* infection by inhibiting adherence of this bacteria to the bladder wall. Individuals who have diabetes should be advised to ingest 4 oz of cranberry juice per serving to prevent hyperglycemia from occurring. When there are no issues of blood glucose or for those who need more kcalories, larger quantities of cranberry juice can be consumed as desired. Concentrated cranberry extract may also be used in tablet form. In one study cranberry juice, as well as cranberry tablets, significantly decreased the number of UTIs by about 10% among persons with a history of urinary tract infection (Stothers, 2002).

Caution needs to be exercised with cranberry tablets among those who have kidney stones. Evidence has shown ingestion of cranberry supplements increases oxalate levels—see Chapter 9 regarding nephrolithiasis (Terris, Issa, and Tacker, 2001). Another potential concern is among persons who use the blood thinner warfarin. Cranberry has the potential to increase the effects of warfarin significantly, and monitoring is advised (Mohammed and colleagues, 2008).

VISION LOSS

Loss of vision occurs with uncontrolled diabetes. This is related to retinopathy, in which very small blood vessels form on the retina; laser treatment is required to correct this condition (see Chapter 8). Another form is related to degenerative diseases of the retina. Many forms of retinal degeneration can be treated with vitamin A or other dietary changes. Vitamin A intake should not exceed the DRI—see the back of the book and Appendix 6 on the Evolve website for food sources.

One common form of retinal degeneration is **macular degeneration**. The incidence of the late form of this condition is 8% for persons 75 years of age or older (Klein and colleagues, 2007).

The macula is found in the retinal area on the back of the eye. The pigment of the macula is believed to help filter out harmful blue light. The macular pigment consists mostly of the phytochemicals/carotenoids: lutein and zeaxanthin (Rehak,

Fric, and Wiedemann, 2008). Degeneration of the macular disc results in slow or sudden, but painless, loss of central vision or visual distortion.

A significant decrease in risk for macular degeneration occurs among those who consume a large amount of spinach, collard greens, and other dark green, leafy vegetables such as kale and broccoli. Increasing frequency of foods high in carotene to more than 5 times per week was found to be most beneficial (Morris and colleagues, 2007). It is believed that the high carotene and lutein content of these vegetables is involved in the prevention of macular degeneration. However, prevention may also involve other nutrients. Therefore it is more appropriate for adults to include a variety of leafy green vegetables and a variety of nutrient-dense foods with the goal of maintaining vision throughout life than to rely on supplements. There is no evidence to date that the general population should take antioxidant vitamin and mineral supplements to prevent or delay the onset of age-related macular degeneration (Evans and Henshaw, 2008).

WHAT ARE SOME CONCERNS RELATED TO FOOD-DRUG INTERACTIONS?

A significant portion of all prescribed and **over-the-counter medications (OTCs)** (those not prescribed) are used by persons over 65 years of age. Older persons may often take three to seven or more separate drugs at any given time. Inappropriate prescribing in older people is a common condition associated with significant morbidity, mortality, and financial costs. Medication use increases with age, and this, in conjunction with an increasing disease burden, is associated with adverse drug reactions (Barry, Gallagher, and Ryan, 2008). Organ deterioration, underlying chronic diseases, dietary regimens, an unstable nutritional status, and other factors make the elderly particularly vulnerable to food and drug interactions. Quality of life and health may be affected as a result.

Polypharmacy, the excessive use of prescription and over-the-counter medications, increases risk for adverse drug reactions and drug-drug interactions. In one group of persons who were at least 65 years of age and received home care in Texas, individuals were found on average to use eight medications. Of this group, 10% had dangerous drug interactions, and among those with polypharmacy, 20% had such interactions (Cannon, Choi, and Zuniga, 2006). A study of pharmaceutical use among beneficiaries, 65 years of age or older, of TRICARE (military health care services) found about one half were on five or more medications and about 3% were on 16 or more medications (Linton and colleagues, 2007). Office visits involving polypharmacy for elderly persons have been estimated to have increased from about 10 million in 1990 to nearly 40 million by the year 2000 (Aparasu, Mort, and Brandt, 2005).

Review and management of elderly persons' medications is recommended by Healthy People 2010. One such approach to reduce polypharmacy entailed review and reduction of medications in a group of disabled persons. Mortality at 1 year was reduced by over 20% compared with a control group (Garfinkel, Zur-Gil, and Ben-Israel, 2007).

Individuals should seek nonmedication alternatives such as medical nutrition therapy to decrease potential risks associated with polypharmacy.

WHAT IS THE NUTRITION SCREENING INITIATIVE, AND WHAT IS ITS ROLE IN PREVENTING MALNUTRITION IN OLDER ADULTS?

The vast majority of elders suffer from chronic diseases that could benefit from changes in diet. Unfortunately, the warning signs of poor nutritional health are often overlooked.

The **Nutrition Screening Initiative** began in 1990 as a 5-year, multifaceted effort to promote nutrition screening and better nutritional care of older adults. This effort is a project of the American Academy of Family Physicians, the American Dietetic Association, and the National Council on Aging. Many related organizations and health professionals continue to help guide the initiative.

The Level I Screen of the Nutrition Screening Initiative is designed for social service and health professionals to identify older Americans who may need medical or nutritional attention. The Level II Screen provides more-specific diagnostic information on nutritional status and is designed for use by health and medical professionals. A public awareness tool that older adults can use to assess their own nutritional risk is called the **DETERMINE Checklist** (Box 13-1).

Many circumstances can negatively affect an elderly person's nutritional status regardless of income. Warning signals include bereavement, physical or mental disabilities, and poor nutrition knowledge. Care providers can be taught to make observations in the home and take appropriate steps to prevent the onset of a nutritional crisis. Practical actions can be simple, informal, and inexpensive. For example, the care provider might arrange for transportation to social activities and might assist the older adult in grocery shopping and the preparation of food. However, independence should be encouraged as much as possible in all activities, including eating.

WHAT IS THE ROLE OF THE NURSE AND OTHER HEALTH CARE PROFESSIONALS IN PROMOTING THE NUTRITIONAL HEALTH OF THE OLDER ADULT?

The nurse and other health care professionals can help with the goal of healthy aging (Figure 13-5) by encouraging young adults through the later years to maintain a healthy diet and active lifestyle. This includes maintaining a desirable weight, eating according to the 2005 Dietary Guidelines and the MyPyramid Food Guidance System, getting regular exercise, avoiding excess alcohol or use of tobacco and drugs, and getting at least 8 hours of sleep nightly. This helps allow for good physical health, but mental well-being is also important through positive social interactions, being engaged in cognitive pursuits such as reading or doing word puzzles, and including humor in one's life.

The nurse is in a unique position to educate regarding the misuse of alcohol. Assessment of alcohol intake by individuals is a basic part of health care screening in the hospital or offices of health care providers. Unfortunately, the emergency department may be the place of contact. The younger adult is at risk for overindulgence at social gatherings often based at bars or other venues, such as college fraternity parties. The use of funnels to consume large amounts of alcohol is

Box 13-1 DETERMINE Checklist

DISEASE
Any disease, illness, or chronic condition that causes changes in eating habits or makes eating difficult increases nutritional risk. Four of every five adults have chronic diseases that are affected by diet. Confusion or memory loss that keeps getting worse is estimated to affect one or more in five older adults. This can make it hard to remember what, when, or if food has been eaten. Feeling sad or depressed, which happens to about one in eight older adults, can cause big changes in appetite, digestion, energy level, weight, and well-being.

EATING POORLY
Eating too little or too much leads to poor health. Eating the same foods day after day or not eating fruit, vegetables, and milk products daily will also cause poor nutritional health. One in five adults skips meals daily. Most adults do not eat the minimum amount of fruit and vegetables needed. One in four adults drinks too much alcohol. Many health problems become worse if more than one or two alcoholic beverages are consumed daily.

TOOTH LOSS OR MOUTH PAIN
A healthy mouth, teeth, and gums are needed to eat. Missing, loose, or rotten teeth or dentures that do not fit well or cause mouth sores make it hard to eat.

ECONOMIC HARDSHIP
Many older Americans have fixed incomes that may interfere with adequate funds to purchase foods. There is often a perceived social stigma to use of food stamps by older Americans.

REDUCED SOCIAL CONTACT
One third of all older people live alone. Being with people daily has a positive effect on morale, well-being, and eating habits.

MULTIPLE MEDICINES
Many older Americans must take medicines for health problems. Almost half of all older Americans take multiple medicines daily. Growing old may change the way we respond to drugs. The more medicines used, the greater the chance for side effects, such as increased or decreased appetite, change in taste, constipation, weakness, drowsiness, diarrhea, and nausea. When taken in large doses, vitamins and minerals act like drugs and can cause harm. Doctors need to be alerted to all medications taken.

INVOLUNTARY WEIGHT LOSS OR GAIN
Losing or gaining a lot of weight when not trying to do so is an important sign that must not be ignored. Being overweight or underweight also increases the chance of poor health.

NEEDS ASSISTANCE IN SELF-CARE
Although most older people are able to eat, one in five has trouble walking, shopping, and buying and cooking food.

ELDER YEARS ABOVE AGE 80
Most older persons lead full and productive lives. But as age increases, risk of frailty and health problems increase. Older persons should check their nutritional health regularly.

Modified with permission by the Nutrition Screening Initiative, Washington, DC, a project of the American Academy of Family Physicians, the American Dietetic Association, and the National Council on the Aging, Inc., and funded in part by a grant from Ross Products, a division of Abbott Laboratories.

FIGURE 13-5 Healthy adults can have productive lives into their senior years.

not uncommon and can easily lead to alcohol toxicity and death. The older adult is at risk because of a diminished ability to tolerate alcohol as a result of physiologic changes.

Because caloric needs generally decrease with age although nutrient needs remain high, using fat-free or low-fat milk and lean meats and limiting sauces, gravies, fats, and high-calorie desserts can be recommended by all health care professionals for those individuals who are overweight or at risk for obesity. Low-calorie desserts can be encouraged because they enhance the nutritional value of the diet (e.g., canned fruits packed in their own juice, puddings and custard made with fat-free or low-fat milk, or low-fat cookies such as fig bars or ginger snaps).

The nurse or other health care professional can provide guidance on how diet affects development of a variety of chronic health problems. Promoting good nutritional intake to meet minimum requirements for the macronutrients and micronutrients and reviewing goals for reducing excess intake are appropriate for all health care professionals. Addressing individual needs when there is chronic illness, along with other concerns of aging, is best undertaken with the expertise of a registered dietitian.

Appropriate fluid intake is a goal for all ages. Younger adults, especially those involved in athletics, may have excess intake of fluid, leading to concerns of hyponatremia. Older adults generally have a greater risk of dehydration because of diminishing loss of thirst. It needs to be explained that the usual daily goal of 8 cups of water includes all beverages and other sources of fluid, such as soups, in order to avoid overhydration.

Chapter Challenge Questions & Classroom Activities

1. Why is it necessary to understand the physiologic changes that occur with aging?
2. Why are young adults and the elderly vulnerable to nutritional deficiencies?
3. Why is an older adult especially at risk for dehydration?
4. What guidelines should be advised for a young adult to prevent later development of osteoporosis?
5. What can be done in young adulthood to lower risk of neurodegenerative diseases?
6. What dietary advice would be appropriate for an overweight widower who has hypertension and an elevated cholesterol level and relies on convenience foods?
7. What are nutritional guidelines for a younger athletic adult compared with an older athlete? Someone serving on active duty in the military?
8. How much food would need to be consumed to meet the protein goals for muscle development for an adult weighing 90 kg?

Case Study

Rachel was still in Iraq. Her enlistment had been extended once again. It was such a hot day, and she had been drinking lots of water to ensure she didn't become dehydrated. She had lost a lot of weight since being in the military and was down to 110 lb. As she stood in the hot sun, she began to have nausea. She thought it must be heat stroke, although her skin did not feel dry. She took another bottle of water just to be sure. Her goal was to keep her urine clear in color.

While standing there, her thoughts returned to home. Her fiancé's grandmother wasn't eating and was losing a lot of weight. Rita said food just didn't taste good anymore, and she just didn't seem to care about living. Her doctor had prescribed another medication, an antidepressant, to encourage her to eat. Rachel hoped this worked and that her wedding plans wouldn't be deferred again because she knew Rita wanted to see her youngest grandson married.

Critical Thinking Applications

1. What might be the cause of Rachel's nausea?
2. List risk factors that can cause Rachel to develop nausea being out in the hot sun and drinking lots of water.
3. What are Rachel's expected fluid needs?
4. Determine her expected kcalorie and protein needs, and relate to food servings in the MyPyramid Food Guide.
5. What are potential causes of Rita's taste changes and weight loss?
6. What meal strategies might help Rita to maintain her weight?

REFERENCES

Adibhatla RM, Hatcher JF: Altered lipid metabolism in brain injury and disorders, *Subcell Biochem* 49:241-268, 2008.

Allais G, Benedetto C: Update on menstrual migraine: from clinical aspects to therapeutical strategies, *Neurol Sci* 25(Suppl 3):S229-S231, 2004.

Almond CS, Shin AY, Fortescue EB, Mannix RC, Wypij D, Binstadt BA, Duncan CN, Olson DP, Salerno AE, Newburger JW, Greenes DS: Hyponatremia among runners in the Boston Marathon, *N Engl J Med* 352(15):1550-1556, 2005.

Aparasu RR, Mort JR, Brandt H: Polypharmacy trends in office visits by the elderly in the United States, 1990 and 2000, *Res Social Adm Pharm* 1(3):446-459, 2005.

Barnard RJ, Kobayashi N, Aronson WJ: Effect of diet and exercise intervention on the growth of prostate epithelial cells, *Prostate Cancer Prostatic Dis* 11(4):362-366, 2008.

Barry PJ, Gallagher P, Ryan C: Inappropriate prescribing in geriatric patients, *Curr Psychiatry Rep* 10(1):37-43, 2008.

Berbert AA, Kondo CR, Almendra CL, Matsuo T, Dichi I: Supplementation of fish oil and olive oil in patients with rheumatoid arthritis, *Nutrition* 21(2):131-136, 2005.

Bertone-Johnson ER, Hankinson SE, Bendich A, Johnson SR, Willett WC, Manson JE: Calcium and vitamin D intake and risk of incident premenstrual syndrome, *Arch Intern Med* 165(11):1246-1252, 2005.

Bonjour JP, Brandolini-Bunlon M, Boirie Y, Morel-Laporte F, Braesco V, Bertière MC, Souberbielle JC: Inhibition of bone turnover by milk intake in postmenopausal women, *Br J Nutr* 100(4):866-874, 2008.

Bovill ME, Tharion WJ, Lieberman HR: Nutrition knowledge and supplement use among elite U.S. army soldiers, *Mil Med* 168(12):997-1000, 2003.

Bruyere O, Reginster JY: Glucosamine and chondroitin sulfate as therapeutic agents for knee and hip osteoarthritis, *Drugs Aging* 24(7):573-580, 2007.

Bushara KO: Neurologic presentation of celiac disease, *Gastroenterology* 128(4 Suppl 1):S92-S97, 2005.

Candow DG, Burke NC, Smith-Palmer T, Burke DG: Effect of whey and soy protein supplementation combined with resistance training in young adults, *Int J Sport Nutr Exerc Metab* 16(3):233-244, 2006.

Cannon KT, Choi MM, Zuniga MA: Potentially inappropriate medication use in elderly patients receiving home health care: a retrospective data analysis, *Am J Geriatr Pharmacother* 4(2):134-143, 2006.

Ciubotariu D, Nechifor M: Zinc involvements in the brain, *Rev Med Chir Soc Med Nat Iasi* 111(4):981-985, 2007.

Cohen D, Stolk RP, Grobbee DE, Gispen-de Wied CC: Hyperglycemia and diabetes in patients with schizophrenia or schizoaffective disorders, *Diabetes Care* 29(4):786-791, 2006.

Coker RH, Hays NP, Williams RH, Brown AD, Freeling SA, Kortebein PM, Sullivan DH, Starling RD, Evans WJ: Exercise-induced changes in insulin action and glycogen metabolism in elderly adults, *Med Sci Sports Exerc* 38(3):433-438, 2006.

Cooper MK, Brock DG, McDaniel CM: Interaction between levodopa and enteral nutrition, *Ann Pharmacother* 42(3):439-442, 2008.

Covington MB: Omega-3 fatty acids, *Am Fam Physician* 70(1):133-140, 2004.

Csendes A, Burdiles P: Scientific foundations for medical treatment based on modifying diet, lifestyle habits, and patient attitudes in chronic gastroesophageal reflux disease, *Cir Esp* 81(2):64-69, 2007.

Das UN: Folic acid and polyunsaturated fatty acids improve cognitive function and prevent depression, dementia, and Alzheimer's disease—but how and why? *Prostaglandins Leukot Essent Fatty Acids* 78(1):11-19, 2008.

de la Monte SM, Tong M, Lester-Coll N, Plater M Jr, Wands JR: Therapeutic rescue of neurodegeneration in experimental type 3 diabetes: relevance to Alzheimer's disease, *J Alzheimers Dis* 10(1):89-109, 2006.

de Lau LM, Koudstaal PJ, Witteman JC, Hofman A, Breteler MM: Dietary folate, vitamin B_{12}, and vitamin B_6 and the risk of Parkinson disease, *Neurology* 67(2):315-318, 2006.

Dupuis L, Corcia P, Fergani A, Gonzalez De Aguilar JL, Bonnefont-Rousselot D, Bittar R, Seilhean D, Hauw JJ, Lacomblez L, Loeffler JP, Meininger V: Dyslipidemia is a protective factor in amyotrophic lateral sclerosis, *Neurology* 70(13):1004-1009, 2008.

Elliot TA, Cree MG, Sanford AP, Wolfe RR, Tipton KD: Milk ingestion stimulates net muscle protein synthesis following resistance exercise, *Med Sci Sports Exerc* 38(4):667-674, 2006.

Ermilova IP, Ermilov VB, Levy M, Ho E, Pereira C, Beckman JS: Protection by dietary zinc in ALS mutant G93A SOD transgenic mice, *Neurosci Lett* 379(1):42-46, 2005.

Evans WJ: Protein nutrition, exercise and aging, *J Am Coll Nutr* 23(6 Suppl):601S-609S, 2004.

Evans JR, Henshaw K: Antioxidant vitamin and mineral supplements for preventing age-related macular degeneration, *Cochrane Database Syst Rev* (1):CD000253, 2008.

Everitt AV, Hilmer SN, Brand-Miller JC, Jamieson HA, Truswell AS, Sharma AP, Mason RS, Morris BJ, Le Couteur DG: Dietary approaches that delay age-related diseases, *Clin Interv Aging* 1(1):11-31, 2006.

Ferrara CM, Goldberg AP, Ortmeyer HK, Ryan AS: Effects of aerobic and resistive exercise training on glucose disposal and skeletal muscle metabolism in older men, *J Gerontol A Biol Sci Med Sci* 61(5):480-487, 2006.

Freeman EW, Sondheimer SJ: Premenstrual dysphoric disorder: recognition and treatment, *Prim Care Companion J Clin Psychiatry* 5(1):30-39, 2003.

Fuso A, Nicolia V, Cavallaro RA, Ricceri L, D'Anselmi F, Coluccia P, Calamandrei G, Scarpa S: B-vitamin deprivation induces hyperhomocysteinemia and brain S-adenosylhomocysteine, depletes brain S-adenosylmethionine, and enhances PS1 and BACE expression and amyloid-beta deposition in mice, *Mol Cell Neurosci* 37(4): 731-746, 2008.

Gaine PC, Pikosky MA, Martin WF, Bolster DR, Maresh CM, Rodriguez NR: Level of dietary protein impacts whole body protein turnover in trained males at rest, *Metabolism* 55(4):501-507, 2006.

Gao X, Chen H, Fung TT, Logroscino G, Schwarzschild MA, Hu FB, Ascherio A: Prospective study of dietary pattern and risk of Parkinson disease, *Am J Clin Nutr* 86(5):1486-1494, 2007.

Garfinkel D, Zur-Gil S, Ben-Israel J: The war against polypharmacy: a new cost-effective geriatric-palliative approach for improving drug therapy in disabled elderly people, *Isr Med Assoc J* 9(6):430-434, 2007.

Genaro Pde S, Martini LA: Vitamin A supplementation and risk of skeletal fracture, *Nutr Rev* 62(2):65-67, 2004.

Gibson GE, Blass JP: Thiamine-dependent processes and treatment strategies in neurodegeneration, *Antioxid Redox Signal* 9(10):1605-1619, 2007.

Gleeson M, Nieman DC, Pedersen BK: Exercise, nutrition and immune function, *J Sports Sci* 22(1):115-125, 2004.

Godek SF, Bartolozzi AR, Burkholder R, Sugarman E, Dorshimer G: Core temperature and percentage of dehydration in professional football linemen and backs during preseason practices, *J Athl Train* 41(1):8-14, 2006.

Godek SF, Bartolozzi AR, Burkholder R, Sugarman E, Peduzzi C: Sweat rates and fluid turnover in professional football players: a comparison of National Football League linemen and backs, *J Athl Train* 43(2):184-189, 2008.

Hagg S, Lindblom Y, Mjorndal T, Adolfsson R: High prevalence of the metabolic syndrome among a Swedish cohort of patients with schizophrenia, *Int Clin Psychopharmacol* 21(2):93-98, 2006.

Hartman JW, Moore DR, Phillips SM: Resistance training reduces whole-body protein turnover and improves net protein retention in untrained young males, *Appl Physiol Nutr Metab* 31(5):557-564, 2006.

Hartman JW, Tang JE, Wilkinson SB, Tarnopolsky MA, Lawrence RL, Fullerton AV, Phillips SM: Consumption of fat-free fluid milk after resistance exercise promotes greater lean mass accretion than does consumption of soy or carbohydrate in young, novice, male weightlifters, *Am J Clin Nutr* 86(2):373-381, 2007.

Heaney RP: Calcium needs of the elderly to reduce fracture risk, *J Am Coll Nutr* 20(2 Suppl):192S-197S, 2001.

Heled Y, Zarian A, Moran D, Hadad E: Exercise induced rhabdomyolysis—characteristics, mechanisms and treatment, *Harefuah* 144(1):34-38, 70, 2005.

Herrmann M, Schmidt J, Umanskaya N, Colaianni G, Al Marrawi F, Widmann T, Zallone A, Wildemann B, Herrmann W: Stimulation of osteoclast activity by low B-vitamin concentrations, *Bone* 41(4):584-591, 2007.

Hersch SM, Gevorkian S, Marder K, Moskowitz C, Feigin A, Cox M, Como P, Zimmerman C, Lin M, Zhang L, Ulug AM, Beal MF, Matson W, Bogdanov M, Ebbel E, Zaleta A, Kaneko Y, Jenkins B, Hevelone N, Zhang H, Yu H, Schoenfeld D, Ferrante R, Rosas HD: Creatine in Huntington disease is safe, tolerable, bioavailable in brain and reduces serum 8OH2'dG, *Neurology* 66(2):250-252, 2006.

Hew TD, Chorley JN, Cianca JC, Divine JG: The incidence, risk factors, and clinical manifestations of hyponatremia in marathon runners, *Clin J Sport Med* 13(1):41-47, 2003.

Hipkiss AR: Could carnosine suppress zinc-mediated proteasome inhibition and neurodegeneration? Therapeutic potential of a non-toxic but non-patentable dipeptide. *Biogerontology* 6(2):147-149, 2005.

Hoane MR, Wolyniak JG, Akstulewicz SL: Administration of riboflavin improves behavioral outcome and reduces edema formation and glial fibrillary acidic protein expression after traumatic brain injury, *J Neurotrauma* 22(10):1112-1122, 2005.

Holzhammer J, Wober C: Alimentary trigger factors that provoke migraine and tension type headache, *Schmerz* 20(2):151-159, 2006.

Hsieh M: Recommendations for treatment of hyponatraemia at endurance events, *Sports Med* 34(4):231-238, 2004.

Isaia GC, Casalis S, Grosso I, Molinatti PA, Tamone C, Sategna-Guidetti C: Hypoparathyroidism and co-existing celiac disease, *J Endocrinol Invest* 27(8):778-781, 2004.

Jorde R, Saleh F, Sundsfjord J, Haug E, Skogen B: Coeliac disease in subjects with secondary hyperparathyroidism, *Scand J Gastroenterol* 40(2):178-182, 2005.

Kaltenbach T, Crockett S, Gerson LB: Are lifestyle measures effective in patients with gastroesophageal reflux disease? An evidence-based approach, *Arch Intern Med* 166(9):965-971, 2006.

Kasparová S, Sumbalová Z, Bystrický P, Kucharská J, Liptaj T, Mlynárik V, Gvozdjáková A: Effect of coenzyme Q_{10} and vitamin E on brain energy metabolism in the animal model of Huntington's disease, *Neurochem Int* 48(2):93-99, 2006.

Kemperman RF, Veurink M, van der Wal T, Knegtering H, Bruggeman R, Fokkema MR, Kema IP, Korf J, Muskiet FA: Low essential fatty acid and B-vitamin status in a subgroup of patients with schizophrenia and its response to dietary supplementation, *Prostaglandins Leukot Essent Fatty Acids* 74(2):75-85, 2006.

Kerksick CM, Rasmussen CJ, Lancaster SL, Magu B, Smith P, Melton C, Greenwood M, Almada AL, Earnest CP, Kreider RB: The effects of protein and amino acid supplementation on performance and training adaptations during ten weeks of resistance training, *J Strength Cond Res* 20(3):643-653, 2006.

Klein R, Klein BE, Knudtson MD, Meuer SM, Swift M, Gangnon RE: Fifteen-year cumulative incidence of age-related macular degeneration: the Beaver Dam Eye Study, *Ophthalmology* 114(2):253-262, 2007.

Klevay LM: Alzheimer's disease as copper deficiency, *Med Hypotheses* 70(4):802-807, 2008.

Kratz A, Siegel AJ, Verbalis JG, Adner MM, Shirey T, Lee-Lewandrowski E, Lewandrowski KB: Sodium status of collapsed marathon runners, *Arch Pathol Lab Med* 129(2):227-230, 2005.

Kuwahara H, Noguchi Y, Inaba A, Mizusawa H: Case of an 81-year-old woman with theophylline-associated seizures followed by partial seizures due to vitamin B_6 deficiency, *Rinsho Shinkeigaku* 48(2):125-129, 2008.

Lakhan SE, Vieira KF: Nutritional therapies for mental disorders. *Nutr J* 7:2, 2008.

Li F, Chong ZZ, Maiese K: Navigating novel mechanisms of cellular plasticity with the NAD+ precursor and nutrient nicotinamide, *Front Biosci* 9:2500-2520, 2004.

Li Y, Zhang J: Serum concentrations of antioxidant vitamins and carotenoids are low in individuals with a history of attempted suicide, *Nutr Neurosci* 10(1-2):51-58, 2007.

Lieberman HR: Nutrition, brain function and cognitive performance, *Appetite* 40(3):245-254, 2003.

Linton A, Garber M, Fagan NK, Peterson MR: Examination of multiple medication use among TRICARE beneficiaries aged 65 years and older, *J Manag Care Pharm* 13(2):155-162, 2007.

Lord C, Chaput JP, Aubertin-Leheure M, Labonté M, Dionne IJ: Dietary animal protein intake: association with muscle mass index in older women, *J Nutr Health Aging* 11(5):383-387, 2007.

Luchsinger JA, Tang MX, Miller J, Green R, Mayeux R: Relation of higher folate intake to lower risk of Alzheimer disease in the elderly, *Arch Neurol* 64(1):86-92, 2007.

Lurie Y, Landau DA, Pfeffer J, Oren R: Celiac disease diagnosed in the elderly, *J Clin Gastroenterol* 42(1):59-61, 2008.

Mahady GB: Black cohosh *(Actaea/Cimicifuga racemosa):* review of the clinical data for safety and efficacy in menopausal symptoms, *Treat Endocrinol* 4(3):177-184. 2005.

Malinauskas BM, Aeby VG, Overton RF, Carpenter-Aeby T, Barber-Heidal K: A survey of energy drink consumption patterns among college students, *Nutr J* 6:35, 2007.

Mannix LK: Menstrual-related pain conditions: dysmenorrhea and migraine, *J Womens Health (Larchmt)* 17(5):879-891, 2008.

McFadden SL, Woo JM, Michalak N, Ding D: Dietary vitamin C supplementation reduces noise-induced hearing loss in guinea pigs, *Hear Res* 202(1-2):200-208, 2005.

Mercer LD, Kelly BL, Horne MK, Beart PM: Dietary polyphenols protect dopamine neurons from oxidative insults and apoptosis: investigations in primary rat mesencephalic cultures, *Biochem Pharmacol* 69(2):339-345, 2005.

Merrill RM, Taylor P, Aldana SG: Coronary Health Improvement Project (CHIP) is associated with improved nutrient intake and decreased depression, *Nutrition* 24(4):314-321, 2008.

Milias GA, Nomikos T, Fragopoulou E, Athanasopoulos S, Antonopoulou S: Effects of baseline serum levels of Se on markers of eccentric exercise-induced muscle injury, *Biofactors* 26(3):161-170, 2006.

Miller SL, Wolfe RR: The danger of weight loss in the elderly, *J Nutr Health Aging* 12(7):487-491, 2008.

Moberg PJ, Arnold SE, Doty RL, Gur RE, Balderston CC, Roalf DR, Gur RC, Kohler CG, Kanes SJ, Siegel SJ, Turetsky BI: Olfactory functioning in schizophrenia: relationship to clinical, neuropsychological, and volumetric MRI measures, *Clin Exp Neuropsychol* 28(8):1444-1461, 2006.

Mohammed Abdul MI, Jiang X, Williams KM, Day RO, Roufogalis BD, Liauw WS, Xu H, McLachlan AJ: Pharmacodynamic interaction of warfarin with cranberry but not with garlic in healthy subjects, *Br J Pharmacol* 154(8):1691-1700, 2008.

Montain SJ, Young AJ: Diet and physical performance, *Appetite* 40(3):255-267, 2003.

Moore DR, Del Bel NC, Nizi KI, Hartman JW, Tang JE, Armstrong D, Phillips SM: Resistance training reduces fasted- and fed-state leucine turnover and increases dietary nitrogen retention in previously untrained young men, *J Nutr* 137(4):985-991, 2007.

Morris MS, Jacques PF, Chylack LT, Hankinson SE, Willett WC, Hubbard LD, Taylor A: Intake of zinc and antioxidant micronutrients and early age-related maculopathy lesions, *Ophthalmic Epidemiol* 14(5):288-298, 2007.

Mosekilde L: Vitamin D and the elderly, *Clin Endocrinol (Oxf)* 62(3):265-281, 2005.

Nardi AE, Valença AM, Nascimento I, Freire RC, Veras AB, de-Melo-Neto VL, Lopes FL, King AL, Soares-Filho GL, Mezzasalma MA, Rassi A, Zin WA: A caffeine challenge test in panic disorder patients, their healthy first-degree relatives, and healthy controls, *Depress Anxiety* 25(10):847-853, 2008.

Nieves JW: Osteoporosis: the role of micronutrients, *Am J Clin Nutr* 81(5):1232S-1239S, 2005.

Nieman DC, Bishop NC: Nutritional strategies to counter stress to the immune system in athletes, with special reference to football, *J Sports Sci* 24(7):763-772, 2006.

O'Brien MC, McCoy TP, Rhodes SD, Wagoner A, Wolfson M: Caffeinated cocktails: energy drink consumption, high-risk drinking, and alcohol-related consequences among college students, *Acad Emerg Med* 15(5):453-460, 2008.

Oliveira FA, Galan DT, Ribeiro AM, Santos Cruz J: Thiamine deficiency during pregnancy leads to cerebellar neuronal death in rat offspring: role of voltage-dependent K+ channels, *Brain Res* 1134(1):79-86, 2007.

Pearlman JP, Fielding RA: Creatine monohydrate as a therapeutic aid in muscular dystrophy, *Nutr Rev* 64(2 Pt 1):80-88, 2006.

Phillips SM, Hartman JW, Wilkinson SB: Dietary protein to support anabolism with resistance exercise in young men, *J Am Coll Nutr* 24(2):134S-139S, 2005.

Pringsheim T, Davenport WJ, Dodick D: Acute treatment and prevention of menstrually related migraine headache: evidence-based review, *Neurology* 70(17):1555-1563, 2008.

Puel C, Quintin A, Agalias A, Mathey J, Obled C, Mazur A, Davicco MJ, Lebecque P, Skaltsounis AL, Coxam V: Olive oil and its main phenolic micronutrient (oleuropein) prevent inflammation-induced bone loss in the ovariectomised rat, *Br J Nutr* 92(1):119-127, 2004.

Qureshi GA, Qureshi AA, Devrajani BR, Chippa MA, Syed SA: Is the deficiency of vitamin B(12) related to oxidative stress and neurotoxicity in Parkinson's patients? *CNS Neurol Disord Drug Targets* 7(1):20-27, 2008.

Raguso CA, Kyle U, Kossovsky MP, Roynette C, Paoloni-Giacobino A, Hans D, Genton L, Pichard C: A 3-year longitudinal study on body composition changes in the elderly: role of physical exercise, *Clin Nutr* 25(4):573-580, 2006.

Raña-Martínez N: Migraine in females, *Rev Neurol* 46(6):373-378, 2008.

Ranganathan R, Nicklas TA, Yang SJ, Berenson GS: The nutritional impact of dairy product consumption on dietary intakes of adults (1995-1996): the Bogalusa Heart Study, *J Am Diet Assoc* 105(9):1391-1400, 2005.

Ray AL, Semba RD, Walston J, Ferrucci L, Cappola AR, Ricks MO, Xue QL, Fried LP: Low serum selenium and total carotenoids predict mortality among older women living in the community: the women's health and aging studies, *J Nutr* 136(1):172-176, 2006.

Rayman MP, Pattison DJ: Dietary manipulation in musculoskeletal conditions, *Best Pract Res Clin Rheumatol* 22(3):535-561, 2008.

Rehak M, Fric E, Wiedemann P: Lutein and antioxidants in the prevention of age-related macular degeneration, *Ophthalmologe* 105(1):37-45, 2008.

Rondanelli M, Trotti R, Opizzi A, Solerte SB: Relationship among nutritional status, pro/antioxidant balance and cognitive performance in a group of free-living healthy elderly, *Minerva Med* 98(6):639-645, 2007.

Schaap LA, Pluijm SM, Deeg DJ, Visser M: Inflammatory markers and loss of muscle mass (sarcopenia) and strength, *Am J Med* 119(6):526.e9-526.e17, 2006.

Schürks M, Diener HC, Goadsby P: Update on the prophylaxis of migraine, *Curr Treat Options Neurol* 10(1):20-29, 2008.

Segal E, Raichlin V, Rimbrot S, Zinman C, Raz B, Ish-Shalom S: Hip fractures in the elderly in Israel—possible impact of preventable conditions, *Arch Gerontol Geriatr* 48(2):182-185, 2008.

Selhub J, Morris MS, Jacques PF: In vitamin B_{12} deficiency, higher serum folate is associated with increased total homocysteine and methylmalonic acid concentrations, *Proc Natl Acad Sci U S A* 104(50):19995-20000, 2007.

Semba RD, Bartali B, Zhou J, Blaum C, Ko CW, Fried LP: Low serum micronutrient concentrations predict frailty among older women living in the community, *J Gerontol A Biol Sci Med Sci* 61(6):594-599, 2006.

Senturk UK, Yalcin O, Gunduz F, Kuru O, Meiselman HJ, Baskurt OK: The effect of antioxidant vitamin treatment on the time course of hematological and hemorrheological alterations following an exhausting exercise episode in human subjects, *J Appl Physiol* 98(4):1272-1279, 2005.

Shatenstein B, Kergoat MJ, Reid I: Poor nutrient intakes during 1-year follow-up with community-dwelling older adults with early-stage Alzheimer dementia compared to cognitively intact matched controls, *J Am Diet Assoc* 107(12):2091-2099, 2007.

Soilu-Hänninen M, Laaksonen M, Laitinen I, Erälinna JP, Lilius EM, Mononen I: A longitudinal study of serum 25-hydroxyvitamin D and intact parathyroid hormone levels indicate the importance of vitamin D and calcium homeostasis regulation in multiple sclerosis, *J Neurol Neurosurg Psychiatry* 79(2):152-157, 2008.

Stimpson JP, Lackan NA: Serum carotenoid levels vary by marital status, *J Am Diet Assoc* 107(9):1581-1585, 2007.

Stoltenberg M, Bush AI, Bach G, Smidt K, Larsen A, Rungby J, Lund S, Doering P, Danscher G: Amyloid plaques arise from zinc-enriched cortical layers in APP/PS1 transgenic mice and are paradoxically enlarged with dietary zinc deficiency, *Neuroscience* 150(2):357-369, 2007.

Stothers L: A randomized trial to evaluate effectiveness and cost effectiveness of naturopathic cranberry products as prophylaxis against urinary tract infection in women, *Can J Urol* 9(3):1558-1562, 2002.

Stowell CP, Barnhill JW: Acute mania in the setting of severe hypothyroidism, *Psychosomatics* 46(3):259-261, 2005.

Sturdee DW: The menopausal hot flush—anything new? *Maturitas* 60(1):42-49, 2008.

Tanvetyanon T: Physician practices of bone density testing and drug prescribing to prevent or treat osteoporosis during androgen deprivation therapy, *Cancer* 103(2):237-241, 2004.

Tarnopolsky M: Protein requirements for endurance athletes, *Nutrition* 20(7-8):662-668, 2004.

Terris MK, Issa MM, Tacker JR: Dietary supplementation with cranberry concentrate tablets may increase the risk of nephrolithiasis, *Urology* 57(1):26-29, 2001.

Tharion WJ, Lieberman HR, Montain SJ, Young AJ, Baker-Fulco CJ, Delany JP, Hoyt RW: Energy requirements of military personnel, *Appetite* 44(1):47-65, 2005.

Thomsen LL, Olesen J: Nitric oxide in primary headaches, *Curr Opin Neurol* 14(3):315-321, 2001.

Unal B, Tan H, Orbak Z, Kiki I, Bilici M, Bilici N, Aslan H, Kaplan S: Morphological alterations produced by zinc deficiency in rat sciatic nerve: a histological, electron microscopic, and stereological study, *Brain Res* 1048(1-2): 228-234, 2005.

Velling DA, Dodick DW, Muir JJ: Sustained-release niacin for prevention of migraine headache, *Mayo Clin Proc* 78(6):770-771, 2003.

Weiss LA, Barrett-Connor E, von Muhlen D: Ratio of n-6 to n-3 fatty acids and bone mineral density in older adults: the Rancho Bernardo Study, *Am J Clin Nutr* 81(4):934-938, 2005.

Wilkinson SB, Tarnopolsky MA, Macdonald MJ, Macdonald JR, Armstrong D, Phillips SM: Consumption of fluid skim milk promotes greater muscle protein accretion after resistance exercise than does consumption of an isonitrogenous and isoenergetic soy-protein beverage, *Am J Clin Nutr* 85(4):1031-1040, 2007.

Wolters M: The significance of diet and associated factors in psoriasis, *Hautarzt* 57(11):999-1004, 2006.

Woolf K, Manore MM: Elevated plasma homocysteine and low vitamin B-6 status in nonsupplementing older women with rheumatoid arthritis, *J Am Diet Assoc* 108(3):443-453, 2008.

Yaegashi Y, Onoda T, Tanno K, Kuribayashi T, Sakata K, Orimo H: Association of hip fracture incidence and intake of calcium, magnesium, vitamin D, and vitamin K, *Eur J Epidemiol* 23(3):219-225, 2008.

Zoppi CC, Hohl R, Silva FC, Lazarim FL, Neto JM, Stancanneli M, Macedo DV: Vitamin C and E supplementation effects in professional soccer players under regular training, *J Int Soc Sports Nutr* 3:37-44, 2006.

chapter

14

Public Health Issues in National and International Nutrition

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Chapter Topics

National Health Concerns
National Nutrition Programs
Preventing Food Poisoning
International Nutrition Concerns and Programs
The Role of the Nurse and Other Health Care Professionals in National and International Nutrition Programs

Objectives

After completing this chapter, you should be able to:

- Identify the basic focus of the various federal community nutrition programs for referral purposes.
- Discuss the importance of controlling food quackery.
- Identify appropriate uses of food additives.
- Describe the principles of home-based food sanitation.
- Explain why public health professionals need to be advocates for consumer nutritional and health needs.
- Describe important international nutrition concerns.

Terms to Identify

Acrylamide
Clostridium botulinum
Clostridium perfringens
Commodity Supplemental Food Program (CSFP)
Communicable disease
Escherichia coli (E. coli)
Fight BAC!
Fixed eruption
Food additives
Food fads
Food insecurity
Food irradiation
Food quack
Food resource management
Generally Recognized as Safe (GRAS) list
Genetically modified foods
Giardia
Listeria
Maillard reaction
Nutrition Program for the Elderly
Older Americans Act
Organic foods
Paraprofessionals
Poverty
Salmonella
Staphylococcus aureus
Thrifty Food Plan

INTRODUCTION

Public health initiatives change as needs change. At the beginning of the twentieth century the average life expectancy was 47 years of age. Women routinely died from childbirth, and approximately 1 in 10 infants died in the first year of life. Infectious respiratory diseases, such as tuberculosis, accounted for nearly a quarter of all deaths. Public health measures routinely focused on sanitation. The advent of immunizations and antibiotics helped to drastically reduce mortality from infections. The challenge for the twenty-first century is how to continue the fight against infectious diseases while helping to prevent chronic illnesses, especially childhood obesity, and providing for the health needs of an aging population.

Public health messages are aimed at particular high-risk groups, such as children or the elderly, or they concern themselves with specific conditions, such as hypertension or diabetes. National initiatives include MyPyramid.gov and food label guidelines aimed at improving food selection to promote optimal health and prevent disease. Iodized salt, vitamin D–fortified milk, and folic acid fortification of processed grain products are all designed to improve the health of large segments of the population.

Public health initiatives can be implemented by a variety of means. There are structured national programs. There are also initiatives implemented by interested groups. Schools increasingly are developing programs to prevent chronic health problems from developing in children.

Public health programs may provide education, but they may also allow individuals to obtain nourishing food, such as in the Food Stamp Program. The Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) (see section later in the chapter) was developed in response to high rates of childhood anemia among lower-income families. It provides both education and food vouchers for iron-fortified cereals and enough juice to meet 100% of vitamin C needs with the goal to lower the rate of childhood anemia.

Public health messages are helpful to get simple information to large numbers of individuals. All health care professionals should promote public health messages such as the importance of eating less saturated fat and more high-fiber foods. More precise guidance is aimed at individual needs such as with medical nutrition therapy provided by a registered dietitian (RD).

WHAT ARE NATIONAL HEALTH CONCERNS?

CHILDHOOD OBESITY

Childhood obesity is currently receiving a great deal of attention. This is due to the recognition that it is easier to prevent obesity than it is to correct it. It also is due to the concern that the children of today may see a decline in life expectancy because of the various chronic health conditions that develop as a result of obesity.

Living in a rural area has been linked with children having higher rates of obesity, heart disease, and diabetes compared with children living in urban areas. Attempts to medically manage and help prevent worsening obesity among rural youth are hampered by the low concentration of doctors and other providers. An

approach to the needs of rural youth is telemedicine weight management consultations. This approach showed improvements in clinical outcomes for children who were "seen" more than once. The majority of children improved their diets and activity levels, and almost half were able to either slow their weight gain or achieve weight loss (Shaikh and colleagues, 2008).

Other public health initiatives to prevent childhood obesity include developing strategies to promote breastfeeding, increase physical activity, discourage television time, and reduce availability of sugar-sweetened beverages at functions that involve children. Training health care providers to use more effective counseling techniques with parents is needed (Homer and Simpson, 2007). Part of the discomfort some health care providers feel when addressing childhood obesity is concern about creating friction between the provider and the family. In a study of lower-income Hispanic families residing in Nevada, it was found that 61% of mothers did not recognize their children as being overweight (Hackie and Bowles, 2007). The American Dietetic Association further promotes nutrition education and community initiatives. Family-based programs are advised for younger children and school-based programs for adolescents (American Dietetic Association, 2006).

Teaching Pearl

A health care provider can assist the family of an overweight, or at-risk overweight, child by starting with an open-ended question, "How do you feel about your child's weight?" If the family responds they have concerns, the next question might be, "What is it that concerns you?" A referral to a registered dietitian with experience working with children may be greatly appreciated by the family. For families who do not recognize the problem, review of the child's growth chart can serve as a nonbiased, objective tool to assist in recognition of the problem. ■

Schools can take a more active role in the meal environment. Although there are standards for school meals to provide nutrients that meet dietary guidelines, these standards do not apply to foods and beverages served and sold outside of the school meal. Such foods are called *competitive foods* by the U.S. Department of Agriculture (USDA), and increasingly nutrition standards are being advised for such foods in the entire school environment. Legislation now mandates that all school districts that participate in the USDA's Child Nutrition Program have developed and implemented a local wellness policy. There are a variety of resources available to assist in the development of wellness policies (see Appendix 1 on the Evolve website).

Some interventions that have resulted in positive change in school food environments include reducing fat content of food in vending machines and making more fruits and vegetables available. Some states now mandate and promote more physical activity in schools despite the increased academic demands from No Child Left Behind legislation. School health services can also help address obesity by providing screening, health information, and referrals to students.

In 2004 the World Health Organization (WHO) called on governments, industry, and society to reduce unhealthy marketing messages to children. Changes have occurred since then with self-regulatory approaches among the food industry.

However, more could be done to restrict food marketing to young people (Hawkes, 2007).

Research into the causes and prevention strategies is a public health approach to childhood obesity. The Children's Health Act of 2000 resulted in the plan to conduct the National Children's Study. The National Children's Study will seek information on environmental risks and genetically programmed individual susceptibility factors for a number of childhood health problems, including obesity. It will be conducted in a nationally representative, prospective cohort of 100,000 children born in the United States. Children will be followed from conception to 21 years of age. Recruitment began in 2007 and includes over 100 sites across the United States. The intention is that data from this study will guide development policies for disease prevention in children (Landrigan and colleagues, 2006).

WATER SAFETY

Historically the focus of public health initiatives has been the provision of clean water. This has been addressed by such factors as wastewater treatment and chlorination of water supplies. The Public Health Service institutes water boiling advisories with flood conditions as a means to reduce risk of waterborne illness. Advice includes avoidance of drinking from streams to avoid parasitic infections such as with ***Giardia*** species. Contamination of water supplies with heavy metals is also of concern. This includes lead poisoning as previously discussed in Chapter 12. Lead may contaminate home drinking water from either lead pipes in older homes or lead solder in newer homes. It is recommended that tap water be run for 1 to 2 minutes each morning to lower risk of lead poisoning.

Water testing is used to help identify problems in a water supply and develop strategies to keep the public safe. An example of this occurred in 2004 when two groundwater wells in Virginia were found to have natural uranium levels either at or above the Environmental Protection Agency (EPA) recommended limit of 30 mcg/L. As a result, a stop-drinking water advisory was issued until a water treatment system could be installed to remove the uranium (Wyatt and colleagues, 2008).

Another heavy metal of concern in drinking water is arsenic, with high concentrations being greater than 10 mcg/L. The arsenic can be found in groundwater from natural geologic sources. Naturally occurring arsenic in the bedrock of the Northern Appalachian Mountains belt was first recognized in the late 1800s. Within this high-arsenic region, between 6% and 22% of households using private drinking-water wells contain high levels of arsenic (Peters, 2008). Other areas near the Appalachian Mountains known to have high arsenic content include portions of Maryland (Haque, Ji, and Johannesson, 2008) and the New England states.

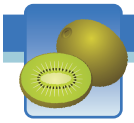
There are contamination issues such as in mining or industrial areas. These include southeastern Michigan, where 8% of the population is estimated to be at risk from home drinking water. It was found that water used for cooking had an insignificant impact on arsenic ingestion (Meliker and colleagues, 2006). In western Nevada, arsenic concentrations in wells averaged greater than 70 mcg/L with a range of nondetectable levels to 3000 mcg/L (Thundiyil and colleagues, 2007). In northwestern New Jersey, increased arsenic levels in groundwater have been noted near the now-closed Franklin Mine. Seasonal variation was found as a result of dilution of arsenic concentrations in river water content. During high stream flow in fall,

winter, and spring there was a lower concentration, whereas concentrated levels were found during low flow in summer (Barringer and colleagues, 2007). Due to seasonal variation, it is advised that multiple testing times of arsenic levels be undertaken to help ensure safe water supplies.

Areas of former apple orchards are at increased risk of arsenic contamination of water supplies. Lead arsenate pesticides were widely used in apple orchards from 1925 to 1955. Soils from historic orchards in Virginia and West Virginia contained elevated concentrations of both arsenic and lead, consistent with pesticide source. Fortunately, there is some evidence arsenic tends to remain in the soil with limited movement into groundwater from surface soils (Robinson and colleagues, 2007). A study in a western Massachusetts apple orchard found the arsenic is confined to the top 20 cm of the soil (Newton, Amarasiriwardena, and Xing, 2006).

Although arsenic is considered a neurotoxin, other adverse health implications have been suggested. These include bladder cancer, with mortality among white men and women being relatively high in the New England region, New York, and New Jersey, where well water and arsenic levels have been implicated (Ayotte and colleagues, 2003). The link between arsenic and cancer risk appears to be impaired DNA repair processes (Andrew and colleagues, 2006). In utero exposure to arsenic is associated with increased risk of allergic disease as well (Selgrade, 2007). Epidemiologic studies suggests a link with arsenic and cardiovascular disease risk factors The findings indicate an effect of chronic arsenic exposure from drinking water on vascular inflammation (Chen and colleagues, 2007).

Methods of arsenic removal from household drinking water have been developed. The method using ferric sulfate coagulation with sand filtration was found to be effective and affordable (Yuan and colleagues, 2003).



Cultural Considerations

Medicinal exposure to arsenic has been reported. A case of a Chinese woman living in the United States with skin manifestations from chronic arsenic ingestion was found due to a 5-year history of Chinese herbal medicine use (Hanjani, Fender, and Mercurio, 2007). ■

Another problem with water safety is residues from therapeutic drugs. This can occur from human waste into the sewage system. Both illicit drugs and pharmaceutical medications have been found in surface waters of rivers and lakes in Italy and Great Britain. These include cocaine, opioids, amphetamines, cannabis derivatives, codeine, and methadone. Because most of these residues still have potent pharmacologic activities, their presence may have potential implications for human health and wildlife (Zuccato and colleagues, 2008). Similar findings are likely in the United States. Increased levels of pharmaceuticals can come from hospitals and long-term care centers that routinely dispose of unused narcotics monthly by flushing them down the toilet. The Drug Enforcement Administration (DEA) is amending its regulations to allow, where state laws permit, retail pharmacy installation of automated dispensing systems at long-term care facilities. Automated dispensing systems would allow dispensing of single-dosage units and would reduce the problem of excess stocks and disposal (Drug Enforcement Administration, 2005).

In the southeastern United States over 40% of male largemouth bass were found to have intersex gonads, suggesting exposure to estrogen-based or other antiandrogenic chemicals (Hinck and colleagues, 2008). Estrogen content of water may be linked to current increased rates of infertility.

HEAVY METAL CONCERNS DURING PREGNANCY AND EARLY CHILDHOOD

Heavy metals such as lead, arsenic, and mercury are neurotoxins and can cause irreversible damage in the brain development of young children. Blood lead concentrations of an infant have been found to be largely affected by maternal blood lead levels. Women with higher blood lead levels have been noted to have lower hematocrit and serum levels of folate and ascorbic acid with low intake of thiamin (Lee, Chun, and Song, 2005). Thus diet counseling of pregnant women to ensure adequate intakes of iron, folic acid, and vitamins B_1 and C may help to lower lead levels in infants. Young children may be exposed to high levels of lead found in paint chips and dust containing lead. Because lead has a sweet taste, children have been known to chew on windowsills, on which old lead paint may be found. If inappropriate lead-paint removal from an older home is done, lead may be found in high concentrations in soil and house dust such that children may be exposed.

Arsenic exposure from treated wood as used in outdoor decks and playground equipment is another threat to children. Arsenic absorption can occur through skin contact. The sand surrounding the playground area may accumulate arsenic from decaying wood of the equipment. The most significant intake of arsenic and lead by children is orally through hand-to-mouth transfer (Hemond and Solo-Gabriele, 2004). For this reason, young children should be reminded over and over not to put their hands in their mouths unless their hands are first washed. See later section for more on international concerns of arsenic toxicity.

Excess mercury needs to be avoided. Mercury induces mitochondrial dysfunction with reduction in energy metabolism, oxidative stress, inflammation, dyslipidemia, hypertension, stroke, renal disease, and immune dysfunction. For this reason, some fish products need to be used sparingly because of their mercury content. Selenium reduces the effects of mercury toxicity (Houston, 2007).

Lead is a well-known neurotoxin, and young children are now routinely screened because of its adverse impact on brain function. Calcium supplements in the form of bone meal tend to be high in lead and should be avoided. Other potential lead-contaminant sources are wine decanters with lead crystal (storage of wine in decanters is discouraged); ceramic dishes with a lead glaze; food left in opened cans that have lead solder; household water pipes that are either made from lead (such as those found in older homes) or have lead in the solder (running the tap water for 1 to 2 minutes before use each morning is advised); lead paint (now illegal in the United States but still found in older homes); lead-based fuel, including its fumes; and dirt and dust contaminated with lead residue. Younger children are particularly susceptible to lead poisoning, in part because of an increased risk of exposure from playing in dirt contaminated with lead (one reason that washing hands before eating is so important) and from eating peeling lead paint, which has a sweet taste.

SAFE FOOD SUPPLIES

Various measures have been taken to help ensure a safe food supply. These include using individual servings of condiments at restaurants and plastic seals on jars with

screw-on lids. Behind the scenes, food inspectors oversee food-processing methods and restaurant adherence to safety guidelines. Such guidelines include storing food at safe temperatures and using safe food-handling procedures (see section on food poisoning).

Environmental impacts on food supplies include heavy metal contamination in water irrigation. Rice, due to its high need for water, is a potentially important source of arsenic contamination. However, arsenic toxicity varies greatly with species. Rice from the United States may be safer than rice from Asia and Europe due, in part, to the variety of rice grown in the United States (Zavala and colleagues, 2008). A wide variability within U.S. rice grain appears to be influenced by region of growth related to environmental contamination. Rice grown in California showed lower amounts of arsenic than in other states (Zavala and Duxbury, 2008).

Although there are water safety guidelines for tolerable arsenic content, there are no criteria for arsenic content of food. One so-called food is rice milk, with samples in Great Britain found to have up to three times the amount allowed in water. Because rice milk is essentially the water that rice was cooked in, this issue may best be resolved by defining rice milk as a substitute for water because it does not contain milk or significant quantities of rice (Meharg and colleagues, 2008a). Various varieties and sources of salmon have been shown to have a low level of mercury (Kelly and colleagues, 2008). Carnivorous pike and long-lived fish contain the highest muscle mercury values (Jewett and Duffy, 2007). Research in Great Britain also found about one third of baby rice cereals contain arsenic. Again, as a food source it is not regulated for arsenic content, but it was found to have levels high enough to prevent its being sold in China, which has regulatory limit of 0.15 mg/kg inorganic arsenic. It was noted when baby inorganic arsenic intake from rice was considered, median intake based on body weight equates levels higher than water regulations permit (Meharg and colleagues, 2008b).

A new potential carcinogen was identified in 2002. **Acrylamide** is a substance formed from the amino acid, asparagine, and sugars or starches under high heat conditions. Grains and potato-based foods are the primary sources. The chemical reaction known as the **Maillard reaction,** which causes browning in foods, is part of the cause. Thus, although bread is low in acrylamide, the longer it is toasted, as noted with the darker color, the more acrylamide that is formed (Jackson and Al-Taher, 2005). In yeast breads there is a lower content of acrylamide formed than in nonyeast breads. This is due to the impact of yeast feeding on the asparagine, resulting in a lower content (Granby and colleagues, 2008). The most promising near-term technical solution is the use of the enzyme asparaginase to help reduce the content of this amino acid in starchy foods. This enzyme has the potential to achieve a 60% to 90% reduction for some products made from dough (Konings and colleagues, 2007).

Blanching potatoes in water, which removes some starch, combined with a shorter oven-roasting time was shown to be an efficient way of reducing the acrylamide content in potato wedges (Skog and colleagues, 2008). A higher level of sugar content of potatoes in 2006 was found, likely related to weather conditions during the growing season. This was reflected in a higher acrylamide content found in potato chips (crisps, as they are called in England), which was approximately twice as high as in preceding years (Viklund and colleagues, 2008). Children might be the

most vulnerable group of the population, partly due to a high preference for French fries (Heudorf, Hartmann, and Angerer, 2008).

The new threat of bioterrorism has increased security around food supplies. For individual families the Centers for Disease Control and Prevention (CDC) recommends stocking private stores of food and water in case of emergencies such as radioactive fallout. With regard to nutritional needs, it is advised to have 1 gallon of water for each person for 3 days, along with nonperishable foods and infant formula as needed. Hand sanitizers should also be kept. Nonperishable foods include canned, dried, or packaged foods. Peanut butter and nuts do not require refrigeration. Milk could be made from the stored water and powdered milk. Stored water should be changed every 6 months, and food items should be replaced after expiration dates. Other emergency preparedness guidelines may be found at www.bt.cdc.gov.

Public health measures with food safety include warnings for persons with food allergies. Labels now routinely state if the food contains wheat or nuts. **Fixed eruption** is a characteristic condition with recurrent reddened skin area in the same location. Two cases of fixed eruption due to quinine contained in tonic water have been observed (Muso and colleagues, 2007). A 71-year-old woman was noted to have fixed eruption along with burning and itching of the area due to cashew nuts (Fukushima, Kidou, and Ihn, 2008).

Other behind-the-scenes actions to ensure safe food supplies, such as analyzing nutrient content of foods, occur at the federal level. The USDA nutrient content data between 1950 and 1999 for 43 garden crops showed significant declines in six nutrients (protein, calcium, phosphorus, iron, riboflavin, and ascorbic acid). Average declines ranged from 6% for protein to 38% for riboflavin. These declines are believed to be primarily a result of use of high-yield crop varieties in this time period, the tradeoff being yield versus nutrient content (Davis, Epp, and Riordan, 2004).

Further efforts at the federal level include research on safe use and regulations for food additives such as preservatives on the **Generally Recognized as Safe (GRAS) list.** The 1958 Food Additives Amendment was designed to protect the consumer. Because of this legislation, **food additives** (substances added to foods, generally to make them safer to eat) used in processed food must be proved safe by industry before they can be incorporated into any food product. Additives must meet strict guidelines for inclusion in the GRAS list. Examples of food additives include nitrites, used to prevent botulism in cured meat products. Ascorbates and other ingredients are added to maintain quality in meat products. Only minute quantities of these additives are used, usually in amounts lower than might exist naturally in many food products. The USDA requires that additives meet the following requirements:

- They must be approved by the U.S. Food and Drug Administration (FDA) and are limited to specific amounts.
- They must meet a specific, justifiable need in the product.
- They must not promote deception as to product freshness, quality, or weight.
- They must be truthfully and properly listed on the product label.

Table 14-1 lists typical food additives. Table 14-2 lists food- and nutrition-related responsibilities of federal agencies.

Table 14-1 Typical Food Additives: Why and Where Used

REASONS FOR USE	SUBSTANCE USED	FOODS
To Impart and Maintain Desired Consistency		
Emulsifiers distribute tiny particles of one liquid in another to improve texture consistency, homogeneity, and quality; stabilizers and thickeners give smooth uniform texture, flavor, and desired consistency	Alginates, lecithin, monoglycerides and diglycerides, agar, methyl cellulose, sodium phosphates, carrageenan	Baked goods, cake mixes, salad dressings, frozen desserts, ice cream, chocolate milk, processed cheese
To Improve Nutritive Value		
Medical and public health authorities endorse this use to eliminate and prevent certain diseases involving malnutrition: iodized salt has eliminated simple goiter; vitamin D in dairy products and infant foods has virtually eliminated rickets; and niacin in bread, cornmeal, and cereals has eliminated pellagra in the southern states	Vitamin A, thiamin, niacin, riboflavin, ascorbic acid, vitamin D, iron, potassium iodide products, margarine, milk, iodized salt	Wheat flour, bread and biscuits, breakfast cereals, cornmeal, macaroni, and noodles
To Enhance Flavor		
Many spices and natural and synthetic flavors give us a desired variety of flavorful foods such as spice cake, gingerbread, and sausage	Cloves, ginger, citrus oils, amyl acetate, benzaldehyde	Ice cream, candy, gingerbread, spice cake, soft drinks, fruit-flavored gelatins, fruit-flavored toppings, sausage
To Provide Desired Texture		
Leavening agents are used in the baking industry in cakes, biscuits, waffles, muffins, and other baked goods	Sodium bicarbonate, phosphates	Cakes, cookies, crackers
To Impart Tartness to Beverages		
	Citric acid, lactic acid, phosphates, phosphoric acid	Soft drinks
To Maintain Appearance, Palatability, and Wholesomeness		
Deterioration caused by microbial growth or oxidation is delayed and food spoilage caused by mold, bacteria, and yeast is prevented or slowed by certain additives; antioxidants keep fats from turning rancid and certain fresh fruits from darkening during processing when cut and exposed to air	Propionic acid, sodium and calcium salts of propionic acid, ascorbic acid, butylated hydroxyanisole, butylated hydroxytoluene, benzoates	Bread, cheese, syrup, pie fillings, crackers, frozen and dried fruits, fruit juices, margarine, lard, shortening, potato chips, cake mixes
To Give Desired and Characteristic Color		
Acceptability and attractiveness are increased by the correction of objectionable natural variations	FDA-approved colors, such as annatto, carotene, cochineal, chlorophyll	Confections, bakery goods, soft drinks, cheeses, ice cream, jams, and jellies
Other Functions		
Humectants retain moisture in some foods and keep others, including salts and powders, free flowing	Glycerine, magnesium carbonate	Coconut, table salt

From Chemical Manufacturers Association: *Food additives … who needs them?* Washington, DC, p. 11.
FDA, Food and Drug Administration.

Table 14-2 Food and Nutrition-Related Responsibilities of Federal Agencies

AGENCY	FUNCTION
Bureau of Alcohol, Tobacco and Firearms (BATF)	Regulation of alcoholic beverages
Consumer Product Safety Commission (CPSC)	Safety of food-handling equipment
Department of Agriculture (USDA)	Provides leadership on food and agricultural research, policies, and initiatives aimed at improved health
Department of Health and Human Services (HHS)	Provides resources in such areas as diseases, safety and wellness, families and children, aging, disasters and emergencies, policies and regulations
Centers for Disease Control and Prevention (CDC)	Analysis and reporting of incidence of foodborne diseases
Food and Drug Administration (FDA)	Food labeling, safety of food and food additives, inspection of food processing plants, control of food contaminants, food standards
National Institutes of Health (NIH)	Research related to diet and health
Environmental Protection Agency (EPA)	Standards for drinking water, water pollution, and use of pesticides on food crops
Federal Trade Commission (FTC)	Food advertising, competition in food industry
National Marine Fisheries Service (NMFS)	Inspection, standards, and quality of seafood
Occupational Safety and Health Administration (OSHA)	Employee safety in food-processing plants
Economics Research Service (ERS)	Analysis and reporting of food situation and outlook
Food and Nutrition Service (FNS)	Administration of the following programs: Food Stamps; School Lunch; Women, Infants, and Children; and Donated Food
Food Safety and Inspection Service (FSIS)	Inspection and labeling of meat, poultry, and eggs; grading of all foods; controlling nitrite in cured meats and poultry
Human Nutrition Information Service (HNIS)	Food consumption standard tables for nutritive value of food, educational materials
Science and Education Administration (SEA)	Extension Service, Agricultural Research Service Cooperative State Research Service, National Agricultural Library

Pasteurization of milk has long been used as a method of destroying harmful bacteria. Generally, adequate heat will kill harmful pathogens. Some individuals advocate the use of raw, unpasteurized milk for its nutrients that may be damaged with the heat of pasteurization. However, this is not without risk. In late 2005, health officials in Clark County, Washington, noted a higher-than-expected number of *Escherichia coli (E. coli)* cases among residents. It was found the consumption of raw milk was the common factor among these individuals, and further testing verified *E. coli* contamination. Because of this case, legislation was passed that clarified that state licensing requirements apply to all milk production facilities, including cow-share programs (Denny, Bhat, and Eckmann, 2008).

Food irradiation is being used in the processing of high-risk foods such as meats to eliminate infectious pathogens. Harmful bacteria can develop internally in leafy vegetables that cannot be effectively removed by surface treatments. Irradiation has been shown to inactivate leaf-internalized bacteria (Niemira, 2008).

However, there is still public concern about possible adverse effects of food irradiation that may be justified. Irradiation of frozen corn and peas was found to cause a reduction in vitamin C content of both corn and peas (Fan and Sokorai, 2007). Although neither of these vegetables has a high content of vitamin C, this effect should prompt further research into the nutritional implications of irradiation. In a study of mice, vitamin K deficiency developed as a consequence of being fed a ration that had been irradiated (Hirayama and colleagues, 2007). There is not adequate evidence currently to support the unconditional endorsement of irradiation of food for consumption (Ashley and colleagues, 2004).

The debate on the benefits of organic foods continues. Recent labeling regulations have gone into effect to ensure that consumers are actually purchasing organic foods, if they desire. **Organic foods** are foods that were grown without the use of commercial fertilizers and pesticides. Generally speaking, persons purchasing organic foods are concerned for the environment, and many feel that the nutritional value is greater. There is some evidence to support this belief. Blueberries, for example, grown from organic culture yielded significantly higher phytochemical and antioxidant activity (Wang and colleagues, 2008). Organic crops in general have been noted to have a significantly higher amount of vitamin C, phytochemicals, and minerals and have higher dry matter content than conventional ones (Györéné, Varga, and Lugasi, 2006).

There also is less pesticide residue on organic foods. The widespread use of organophosphorus pesticides prompted the Children's Pesticide Exposure Study in the greater Seattle, Washington, area. It was found by substituting organic fresh fruits and vegetables for corresponding conventional food items there were reduced levels of pesticide residue in children (Lu and colleagues, 2008).

On the other hand, the use of animal manure as a fertilizer for organically grown produce can increase the risk of foodborne pathogens such as *Salmonella* and *E. coli.* Good food hygiene practices at home are essential to reduce the incidence of foodborne illnesses (Leifert and colleagues, 2008).

The manner in which cattle are raised for human consumption can have an impact on health. In cattle the polyunsaturated to saturated fatty acid ratio (P:S ratio) was found to increase with duration of grazing, mainly as a consequence of the increased concentration of omega-3 fat (Noci and colleagues, 2005). Organic milk was found to have a higher proportion of polyunsaturated fatty acids (PUFAs) to monounsaturated fatty acids and of omega-3 fatty acids than conventional milk and contained a consistently lower PUFA:omega-3 ratio (which is considered beneficial) compared with conventional milk (Ellis and colleagues, 2006). This is primarily due to the diet of grazing cattle.

As the organic food movement continues, we may learn more about the nutritional benefits of this approach. One lesson learned is that many consumers are willing to pay more for organic foods. Although this is positive in the sense that it encourages more farms to be less reliant on pesticides, the consumer can be paying excessively for the nutritional benefits provided.

Genetically modified foods include traditional hybrid versions of plants. Traditional hybridization, or cross-pollination, has been used for centuries. Cross-pollination of plants occurs when the pollen from one plant is transferred to another. It can be either encouraged or discouraged, resulting in different varieties of the same plant. The cruciferous vegetables (broccoli, cauliflower, cabbage, Brussels sprouts), for example, originated from one plant. Broccoli is biologically much like cauliflower except that it is green and consequently higher in beta-carotene and vitamin C. Cauliflower is high in vitamin K because it is related to leafy green cruciferous vegetables. A variety of fruits and vegetables has been developed with hybridization. Genetic manipulation of plants has become more sophisticated owing to advances in the sciences of molecular biology and genetics.

It is now possible to physically extract genes from or add them to plants to change the characteristics of new generations of plants. Such crops are being grown extensively in the United States, South America, Africa, and China. Europe, however, has voiced significant objections to such genetic alteration and has been avoiding the practice of these methods.

One concern is the development of altered proteins in genetically modified foods that humans have not previously been exposed to. This may result in increased frequency of food allergies. To date the methodology used to prevent this potentially adverse outcome has been effective (Goodman and colleagues, 2005). Bioactive compounds have been found to be altered in genetically modified grapefruit. It was found that alterations varied according to the type of postharvest preservation used (Vanamala and colleagues, 2005). Because of potential nutritional issues, it has been advised that more research is needed to ensure genetically modified foods are safe for human consumption (Bakshi, 2003).

In regard to the environment, there were several reports in 2001 of harmful impact on monarch butterflies from genetically modified corn; more recent research is disputing these claims. Genetically modified potatoes in the central Andes were found to alter wild potatoes growing nearby. Concern was that modification of wild potatoes might make them unstable in the environment. Researchers were able to alter the genetically modified potatoes to prevent further cross-pollination (Celis and colleagues, 2004).

An example of potential environmental, as well as human, risk relates to a variety of genetically engineered corn called Starlink. This crop contains an insecticide protein that is not approved for human consumption because of risk of allergy. However, in the fall of 2000 the protein appeared to have entered the human food supply. Subsequently some consumers of corn-based products reported symptoms similar to an allergic reaction. Research did not support the likely occurrence of allergic reactions to this protein, but reactions could not be ruled out (Raybourne and colleagues, 2003).

NUTRITION MISINFORMATION

Food fads (a short-term, "quick-fix" diet or supplement) and nutritional quackery have multiplied as the science of nutrition has grown. A trained person can easily differentiate between accurate and unsound information, but unfortunately the layperson often cannot. The dramatic manner in which fads and fallacies are presented

covers the falseness. Anything that is out of line with current scientific evidence can be considered misinformation.

The **food quack** of today has been likened to the patent medicine man of the past. Food quacks use scientific jargon to sell a product, be it a special food or dietary supplement, special diet, regimen, book, magazine, or weight-reducing gadget. It is wise to be suspicious of any writer, lecturer, or television speaker who makes claims contrary to accepted information. Be wary of those who claim that wholesome food is harmful or undesirable in some way; use a scare technique with regard to health; claim to be a scientist or authority; claim association with an unheard-of organization; or attack the FDA or medical, public health, or nutrition authorities. One should always be suspicious of any material that comes from an anonymous source. The Internet is one place where both sound nutritional advice and false and misleading information can be found. See Appendix 1 on the Evolve website for website addresses of reputable health and nutrition organizations.

Individuals seeking health and nutrition information should make sure it is reliable and unbiased. As the expression states, "Question authority." The proposed authority on a given subject may not be a qualified authority at all. Registered dietitians (RDs) are authorities who are legally bound to give sound, scientific advice on a variety of nutritional issues. Look for the credentials RD, licensed dietitian (LD), or certified dietitian-nutritionist (CDN) when looking for guidance on nutritional issues.

The FDA has long been concerned about the promotion of food supplements as cure-alls for conditions that require medical attention. Misleading promotion of food supplements violates federal law but nevertheless continues via the following:

1. Health food lecturers who claim, directly or indirectly, that the products they are promoting are of value in preventing and curing disease when in fact they are not
2. Door-to-door sales agents who pose as experts on nutrition
3. Pseudoscientific books and journals (written by persons with little nutritional background or training) that frequently recommend some particular food or food combination and that may include advertisements for various products in which the publisher has a commercial interest

Nutrition authorities agree that the best way to buy vitamins and minerals is in the packages provided by nature: whole-grain breads and cereals, vegetables and legumes, fruits, milk, eggs, meat, and fish. The normal American diet now includes such a variety of foods that most persons can hardly fail to have an ample supply of the essential food constituents if they choose foods wisely. The public should distrust any suggestion of self-medication with vitamins and minerals to cure diseases of the nerves, bones, blood, liver, kidneys, heart, or digestive system, unless information from a nonbiased and educated source is provided. Supplements can play a positive role in health promotion but need to be done on an individual basis and based on research outcomes.

HUNGER AND FOOD INSECURITY

Hunger has always been and will always be with us, but the attempts to control its ravages have changed over the course of history. In the twentieth century the Great

Depression of the 1930s led to the establishment of soup kitchens and the Food Stamp Program. During the draft of World War II, poor nutritional status kept many young men from being admitted to the military service. In response to the observations made at that time, the School Lunch Program was developed. During the 1960s the issue of domestic hunger received major attention from the Kennedy and Johnson administrations, which resulted in the expansion of food programs.

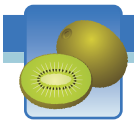
Beginning in the 1980s and continuing into the twenty-first century, underconsumption has again become an acute problem for many Americans. Starting under the Reagan administration, benefits were cut back or eliminated that have not increased since. Of the persons living in **poverty** (the condition of lacking the means to meet basic needs, such as housing and food), many are children.

Individuals experiencing **food insecurity** (episodes of lack of access to adequate amounts of acceptable foods needed for an active, healthy life) from the Lower Mississippi Delta region were found to consistently have lower percentages of intake of the Dietary Reference Intake (DRI) than those who were food secure. This was especially evident for vitamin A and zinc (Champagne and colleagues, 2007). Neighborhood areas of deprivation were associated with lower serum levels of carotenoids. There was a substantial difference in fruit and vegetable intake between low-deprivation and high-deprivation residential areas (Stimpson and colleagues, 2007). In a study of five states across the United States about one in five children lived in food-insecure households (Rose-Jacobs and colleagues, 2008). Young children in Mexican immigrant families are at especially high risk for hunger and household food insecurity (Kersey, Geppert, and Cutts, 2007). In Canada poorer dietary intakes were observed among adolescents and adults in food-insecure households with the differences most marked for protein, vitamin A, B vitamins, magnesium, phosphorus, and zinc (Kirkpatrick and Tarasuk, 2008).

Young children in food-insecure households were reported by parents to have lower physical function, and adolescents were reported to have lower psychosocial function. Food security should be considered an important risk factor for child health (Casey and colleagues, 2005).

The National Health and Nutrition Examination Survey (NHANES) 1999-2002 found household and child food insecurity are associated with being at risk for overweight and overweight status (Casey and colleagues, 2006). This may be due to cycles of hunger and consequential overeating when food is available. Obesity and diabetes occur in the highest frequency among the low-income population. Refined grains, added sugars, and added fats are relatively low in cost but also have limited satiety value. Evidence is emerging that obesity in America is a largely economic issue (Drewnowski and Darmon, 2005). It may also be a result of family dysfunction with an increased percentage of mothers contending with food insecurity having either major depressive episodes or generalized anxiety disorders. Among children, the percentage with a behavior problem also increased with increasing food insecurity (Whitaker, Phillips, and Orzol, 2006).

Seasonal differences in the incidence of very low food security occur, especially among elderly households. In southern states where summer air-conditioning is required, summer is the season of more food insecurity. Northern states have a higher incidence of low food security during the winter months, associated with the increased costs of household heat (Nord and Kantor, 2006).



Cultural Considerations

It is a fairly common presumption that individuals receiving food stamps do not make wise choices. Factors that go into making food choices when income is limited include price. Fats and sugars are the most inexpensive sources of kilocalories. A family that does not have a good water supply may find soft drinks are less expensive than purchasing bottled water. White bread is far less expensive than whole-grain bread. Food preparation facilities may be inadequate to prepare more inexpensive meals—for example, there may not be a working oven. Therefore more expensive prepackaged foods that can be cooked on top of the stove may be chosen. If freezer space is inadequate, purchase of less-expensive bulk quantities of frozen foods will be limited. Another common presumption is that the WIC program provides excess juice. However, at about 1 cup maximum per day, it provides a moderate intake of fruit juice. Families who have experienced food insecurity and have known severe hunger may find it difficult to avoid excess intake when it is available. Health care providers need to be very diplomatic and nonjudgmental when providing nutrition guidance so that it is appropriate to a given family's circumstances. ■

WHAT NATIONAL PROGRAMS HELP IMPROVE NUTRITION?

Several federal programs give people access to food, and there are also local soup kitchens, food banks, and food pantries. These volunteer organizations depend on contributions and local, state, and federal grants. They help feed the homeless, unemployed, working poor, and developmentally disabled in many states. Other nutrition programs are discussed in the following sections.

THE CHILD AND ADULT CARE FEEDING PROGRAM

The Child and Adult Care Feeding Program (CACFP) promotes good nutrition through financial reimbursement. Those who qualify are licensed home day care providers and day care centers that serve nutritious meals based on nutritional meal planning guidelines. At-risk after school care centers that are located in low-income areas can now receive reimbursement at the free rate for snacks. The intended effect of this rule is to support after school care programs through the provision of snacks that meet CACFP meal pattern requirements (Food and Nutrition Service, 2007).

THE EXPANDED FOOD AND NUTRITION EDUCATION PROGRAM

The Expanded Food and Nutrition Education Program (EFNEP) is offered by Cooperative Extension Associations and is aimed primarily at the nutritional needs of low-income families. Local **paraprofessionals** (people who are trained by professionals) are trained in nutrition to provide free nutrition education at the homes of low-income families (Figure 14-1). They focus on **food resource management** (strategies to control food costs) and other areas relevant to nutrition, such as breastfeeding support for low-income mothers. One recommended target population for nutrition education is new mothers, where a positive change in some food choice behaviors has been noted. These behaviors included consuming more fruits and vegetables and eating breakfast every day (Olson, 2005).

A series of six or more food and nutrition lessons provided through EFNEP was found to positively influence food and nutrition behavior changes. Cost-effectiveness

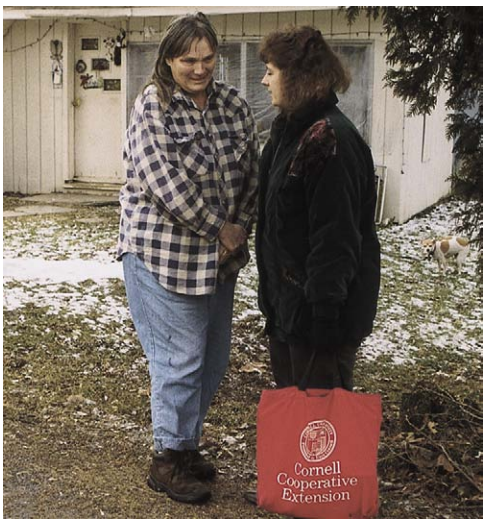


FIGURE 14-1 A nutrition teaching assistant with the Expanded Food and Nutrition Education Program (EFNEP) visits the home of a low-income family.

of EFNEP teaching is estimated to be as great as for many current health interventions (Dollahite, Kenkel, and Thompson, 2008).

THE FOOD STAMP PROGRAM

The Food Stamp Program provides debit cards that can be used to purchase food or seeds to grow food. The allotment is based on the **Thrifty Food Plan,** a meal plan designed to meet the lowest possible cost for nutritional adequacy. The Thrifty Food Plan, although beneficial, was not intended to serve long-term nutritional needs. Therefore relying on food stamps alone to meet food and nutritional needs is an extreme challenge for even the best-educated person. In the state of Maryland, of households receiving food stamps, two thirds experienced food insecurity. Food security status was associated with participation in the WIC program, the summer food program, and a food bank (Oberholser and Tuttle, 2004). It is estimated that slightly over half of all Americans will, at some point during adulthood, receive food stamps (Rank and Hirschl, 2005).

AID TO FAMILIES WITH DEPENDENT CHILDREN

The Aid to Families With Dependent Children (AFDC) program is also referred to as the welfare program and was started in the Roosevelt administration during the Great Depression. Today there is still evidence that both AFDC and the Food Stamp Program have a positive effect on children's nutritional status.

COMMODITY SUPPLEMENTAL FOOD PROGRAM

The **Commodity Supplemental Food Program (CSFP)** is offered to lower-income women and their children up to age 6 years who are eligible for other public assistance. It is also available for seniors over 60 years of age with income less than 130% of the federal poverty level. Food or cash benefits may be provided. The program

targets population groups most at risk for malnutrition and helps farmers financially.

THE NUTRITION PROGRAM FOR THE ELDERLY

The federal **Older Americans Act** provides the states with money to conduct nutrition programs for the elderly. Under this Title III legislation, a hot noon meal is served to elderly persons 5 days a week in senior centers. This funding also provides transportation for individuals who are otherwise unable to get to the center. Nutrition education, health services, and recreational activities are planned around meals. For homebound elderly persons, up to a week's worth of meals are prepared at the center and delivered. Each of the one or two daily meals provides one third of the recommended dietary allowance (RDA) of nutrients. The Title III-C program is commonly called the **Nutrition Program for the Elderly.** In some states, food stamps can be used to pay for food provided by the Nutrition Program for the Elderly.

PROJECT HEAD START

Head Start is aimed at children 3 to 5 years old whose parents' income is below the poverty line. The program combines nutrition, social services, parent involvement, and health services within an educational setting. Nutritious meals and snacks are provided. Family-style eating is promoted in that the classroom teachers eat the same foods as the children to serve as role models and promote a positive meal environment. Food is served family style in common dishes and passed around the table so children can take their own portions. This helps build social and fine-motor skills and gives children a feeling of control over food choices.

THE SCHOOL LUNCH AND BREAKFAST PROGRAM

The School Lunch and Breakfast Program provides nutritious foods at reduced cost for children whose families fall within 185% of the poverty line. It further provides free meals for those below the poverty line. Government guidelines for school lunch patterns are provided in Appendix 13 on the Evolve website.

SPECIAL SUPPLEMENTAL NUTRITION PROGRAM FOR WOMEN, INFANTS, AND CHILDREN

The WIC program began as a means to eradicate childhood anemia. It provides food vouchers for prescribed supplemental foods that contribute 100% of the daily needed vitamin C (via 3 to 9 oz of fruit juices, based on age), calcium, and vitamin D (via about 3 cups of milk daily) and at least 45% of iron needs (via 1 oz of iron-fortified cereal). The program also provides peanut butter or legumes, and eggs. For infants who are bottle-fed, formula is provided. The Institute of Medicine (IOM) has recently advised changes with decreased juice, addition of fruits and vegetables, and inclusion of whole-grain breads.

The program is aimed at promoting the growth of the young child (Figure 14-2), and nutrition education is provided. Because the program is a grant program rather than an entitlement program, Congress is not mandated to allocate funds to serve all eligible participants. As a result, waiting lists for enrollment in WIC often occur, at which time the highest-risk individuals are served in priority status.

Women who are pregnant or breastfeeding, infants, and children up to the age of 5 years are eligible if the family income is within 185% of the poverty line.

FIGURE 14-2 Monitoring growth of an infant in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC).

Nutritional risk criteria, such as low hematocrit, poor growth, frequent illness, and other qualifying medical conditions, are specified for eligibility for enrollment in the WIC program. To further promote child welfare, single fathers, foster parents, and other guardians of children can receive WIC benefits for their children.

Children in the Massachusetts WIC program who were breastfed for over 6 months were found to have the greatest improvement in hemoglobin levels (Altucher and colleagues, 2005). Infants who were eligible but did not receive WIC assistance because of accessibility issues were more likely to be underweight, of short stature, and perceived as having fair or poor health compared with infants receiving WIC benefits (Black and colleagues, 2004).

The Farmers' Market Nutrition Program augments the WIC program by providing coupons that can be used to purchase fresh fruits and vegetables from farmers' markets. One study found vegetable intake servings were greater with participation in the Farmers' Market Nutrition Program (Kropf and colleagues, 2007). WIC participants were found to value fresh fruits and vegetables, and adding them to the WIC food packages can result in increased fruit and vegetable consumption (Herman and colleagues, 2008).

WHAT IS THE IMPORTANCE OF FOOD POISONING AND HOW CAN IT BE PREVENTED?

Food sanitation, although it appears at times unimportant to the general population, can be a matter of life and death, especially for the debilitated or acutely ill patient or young child. Eating can be hazardous to health unless three general principles are followed: (1) conditions when preparing and consuming food should be clean; (2) when in doubt, throw it out; and (3) keep hot foods hot and cold foods cold (above 140° or below 40° F; Figure 14-3).

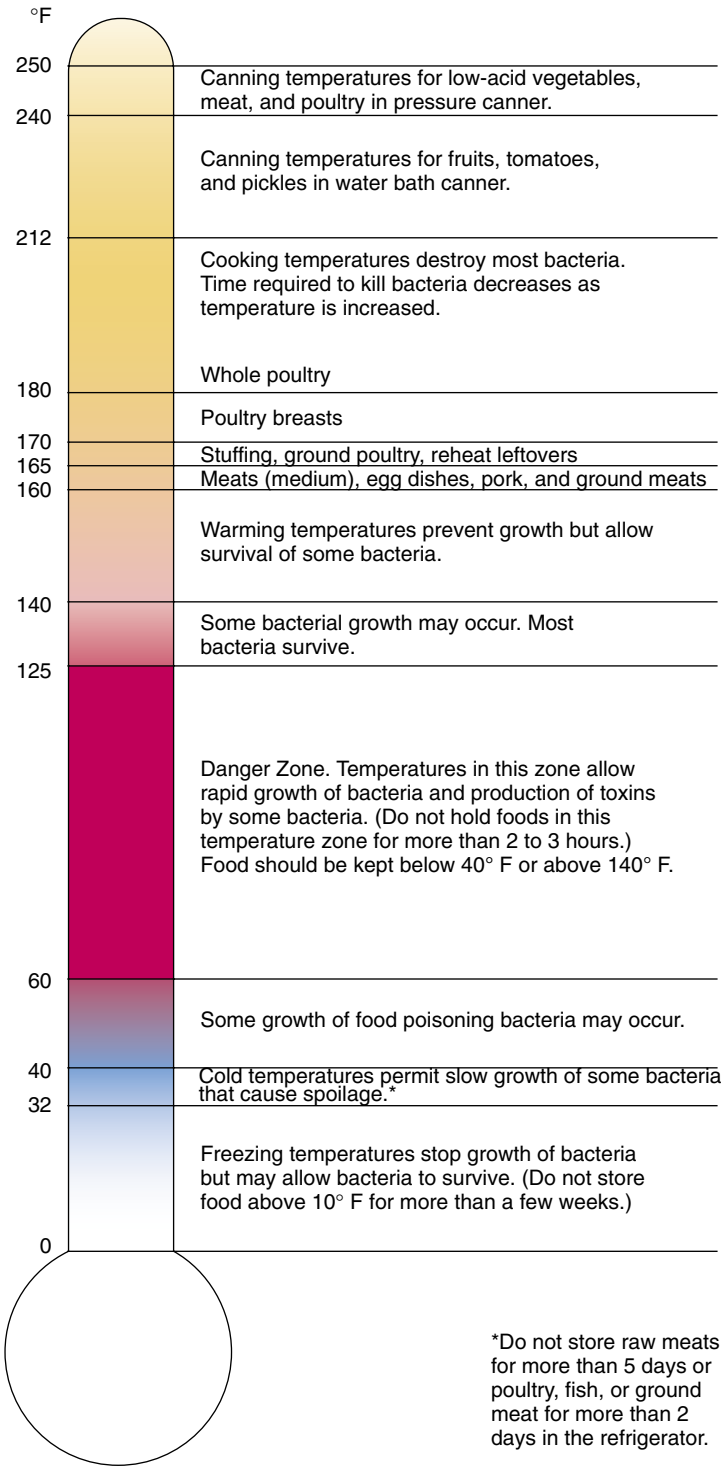


FIGURE 14-3 Temperature of food for control of bacteria.

The health of a community depends on safe food and water supplies. Many agencies promote good sanitation practices to prevent and control **communicable disease** (disease that can spread from person to person, often through water and food). These agencies are concerned with all aspects of food quality, including food preservation and food additives, prevention of both natural and bacterial food poisoning, waterborne diseases, and the dangerous effects of pesticides and other toxic chemicals, such as the heavy metals lead and mercury. The U.S. Public Health Service, which is the principal health agency of the federal government, concerns itself with all factors affecting public health, including nutrition. **Fight BAC!** is a national effort to educate the public on the importance of preventing foodborne illness and strategies to accomplish this (see www.fightbac.org).

Lack of sanitation, insufficient cooking, and improper storage (see Appendix 14 on the Evolve website for food storage guidelines) can allow bacteria in food to increase to dangerous levels. Most foodborne illness results from bacterial growth in food held at an improper temperature and poor personal hygiene of food handlers. Some bacteria produce poisonous substances called *toxins* that cause illness when contaminated food is eaten. The following are some guidelines to preventing food poisoning:

- Serve food soon after cooking or refrigerate promptly. Hot foods may be refrigerated if they do not raise the temperature of the refrigerator to greater than 45° F (7° C).
- Keep food in the refrigerator until served or reheated.
- Speed the cooling of leftovers by refrigerating them in shallow containers.
- Keep hot foods hot (at temperatures greater than 140° F or 60° C) and cold foods cold (less than 40° F or 4° C). Food may not be safe to eat if held more than 2 or 3 hours at temperatures between 60° F (15° C) and 125° F (52° C), the zone in which bacteria grow rapidly. Remember to count time spent in preparation, storage, and serving.
- Thoroughly clean all dishes, utensils, and work surfaces with soap and water after each use. It is especially important to thoroughly clean equipment and work surfaces that have been used for raw food before using them for cooked food. This prevents the cooked food from becoming contaminated with bacteria that may have been present in the raw food. Bacteria can be destroyed by rinsing utensils and work surfaces with chlorine laundry bleach in the proportion recommended on the package. Cutting boards, meat grinders, blenders, and can openers particularly need this protection.
- Always wipe up spills with paper towels or other disposable material.
- Thoroughly cook meat to avoid *E. coli* contamination.
- If the odor or color of any food is poor or questionable, do not taste it. Throw it out. The food may be dangerous. However, remember that there is not always an indication of food spoilage. When in doubt, throw it out.

PERSONAL HYGIENE AND FOOD SAFETY

Infection of food with bacteria can begin in the farm fields by workers who have not engaged in good personal hygiene picking vegetables and fruits. For this reason,

along with the potential for diseases carried by insects or larvae left behind from contact with produce, raw fruits and vegetables need to be washed before consumption. Once food is in the house, it can be cross-contaminated from other foods, such as raw meat. Hand washing is crucial in preventing cross-contamination. It is recommended that hands be washed frequently, using an anti-bacterial soap on areas that have been in contact with raw meat, poultry, seafood, eggs, vegetables, or other foods that may have been contaminated with an infectious agent.

Anyone who has an infectious disease should not handle, prepare, or serve food. The bacteria in infected cuts or other skin infections may be the source of foodborne illness. Food handlers must always work with clean hands, hair, fingernails, and clothing. Hands must be washed after using the toilet or assisting anyone with using the toilet; after cigarette smoking; after blowing the nose or touching the face or hair; after touching raw meat, poultry, or eggs; and before working with other food. Food should be mixed using clean utensils rather than by hand; however, plastic gloves may be worn if it is easier to use the hands. Hands should be kept away from the mouth, nose, and hair. It is important to cover coughs and sneezes with disposable tissues and to wash hands afterward. The same spoon should not be used more than once for tasting food while preparing, cooking, or serving, unless the two-spoon method is used (see Teaching Pearl).

Home food preparation also may lead to food poisoning. As shown in a study of consumer volunteers who were videotaped in their homes while preparing a meal, there was low adherence to Fight BAC! recommendations. There was inadequate hand washing length, lower than the 20-second recommendation, and the majority did not use soap. Food surfaces were not cleaned adequately by most persons before or during food preparation, with the majority cross-contaminating surfaces with raw meat, poultry, seafood, eggs, and/or unwashed vegetables with ready-to-eat foods. Undercooked meat and poultry entrees and lack of use of a food thermometer were observed (Anderson and colleagues, 2004).

Teaching Pearl

The two-spoon method should be promoted for repeated tasting of food while cooking. One spoon is used to obtain a sample for tasting of the food item. This spoon is then used to transfer the portion for tasting onto the second spoon without having the spoons touch. This way there is no likelihood of personal contamination of food to be served to others. This method will also prolong the safety of remaining leftovers by preventing bacteria in saliva from growing and multiplying in them. ■

FOOD-SAFETY ISSUES FOR OLDER ADULTS

Food preparation, shopping, and storage can be very demanding jobs for many elderly persons living alone. The elderly are highly susceptible to food poisoning because of their declining immune systems. Tight budgets and ingrained

feelings about waste cause many elderly people to store food longer than is safe. With declining vision and sense of taste and smell, food spoilage may go undetected. Food preparation leads to safety concerns. For instance, an older adult may forget that the stove is turned on. Microwave ovens can be helpful in this regard. Advice includes having an older person write dates on food containers as a reminder to discard these items that are past times of safe eating. Home-delivered meals need to have dates and time included on delivered foods with a notice not to consume past times of safe eating. The nurse and other health professionals must be alert in identifying problems in household management.

WHAT ARE SOME TYPES OF FOOD POISONING?

To understand the importance of food-poisoning prevention, the various types of foodborne illnesses must be recognized. Specific information on the causes, symptoms, and prevention of these bacterial foodborne illnesses is found in Table 14-3. The more common of these are caused by the following bacteria:

- ***Salmonella*** (a common bacteria linked to the gastrointestinal tract)
- ***Staphylococcus aureus*** (causes staph poisoning)
- ***Clostridium botulinum*** (causes botulism)
- ***Clostridium perfringens***
- ***E. coli***
- ***Listeria***—a relatively newly recognized pathogen that causes fever and possible death and is carried by raw and unprocessed foods such as soft cheeses, deli meats, and some vegetable products.

Salmonella, in its various forms, is among the most common bacterial causes of foodborne gastroenteritis in the United States, associated with over one million human illnesses annually. The Foodborne Diseases Active Surveillance Network in Tennessee has noted there are over 35 cases of *Salmonella* infection for each reported case (Jones, Scallan, and Angulo, 2007).

Undercooked or raw eggs can cause salmonella infection. The risk has lessened from the initial epidemic in the 1980s as a result of improved safety guidelines at the point of production. However, the potential still exists for *Salmonella* poisoning due to undercooked or raw eggs. Restaurant food-handling practices can contribute to risk of salmonella infection. Because of time constraints, shelled eggs may be prepared in advance of need. One study found over half of restaurants hold these shelled eggs for 4 to 6 hours before service and utensils used to prepare eggs were sanitized only once every 4 hours in nearly half (Lee and colleagues, 2004). A salmonella infection outbreak occurred from intake of coconut meringue pie at a cafeteria. Public health professionals found the meringue was made with raw shelled eggs and was baked to an internal temperature of 83° F rather than the required 155° F. Use of pasteurized egg products can help reduce foodborne illness (Mazurek and colleagues, 2005). Eggs that are cooked for immediate consumption are required to be heated to at least 145° F for 15 seconds in long-term care settings per surveyor standards.

Table 14-3 Bacterial Foodborne Illness: Causes, Symptoms, and Prevention

FOODS INVOLVED	SYMPTOMS	CHARACTERISTICS OF ILLNESS	PREVENTIVE MEASURES
Salmonellosis: *Salmonella*			
Bacteria widespread in nature that live and grow in intestinal tracts of human beings and animals	Severe headache, followed by vomiting, diarrhea, abdominal cramps, and fever; infants, the elderly, and persons with lower resistance are most susceptible; severe infections cause high fever and may even cause death	Transmitted by eating contaminated food or by contact with infected persons or carriers of the infection; also transmitted by insects, rodents, and pets	Salmonellae are destroyed by heating the food to 140° F and holding for 10 minutes, or to higher temperature for less time (e.g., 155° F for a few seconds; individual eggs for consumption: 145° for 15 seconds)
Foods involved: Poultry Red meats Eggs Dried foods Dairy products		*Onset:* Usually within 12-36 hours *Duration:* 2-7 days	Refrigeration at 40° F inhibits the ultiplication of salmonellae, but they remain alive in foods in the refrigerator or freezer and even in dried food
Perfringens Poisoning: *Clostridium Perfringens*			
Spore-forming bacteria that grow in the absence of oxygen; temperatures reached in thorough cooking of most foods are sufficient to destroy vegetative cells, but heat-resistant spores can survive	Nausea without vomiting, diarrhea, acute inflammation of stomach and intestines	Transmitted by eating food contaminated with abnormally large numbers of bacteria	To prevent growth of surviving bacteria in cooked meats, gravies, and meat casseroles that are to be eaten later, cool foods rapidly and refrigerate promptly at 40° F or below, or hold them above 140° F
Foods involved: Stews, soups, or gravies made from poultry or red meat		*Onset:* Usually within 8-20 hours *Duration:* May persist for 24 hours	
Staphylococcal Poisoning: *Staphylococcus aureus*			
Bacteria fairly resistant to heat; growing in food, they produce a toxin that is extremely resistant to heat	Vomiting, diarrhea, prostration, abdominal cramps; generally mild and often attributed to other causes	Transmitted by food handlers who carry the bacteria and by eating food containing the toxin	Growth of bacteria that produce toxin is inhibited by keeping hot foods above 140° F and cold foods at or below 40° F
Foods involved: Custards Egg salad Potato salad Chicken salad Macaroni salad Ham salad Salami Cheese		*Onset:* Usually within 3-8 hours *Duration:* 1-2 days	Toxin is destroyed by boiling for several hours or heating the food in a pressure cooker at 240° F for 30 minutes

Table 14-3 Bacterial Foodborne Illness: Causes, Symptoms, and Prevention—cont'd

FOODS INVOLVED	SYMPTOMS	CHARACTERISTICS OF ILLNESS	PREVENTIVE MEASURES
Botulism: *Clostridium botulinum*			
Spore-forming organisms that grow and produce toxin in the absence of oxygen, such as in a sealed container Foods involved: Canned low-acid foods Smoked fish	Double vision, inability to swallow, speech difficulty, progressive respiratory paralysis Fatality rate is high, in the United States about 65%	Transmitted by eating food containing the toxin *Onset:* Usually within 12-36 hours or longer *Duration:* 3-6 days	Bacterial spores in food are destroyed by high temperatures obtained only in the pressure canner*; more than 6 hours is needed to kill the spores at boiling temperature (212° F); toxin is destroyed by boiling for 10 to 20 minutes; time required depends on type of food
Infection With *Escherichia coli* (*E. coli* 0157:H7)			
Organism that lives in the intestinal tract Foods involved: Beef Raw milk Lettuce Alfalfa sprouts Salami	Abdominal cramping Bloody diarrhea†	73,000 cases of infection and 61 deaths annually per CDC Kidney failure occurs in 2%-7% of cases; illness usually resolves in 5-10 days	Thoroughly cook meat; do not eat burgers that are pink in the middle; handle food safely; wash vegetables and fruits, especially if they will be served raw
Infection With *Listeria*			
Bacteria found in soil, plants, and animals Foods involved: Soft and unpasteurized cheese Raw meat and poultry Raw and smoked seafood Raw milk	Fever Headache Nausea Vomiting Pregnant women can get flulike symptoms of chills and fever, altered mental status, headache, and seizures with a form of meningitis	Symptoms occur from 2 days to 6 weeks Dangerous to unborn babies and persons with compromised immune systems Infections treated with antibiotics	Use pasteurized milk and milk products; use cottage cheese and and cheese aged >60 days; pregnant women should reheat cold cuts Wash fruits and vegetables; thoroughly cook meat; follow good food-safety precautions; do not use bulging canned goods

From U.S. Department of Agriculture: *Keeping food safe to eat—a guide for homemakers*, Home and Garden Bulletin no. 162. Washington, DC, U.S. Department of Agriculture; and CDC National Center for Infectious Diseases/Division of Bacterial and Mycotic Diseases website for *Listeria:* http://www.cdc.gov/ncidod/dbmd/diseaseinfo/default.htm#L, 2006.
CDC, Centers for Disease Control and Prevention.
*For processing times in home canning, see Home and Garden Bulletins no. 8, *Home canning of fruits and vegetables,* and no. 106, *Home canning of meat and poultry,* Washington, DC, U.S. Department of Agriculture.
†All persons with bloody diarrhea should have their stools tested for *E. coli* 0157:H7.

Fact & Fallacy

FALLACY Adding an egg to a milkshake or making eggnog is a good idea for someone who is too ill to eat.

FACT Raw eggs can contain *Salmonella* (especially when the shell is cracked or soiled) for a person with an already weakened immune system. Eggs are safest when used in foods that are to be thoroughly cooked, such as baked goods or casseroles. Single eggs for consumption need to be cooked to at least 145° F for at least 15 seconds to avoid risk of Salmonella infection. Proper handling of foods containing cooked eggs is also important. Set custards and puddings in ice water to cool quickly after their preparation; then refrigerate promptly until serving. Pasteurized egg products are generally safe. ■

WHAT ARE SOME INTERNATIONAL NUTRITION PROBLEMS AND THE INTERESTED AGENCIES?

MALNUTRITION

According to current World Health Organization estimates, more than 3 billion people worldwide, primarily in developing countries, are malnourished in essential nutrients. Malnutrition, including protein-energy malnutrition and micronutrient deficiencies, continues to be the most important risk factor for illness and death. Aside from kwashiorkor and marasmus, deficiencies in iron, iodine, vitamin A, and zinc remain in developing countries (Muller and Krawinkel, 2005). A new risk to world hunger is the shift to biofuels. The rapid increase in the production of ethanol in the United States is impacting food costs here and abroad. Those who suffer most are the already high-risk persons living in urban areas of developing countries. The effect of this change and strategies to contend with the expected increased rates of malnutrition are not yet fully appreciated.

Historically, efforts to lower world hunger have been aimed at the provision of food aid, targeted supplements, and education on local food growth for its sustainability. The prevention of blindness from severe vitamin A deficiency in children is a priority within the VISION 2020 program of WHO. This is due to vitamin A deficiency being a preventable cause of blindness and severe visual impairment due to cataract and corneal disorders. In Indonesia a decrease in incidence of childhood corneal disorders has occurred over the past 10 to 20 years, which is believed to be due to vitamin A supplementation (Sitorus, Abidin, and Prahartono, 2007). Vitamin A capsules have been given to children under 5 years of age since the early 1970s in an attempt to control the millions of children who suffer from vitamin A deficiency. Annually, 500 million vitamin A capsules are distributed at an estimated cost currently of around U.S. $1 per capsule (Neidecker-Gonzales, Nestel, and Bouis, 2007).

In India a significant decline in vitamin A deficiency as evidenced with no cases of Bitot's spot (see Figure 14-4) was found in intervention children compared with control children, in whom the prevalence of Bitot's spot was about 5%. The mortality rate was found to be higher in control children, with a death rate of 8 per 1000 children during the study period compared with intervention children, in whom no deaths were recorded (Swami, Thakur, and Batia, 2007).

Vitamin A deficiency is a public health problem in Sri Lanka, disproportionately affecting preschool children. The inclusion of high–carotene-content vegetables,

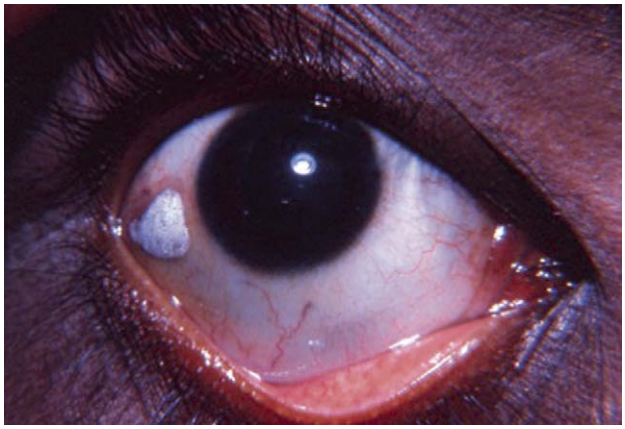


FIGURE 14-4 Classic Bitot's spot of avitaminosis-A in an adult in rural India. (Courtesy William Charles Caccamise Sr, MD)

prepared as a curry with coconut milk, enhances uptake of carotene. Carrots, pumpkins, squashes, and sweet potatoes are common vegetables that are cooked with coconut milk and provide significant amounts of vitamin A (Priyadarshani and Chandrika, 2007).

Vitamin A deficiency is a public health problem in Cameroon on the west coast of Africa. Papaya and mangoes available in this region, when consumed as juice or fresh fruit versus dried, are the best forms because they have higher bioavailability values of lutein and beta-carotene (Gouado and colleagues, 2007). Mango and papaya also are widely consumed in India. The beta-carotene content was found to be the highest in the Mallika variety followed by Badami variety of mangoes. Mango and papaya are consumed as a blend with milk that significantly increases the bioaccessibility of beta-carotene from mango up to about 50%, with similar effects when papaya was cooked with milk. Considering the beta-carotene content of mango and papaya, the latter has to be consumed in amounts roughly three times that of mango to derive the same amount of beta-carotene (Veda, Platel, and Srinivasan, 2007).

A homestead gardening program designed to control vitamin A deficiency in Bangladesh doubled the intake of vegetables. Income from selling additional produce also contributed to household purchases of other foods (Bushamuka and colleagues, 2005).

It is most appropriate to promote intake of local produce high in beta-carotene rather than providing vitamin A supplements. It is both potentially more sustainable and has reduced risk of toxic intake of vitamin A. To control vitamin A deficiency, large therapeutic doses are administered in developing countries to women and children, who often are undernourished. Appropriate dosing regimens have not been systematically evaluated (Penniston and Tanumihardjo, 2006).

Iodine supplementation is another example where appropriate amounts are beneficial, but where excess intake has been documented. In Eastern Sudan the primary sources of iodine for the children are mainly iodized salt and rations supplied by local donors and various aid agencies operating in the Sudan. All the salt

samples collected from the local schools had more than 150 mg potassium iodate per kilogram of salt, providing excessive intake of iodine. This was due to inappropriate and unregulated local fortification of salt and lack of monitoring of the imported and donated salt (Izzeldin, Crawford, and Jooste, 2007).

In Kenya micronutrient deficiency is a major problem because of overcooking vegetables, use of processed grains, and poor intake of fruits. Because vitamin supplements are extremely expensive relative to income in this country, approaches have been aimed at increasing intake of foods rich in a variety of vitamins and minerals (Wanja, 2004).

Zinc deficiency in Africa, Asia, and Latin America accounted for about one in six deaths from diarrhea and also was related to death from malaria and pneumonia deaths among young children. Zinc supplementation provided as an adjunct treatment for diarrhea may be the best way to target children most at risk of deficiency (Fischer and colleagues, 2008).

Vitamin C deficiency (scurvy) seldom occurs nowadays and may be misdiagnosed as a consequence. Health delegates of the International Committee of the Red Cross encountered prisoners in East Africa suffering from an undiagnosed illness, consisting mainly of swollen and hard legs described as "wooden leg" syndrome. Ultimately a diagnosis of scurvy was confirmed, and treatment with vitamin C was successful. Historic records describe this unusual clinical presentation of scurvy (Bennett and Coninx, 2005).

Outbreaks of pellagra were documented during the civil war in Angola. The incidence of clinical pellagra has not decreased since the end of the civil war in 2002. The identification of niacin deficiency as a public health problem should refocus attention on this nutritional deficiency in Angola and other areas of Africa where maize is the staple. In children, good niacin status was positively correlated with the household consumption of peanuts and eggs (Seal and colleagues, 2007).

Developing countries also are experiencing trends toward chronic, noncommunicable, lifestyle-related diseases. Countries in transition to Westernized lifestyles and foods may be at increased risk for inadequate micronutrient intake and for excess caloric intake from fats and sugars, which leads to obesity. Food systems of Canadian Arctic indigenous peoples contain many species of traditional animal and plant food, but the extent of use today is limited because purchased food displaces much of the traditional species from the diet. The most frequently consumed Arctic foods were derived from animals and fish. In adults these foods contributed 6% to 40% of daily energy of adults. Children consumed much less, up to 15% of energy, and over 40% of their total energy was contributed by "sweet" and "fat" food sources. Children did not meet their needs for vitamin D or manganese (Kuhnlein and Receveur, 2007).

The coexistence of child malnutrition and maternal overweight in the same households typifies rapid nutrition transition in developing countries. It is more common in Latin America and Asia. In Africa, households with overweight mothers were generally found to have better socioeconomic conditions, higher maternal education, less food insecurity, better household sanitation, and a more diversified diet. Households with both overweight mothers and underweight children were found to have the lowest food variety, and poor household sanitation increased the odds of protein-energy malnutrition of the children (Deleuze Ntandou Bouzitou, Fayomi, and Delisle, 2005).

Breastfeeding is beneficial to all infants, especially those who live in areas with unsafe water supplies. Although Switzerland has a clean water supply, lessons learned from their attempts to follow United Nations Children's Fund (UNICEF) guidelines for increased successful breastfeeding can be applied elsewhere. The Baby-Friendly Hospital Initiative (BFHI) proposed by UNICEF was introduced in 1993 to promote breastfeeding nationwide. In a little under 10 years the duration of breastfeeding in Switzerland went from 22 weeks to 31 weeks using the BFHI approach. The proportion of exclusively breastfed infants up to 5 months of age was 42% for infants born in baby-friendly hospitals. If a child had been exclusively breastfed in the hospital, the median duration of breastfeeding was considerably longer than for those who had received water-based liquids or supplements in the hospital. A positive effect on breastfeeding duration could be shown for full rooming in, first suckling within 1 hour, and breastfeeding on demand (Merten, Dratva, and Ackermann-Liebrich, 2005).

In a study in Iran, growth of breastfed infants was greater in the long run, with these infants being significantly heavier and taller than those who were bottle-fed. This was positive because the mean heights and weights of breastfed infants were still on the lower end of the National Center for Health Statistics (NCHS) growth charts—see Appendix 12 on the Evolve website (Emamghorashi and Heydari, 2007).

The United States has developed various programs and campaigns that assist developing countries in combating undernutrition. The U.S. Foreign Aid and Food for Peace programs and the activities of the Agency for International Development are coordinated with United Nations agencies. The governments of many nations contribute to the organizations that distribute food or money for the purpose of improving nutritional standards. Some of these agencies are listed in Table 14-4.

Food donations must reflect the health needs of the population. Lactose intolerance is commonly found worldwide; therefore simply providing milk or milk powder may actually induce diarrhea and further impair nutritional status.

Table 14-4 World Organizations for Better Nutrition

ORGANIZATION	PURPOSES
United Nations Food and Agriculture Organization (FAO)	Studying aspects of world food problems Raising nutrition standards by improving growth, distribution, and storage of food
World Health Organization (WHO)	Focusing on worldwide health problems, including nutrition
United Nations Education, Scientific and Cultural Organization (UNESCO)	Improving the standard of living through science education and elimination of illiteracy
United Nations International Children's Emergency Fund (UNICEF)	Directing the distribution of milk to children worldwide through emergency relief, school feeding, and maternal-child health care centers
Oxford Famine Society (OXFAM-UK)	Donating money and services for agricultural development
CARE	Receiving food from the Food for Peace Program for relief activities
World Bank	Sponsoring international projects through its agricultural and nutritional divisions

UNSAFE WATER

Millions of deaths annually are attributable to unsafe water supplies. Education can help. Boiling of water is critical when its sanitation cannot be confirmed. Distribution of chlorine tablets is another option. Contamination issues with heavy metals needs to be addressed by other avenues.

People living in almost 50% of the districts in West Bengal, India, are exposed to arsenic-contaminated water. Attempts to remove arsenic from groundwater are economically beneficial, aside from the positive health implications (Roy, 2008). Groundwater is the primary source of drinking water for more than 95% of the population in Punjab, in northwest India. WHO and the U.S. EPA recently established a new maximum contaminant level of 10 ppb for arsenic in drinking water. The arsenic concentration of deep water tube wells and in hand pump water ranges from safe to unsafe levels. Arsenic content in canal water was within safe levels (Hundal, Singh, and Singh, 2008). Millions in South Asia are exposed to naturally occurring arsenic and manganese through household wells. Stunting affects more than 25% of young children in developing countries. The combined neurocognitive loss from both risks, although rarely jointly studied, represents a substantial loss of global potential (Wasserman and colleagues, 2008).

Arsenic is found throughout the world. In Germany, over a thousand years of mining and metallurgic engineering in the Harz Mountains caused heavy metal contamination in soil and air by arsenic as well as cadmium and lead (Hennighausen, 2004). Public health education programs focused on residential hygiene are appropriate in high-risk areas of arsenic contamination. Children playing in soil with hand-to-mouth contact are the highest-risk group for both arsenic and lead toxicity.

Drinking tea has been shown to significantly counteract the adverse effects of arsenic. Black tea and green tea were both found to be effective (Sinha and colleagues, 2003). The positive effect of tea was noted to significantly decrease chromosome damage induced by arsenic (Poddar, 2004).

HIV and AIDS

Africa is being devastated by human immunodeficiency virus (HIV) and acquired immunodeficiency syndrome (AIDS). Alternatives to breast milk for HIV-infected mothers include commercial formulas and UNICEF vitamin and mineral supplement packets, which can be added to fresh or powdered whole milk. This protocol was developed by WHO, the Joint United Nations Programme on HIV/AIDS (UNAIDS), and UNICEF. It was found, however, that UNICEF packets with the whole milk contain at least 40% less of a variety of vitamins and minerals than commercial formulas. It is advised that the protocol be revised to include vegetable oils, such as soybean oil, as a source of linoleic and alpha-linolenic acids, with additional vitamins and minerals (Papathakis and Rollins, 2004). Maintaining adequate selenium status in the infant born to an HIV-infected woman appears to help prevent child mortality (Kupka and colleagues, 2005). Chapter 15 reviews medical nutrition therapy for HIV and AIDS.

WHAT IS THE ROLE OF THE NURSE AND OTHER HEALTH CARE PROFESSIONALS IN NATIONAL AND INTERNATIONAL NUTRITION PROGRAMS?

NATIONAL NUTRITION

Nurses and other health care professionals can provide information related to the MyPyramid such as portion sizes and label reading related to high-fiber, low–saturated-fat, or low-sugar alternatives. It was found that individuals who have knowledge about choosing a low-fat restaurant meal or using food labels were found later to avoid high-fat foods and increase fiber intake (Krummel and colleagues, 2004). Health professionals can play a positive role in promoting health in the community. Describing the rationale for making dietary changes in line with physiologic needs particularly suits the nurse's role in education. Providing advice on low-cost food shopping is also appropriate (Box 14-1).

The nurse's skill level is of particular importance in providing guidelines for emergency preparedness and survival with prevention of illness during times of crisis. This is especially true during times of environmental catastrophes such as the aftermath of Hurricane Katrina.

A health care team approach can help promote good nutritional status. The nurse or other health professional can help combat potentially dangerous nutrition myths and fads by providing correct information and assisting the public in recognizing false nutritional health claims. On a larger scale, the health care professional can help raise societal health consciousness by documenting the health needs of those who have a low income or are homeless. This documentation is necessary to justify equitable allocation of resources by legislators and other policy makers.

It is important for the nurse and other health care professionals to be aware of programs for referral purposes and direct care. Ambulatory care in particular is a growing type of health care, where the nurse is often called on to help patients cope with therapeutic diets and to help prevent the effects of poor food sanitation on the debilitated patient.

Box 14-1 Money-Saving Food-Shopping Skills

- Use less-tender cuts of meat, which are less expensive. To tenderize, cook slowly with moisture (such as in stews) or grind, cube, or pound the meat. Marinating in an acid such as lemon or tomato juice also helps to tenderize meat.
- Extend meat, poultry, and fish by making casseroles using legumes (dried beans), pasta, rice, or potatoes.
- Include meatless meals once or twice a week using legumes, eggs, cheese, or peanut butter in the place of meat for protein.
- Buy in bulk whenever possible and freeze as needed.
- Study unit pricing to determine the best buy per pound or ounce.
- Take advantage of specials and use coupons.
- Try lower-priced generic store brands, which are often similar in quality to more expensive brands.
- Plan meals to include leftovers.
- Shop for low-cost foods within each food group.
- Use food labels to compare nutritional value for cost to get your money's worth.

Promoting good hygiene such as washing hands before eating is important. Although the wearing of gloves by workers in restaurant settings has become routine, continued education by nurses or other health care professionals is warranted. A person wearing gloves may not realize that once money is handled or a contaminated surface is touched, a change to a new pair of gloves is required. Use of food-safety measures in the home is often a neglected area that makes food poisoning an issue, particularly for the vulnerable population of the young, old, and those with chronic health issues.

INTERNATIONAL NUTRITION

For international concerns, the nurse or other health care professional should be aware of programs that can be effectively promoted, such as recommending vitamin A tablets or foods to prevent blindness. Food programs meant to help should be closely examined. Attempts to end world hunger must be undertaken in a way that encourages independence. Efforts by credible international agencies, such as the Agency for International Development and the United Nations (see Table 14-4), can be supported. For Americans, eating less meat contributes, if only in a small way: it takes about 4 lb of grain to produce 1 lb of meat. Grain grown to feed cattle could be redirected to feed the world's hungry population.

Chapter Challenge Questions & Classroom Activities

1. What community programs might help a lower-income family?
2. How has legislation affected public health in relation to food and nutrition issues?
3. What are some food-safety guidelines?
4. What are the signs of a food faddist?
5. Arrange to have students observe health inspectors in restaurants.
6. Identify other organizations in your area that focus on the promotion of nutrition. Describe who they are and what their programs cover.
7. Contact a federal or state legislator through a letter or a phone call to express your support for legislation on a particular public health issue.
8. Assign a student volunteer to swab the inside of a home refrigerator using a cotton-tipped swab. Students in the class can then rub the swab on a Petri dish and observe bacterial growth.
9. How might you assist a low-income individual who has hypertension and needs to rely on donated canned foods?

Case Study

The woman was standing in line at the food pantry. She was so hungry. It was the end of the month, and her food stamps had run out. The EFNEP aides had given her some advice on how to stretch her food dollars, but with her growing children she always fed them first. It just didn't last. Her freezer was broken, and she couldn't keep foods very long without their spoiling. She saw the day-old donuts on the table that were donated from the local grocery store. She'd wait to eat them until she got outside. She knew if she ate them now someone would look at her like she was a glutton. And she didn't like that. She also didn't like the fact she was so overweight.

Things weren't like that when her husband was working. But because his job with General Motors had ended and their house was foreclosed, they had to live with different family members and her eating habits had changed so drastically. She could no longer afford going to the gym, she hadn't bought new clothes in years, and she was down to just a few outfits that she could still fit into. Fortunately, she had become a lifetime member of Weight Watchers, but the goal of determining points on the foods at the pantry didn't seem worthwhile. She just wanted to make the hunger pains go away.

Critical Thinking Applications

1. What foods at a food pantry might have a low number of "points" (low in fat and high in fiber)?
2. What high-fiber foods could be prepared that do not require a working oven or need to be stored in the freezer?
3. List some other food programs that may be of help to this woman to help her children to eat better and stretch the family food dollars.

REFERENCES

Altucher K, Rasmussen KM, Barden EM, Habicht JP: Predictors of improvement in hemoglobin concentration among toddlers enrolled in the Massachusetts WIC Program, *J Am Diet Assoc* 105(5):709-715, 2005.

American Dietetic Association: Position of the American Dietetic Association: individual-, family-, school-, and community-based interventions for pediatric overweight, *J Am Diet Assoc* 106(6):925-945, 2006.

Anderson JB, Shuster TA, Hansen KE, Levy AS, Volk A: A camera's view of consumer food-handling behaviors, *J Am Diet Assoc* 104(2):186-191, 2004.

Andrew AS, Burgess JL, Meza MM, Demidenko E, Waugh MG, Hamilton JW, Karagas MR: Arsenic exposure is associated with decreased DNA repair in vitro and in individuals exposed to drinking water arsenic, *Environ Health Perspect* 114(8):1193-1198, 2006.

Ashley BC, Birchfield PT, Chamberlain BV, Kotwal RS, McClellan SF, Moynihan S, Patni SB, Salmon SA, Au WW: Health concerns regarding consumption of irradiated food, *Int J Hyg Environ Health* 207(6):493-504, 2004.

Ayotte JD, Montgomery DL, Flanagan SM, Robinson KW: Arsenic in groundwater in eastern New England: occurrence, controls, and human health implications, *Environ Sci Technol* 37(10):2075-2083, 2003.

Bakshi A: Potential adverse health effects of genetically modified crops, *J Toxicol Environ Health B Crit Rev* 6(3):211-225, 2003.

Barringer JL, Bonin JL, Deluca MJ, Romagna T, Cenno K, Alebus M, Kratzer T, Hirst B: Sources and temporal dynamics of arsenic in a New Jersey watershed, USA, *Sci Total Environ* 379(1):56-74, 2007.

Bennett M, Coninx R: The mystery of the wooden leg: vitamin C deficiency in East African prisons, *Trop Doct* 35(2):81-84, 2005.

Black MM, Cutts DB, Frank DA, Geppert J, Skalicky A, Levenson S, Casey PH, Berkowitz C, Zaldivar N, Cook JT, Meyers AF, Herren T; Children's Sentinel Nutritional Assessment Program Study Group: Special Supplemental Nutrition Program for Women, Infants, and Children participation and infants' growth and health: a multisite surveillance study, *Pediatrics* 114(1):169-176, 2004.

Bushamuka VN, de Pee S, Talukder A, Kiess L, Panagides D, Taher A, Bloem M: Impact of a homestead gardening program on household food security and empowerment of women in Bangladesh, *Food Nutr Bull* 26(1):17-25, 2005.

Casey PH, Simpson PM, Gossett JM, Bogle ML, Champagne CM, Connell C, Harsha D, McCabe-Sellers B, Robbins JM, Stuff JE, Weber J: The association of child and household food insecurity with childhood overweight status, *Pediatrics* 118(5):e1406-e1413, 2006.

Casey PH, Szeto KL, Robbins JM, Stuff JE, Connell C, Gossett JM, Simpson PM: Child health–related quality of life and household food security, *Arch Pediatr Adolesc Med* 159(1): 51-56, 2005.

Celis C, Scurrah M, Cowgill S, Chumbiauca S, Green J, Franco J, Main G, Kiezebrink D, Visser RG, Atkinson HJ: Environmental biosafety and transgenic potato in a centre of diversity for this crop, *Nature* 432(7014):222-225, 2004.

Champagne CM, Casey PH, Connell CL, Stuff JE, Gossett JM, Harsha DW, McCabe-Sellers B, Robbins JM, Simpson PM, Weber JL, Bogle ML; Lower Mississippi Delta Nutrition Intervention Research Initiative: Poverty and food intake in rural America: diet quality is lower in food insecure adults in the Mississippi Delta, *J Am Diet Assoc* 107(11):1886-1894, 2007.

Chen Y, Santella RM, Kibriya MG, Wang Q, Kappil M, Verret WJ, Graziano JH, Ahsan H: Association between arsenic exposure from drinking water and plasma levels of

soluble cell adhesion molecules, *Environ Health Perspect* 115(10):1415-1420, 2007.
Davis DR, Epp MD, Riordan HD: Changes in USDA food composition data for 43 garden crops, 1950 to 1999, *J Am Coll Nutr* 23(6):669-682, 2004.
Deleuze Ntandou Bouzitou G, Fayomi B, Delisle H: [Child malnutrition and maternal overweight in same households in poor urban areas of Benin], *Sante* 15(4):263-270, 2005.
Denny J, Bhat M, Eckmann K: Outbreak of *Escherichia coli* O157:H7 associated with raw milk consumption in the Pacific Northwest, *Foodborne Pathog Dis* 5(3):321-328, 2008.
Dollahite J, Kenkel D, Thompson CS: An economic evaluation of the Expanded Food and Nutrition Education Program, *J Nutr Educ Behav* 40(3):134-143, 2008.
Drewnowski A, Darmon N: The economics of obesity: dietary energy density and energy cost, *Am J Clin Nutr* 82(1 Suppl):265S-273S, 2005.
Drug Enforcement Administration; Justice: Preventing the accumulation of surplus controlled substances at long term care facilities: final rule, *Fed Regist* 70(92):25462-25466, 2005.
Ellis KA, Innocent G, Grove-White D, Cripps P, McLean WG, Howard CV, Mihm M: Comparing the fatty acid composition of organic and conventional milk, *J Dairy Sci* 89(6): 1938-19350, 2006.
Emamghorashi F, Heydari ST: Growth of infants in relation to type of feeding in Jahrom, Islamic Republic of Iran, *East Mediterr Health J* 13(4):846-854, 2007.
Fan X, Sokorai KJ: Effects of ionizing radiation on sensorial, chemical, and microbiological quality of frozen corn and peas, *J Food Prot* 70(8):1901-1908, 2007.
Fischer Walker CL, Ezzati M, Black RE: Global and regional child mortality and burden of disease attributable to zinc deficiency, *Eur J Clin Nutr* Feb 13, 2008 (Epub in advance of print).
Food and Nutrition Service, USDA: Afterschool snacks in the Child and Adult Care Food Program: final rule, *Fed Regist* 72(146):41591-41611, 2007.
Fukushima S, Kidou M, Ihn H: Fixed food eruption caused by cashew nut, *Allergol Int* 57(3):285-287, 2008.
Goodman RE, Hefle SL, Taylor SL, van Ree R: Assessing genetically modified crops to minimize the risk of increased food allergy: a review, *Int Arch Allergy Immunol* 137(2):153-166, 2005.
Gouado I, Schweigert FJ, Ejoh RA, Tchouanguep MF, Camp JV: Systemic levels of carotenoids from mangoes and papaya consumed in three forms (juice, fresh and dry slice), *Eur J Clin Nutr* 61(10):1180-1188, 2007.
Granby K, Nielsen NJ, Hedegaard RV, Christensen T, Kann M, Skibsted LH: Acrylamide-asparagine relationship in baked/toasted wheat and rye breads, *Food Addit Contam* 25(8):921-929, 2008.
Györéné KG, Varga A, Lugasi A: [A comparison of chemical composition and nutritional value of organically and conventionally grown plant derived foods], *Orv Hetil* 147(43):2081-2090, 2006.
Hackie M, Bowles CL: Maternal perception of their overweight children, *Public Health Nurs* 24(6):538-546, 2007.
Hanjani NM, Fender AB, Mercurio MG: Chronic arsenicism from Chinese herbal medicine, *Cutis* 80(4):305-308, 2007.
Haque S, Ji J, Johannesson KH: Evaluating mobilization and transport of arsenic in sediments and groundwaters of Aquia aquifer, Maryland, USA, *J Contam Hydrol* 99(1-4): 68-84, 2008.
Hawkes C: Regulating and litigating in the public interest: regulating food marketing to young people worldwide: trends and policy drivers, *Am J Public Health* 97(11):1962-1973, 2007.
Hemond HF, Solo-Gabriele HM: Children's exposure to arsenic from CCA-treated wooden decks and playground structures, *Risk Anal* 24(1):51-64, 2004.
Hennighausen RH: Assessment of health-risk groups by the German public health service and realisation of preventive measures, *Gesundheitswesen* 66(12):821-826, 2004.
Herman DR, Harrison GG, Afifi AA, Jenks E: Effect of a targeted subsidy on intake of fruits and vegetables among low-income women in the Special Supplemental Nutrition Program for Women, Infants, and Children, *Am J Public Health* 98(1):98-105, 2008.
Heudorf U, Hartmann E, Angerer J: Acrylamide in children—exposure assessment via urinary acrylamide metabolites as biomarkers, *Int J Hyg Environ Health* 212(2):135-141, 2008.
Hinck JE, Blazer VS, Denslow ND, Echols KR, Gale RW, Wieser C, May TW, Ellersieck M, Coyle JJ, Tillitt DE: Chemical contaminants, health indicators, and reproductive biomarker responses in fish from rivers in the Southeastern United States, *Sci Total Environ* 390(2-3):538-557, 2008.
Hirayama K, Uetsuka K, Kuwabara Y, Tamura M, Itoh K: Vitamin K deficiency of germfree mice caused by feeding standard purified diet sterilized by gamma-irradiation, *Exp Anim* 56(4):273-278, 2007.
Homer C, Simpson LA: Childhood obesity: what's health care policy got to do with it? *Health Aff (Millwood)* 26(2):441-444, 2007.
Houston MC: The role of mercury and cadmium heavy metals in vascular disease, hypertension, coronary heart disease, and myocardial infarction, *Altern Ther Health Med* 13(2):S128-S133, 2007.
Hundal HS, Singh K, Singh D: Arsenic content in ground and canal waters of Punjab, North-West India, *Environ Monit Assess*, June 21, 2008 (Epub in advance of print).
Izzeldin HS, Crawford MA, Jooste PL: Population living in the Red Sea State of Sudan may need urgent intervention to correct the excess dietary iodine intake, *Nutr Health* 18(4):333-341, 2007.
Jackson LS, Al-Taher F: Effects of consumer food preparation on acrylamide formation, *Adv Exp Med Biol* 561:447-465, 2005.

Jewett SC, Duffy LK: Mercury in fishes of Alaska, with emphasis on subsistence species, *Sci Total Environ* 387(1-3):3-27, 2007.

Jones TF, Scallan E, Angulo FJ: FoodNet: overview of a decade of achievement, *Foodborne Pathog Dis* 4(1):60-66, 2007.

Kelly BC, Ikonomou MG, Higgs DA, Oakes J, Dubetz C: Mercury and other trace elements in farmed and wild salmon from British Columbia, Canada, *Environ Toxicol Chem* 27(6):1361-1370, 2008.

Kersey M, Geppert J, Cutts DB: Hunger in young children of Mexican immigrant families, *Public Health Nutr* 10(4):390-395, 2007.

Kirkpatrick SI, Tarasuk V: Food insecurity is associated with nutrient inadequacies among Canadian adults and adolescents, *J Nutr* 138(3):604-612, 2008.

Konings EJ, Ashby P, Hamlet CG, Thompson GA: Acrylamide in cereal and cereal products: a review on progress in level reduction, *Food Addit Contam* 24(Suppl 1):47-59, 2007.

Kropf ML, Holben DH, Holcomb JP Jr, Anderson H: Food security status and produce intake and behaviors of Special Supplemental Nutrition Program for Women, Infants, and Children and Farmers' Market Nutrition Program participants, *J Am Diet Assoc* 107(11):1903-1908, 2007.

Krummel DA, Semmens E, Boury J, Gordon PM, Larkin KT: Stages of change for weight management in postpartum women, *J Am Diet Assoc* 104(7):1102-1108, 2004.

Kuhnlein HV, Receveur O: Local cultural animal food contributes high levels of nutrients for Arctic Canadian indigenous adults and children, *J Nutr* 137(4):1110-1114, 2007.

Kupka R, Msamanga GI, Spiegelman D, Rifai N, Hunter DJ, Fawzi WW: Selenium levels in relation to morbidity and mortality among children born to HIV-infected mothers, *Eur J Clin Nutr* 59(11):1250-1258, 2005

Landrigan PJ, Trasande L, Thorpe LE, Gwynn C, Lioy PJ, D'Alton ME, Lipkind HS, Swanson J, Wadhwa PD, Clark EB, Rauh VA, Perera FP, Susser E: The National Children's Study: a 21-year prospective study of 100,000 American children, *Pediatrics* 118(5):2173-2186, 2006.

Lee MG, Chun OK, Song WO: Determinants of the blood lead level of U.S. women of reproductive age, *J Am Coll Nutr* 24(1):1-9, 2005.

Lee R, Beatty ME, Bogard AK, Esko MP, Angulo FJ, Selman C; EHS-NET Working Group: Prevalence of high-risk egg-preparation practices in restaurants that prepare breakfast egg entrées: an EHS-Net study, *J Food Prot* 67(7):1444-1450, 2004.

Leifert C, Ball K, Volakakis N, Cooper JM: Control of enteric pathogens in ready-to-eat vegetable crops in organic and "low input" production systems: a HACCP-based approach, *J Appl Microbiol* 105(4):931-950, 2008.

Lu C, Barr DB, Pearson MA, Waller LA: Dietary intake and its contribution to longitudinal organophosphorus pesticide exposure in urban/suburban children, *Environ Health Perspect* 116(4):537-542, 2008.

Mazurek J, Holbert L, Parrish MK, Salehi E: Raw eggs—lessons learned from an outbreak of *Salmonella* serotype enteritidis infections associated with meringue pie, *J Public Health Manag Pract* 11(3):201-207, 2005.

Meharg AA, Deacon C, Campbell RC, Carey AM, Williams PN, Feldmann J, Raab A: Inorganic arsenic levels in rice milk exceed EU and US drinking water standards, *J Environ Monit* 10(4):428-431, 2008a.

Meharg AA, Sun G, Williams PN, Adomako E, Deacon C, Zhu YG, Feldmann J, Raab A: Inorganic arsenic levels in baby rice are of concern, *Environ Pollut* 152(3):746-749, 2008b.

Meliker JR, Franzblau A, Slotnick MJ, Nriagu JO: Major contributors to inorganic arsenic intake in southeastern Michigan, *Int J Hyg Environ Health* 209(5):399-411, 2006.

Merten S, Dratva J, Ackermann-Liebrich U: Do baby-friendly hospitals influence breastfeeding duration on a national level? *Pediatrics* 116(5):e702-e708, 2005.

Muller O, Krawinkel M: Malnutrition and health in developing countries, *CMAJ* 173(3):279-286, 2005.

Muso Y, Kentarou O, Itami S, Yoshikawa K: Fixed eruption due to quinine: report of two cases, *J Dermatol* 34(6):385-386, 2007.

Neidecker-Gonzales O, Nestel P, Bouis H: Estimating the global costs of vitamin A capsule supplementation: a review of the literature, *Food Nutr Bull* 28(3):307-316, 2007.

Newton K, Amarasiriwardena D, Xing B: Distribution of soil arsenic species, lead and arsenic bound to humic acid molar mass fractions in a contaminated apple orchard, *Environ Pollut* 143(2):197-205, 2006.

Niemira BA: Irradiation compared with chlorination for elimination of *Escherichia coli* O157:H7 internalized in lettuce leaves: influence of lettuce variety, *J Food Sci* 73(5):M208-M213, 2008.

Noci F, Monahan FJ, French P, Moloney AP: The fatty acid composition of muscle fat and subcutaneous adipose tissue of pasture-fed beef heifers: influence of the duration of grazing, *J Anim Sci* 83(5):1167-1178, 2005.

Nord M, Kantor LS: Seasonal variation in food insecurity is associated with heating and cooling costs among low-income elderly Americans, *J Nutr* 136(11):2939-2944, 2006.

Oberholser CA, Tuttle CR: Assessment of household food security among food stamp recipient families in Maryland, *Am J Public Health* 94(5):790-795, 2004.

Olson CM: Tracking of food choices across the transition to motherhood, *J Nutr Educ Behav* 37(3):129-136, 2005.

Papathakis PC, Rollins NC: Are WHO/UNAIDS/UNICEF-recommended replacement milks for infants of HIV-infected mothers appropriate in the South African context? *Bull World Health Organ* 82(3):164-171, 2004.

Penniston KL, Tanumihardjo SA: The acute and chronic toxic effects of vitamin A, *Am J Clin Nutr* 83(2):191-201, 2006.

Peters SC: Arsenic in groundwaters in the Northern Appalachian Mountain belt: a review of patterns and processes, *J Contam Hydrol* 99(1-4):8-21, 2008.

Poddar S: Dietary intervention with iron and black tea infusion in reducing cytotoxicity of arsenic, *Indian J Exp Biol* 42(9):900-903, 2004.

Priyadarshani AM, Chandrika UG: Content and in-vitro accessibility of pro-vitamin A carotenoids from Sri Lankan cooked non-leafy vegetables and their estimated contribution to vitamin A requirement, *Int J Food Sci Nutr* 1-8, 2007.

Rank MR, Hirschl TA: Likelihood of using food stamps during the adulthood years, *J Nutr Educ Behav* 237(3):137-146, 2005.

Raybourne RB, Williams KM, Vogt R, Reissman DB, Winterton BS, Rubin C: Development and use of an ELISA test to detect IgE antibody to Cry9c following possible exposure to bioengineered corn, *Int Arch Allergy Immunol* 132(4):322-328, 2003.

Robinson GR Jr, Larkins P, Boughton CJ, Reed BW, Sibrell PL: Assessment of contamination from arsenical pesticide use on orchards in the Great Valley region, Virginia and West Virginia, USA, *J Environ Qual* 36(3):654-663, 2007.

Rose-Jacobs R, Black MM, Casey PH, Cook JT, Cutts DB, Chilton M, Heeren T, Levenson SM, Meyers AF, Frank DA: Household food insecurity: associations with at-risk infant and toddler development, *Pediatrics* 121(1):65-72, 2008.

Roy J: Economic benefits of arsenic removal from ground water—a case study from West Bengal, India, *Sci Total Environ* 397(1-3):1-12, 2008.

Seal AJ, Creeke PI, Dibari F, Cheung E, Kyroussis E, Semedo P, van den Briel T: Low and deficient niacin status and pellagra are endemic in postwar Angola, *Am J Clin Nutr* 85(1):218-224, 2007.

Selgrade MK: Immunotoxicity: the risk is real, *Toxicol Sci* 100(2):328-332, 2007.

Shaikh U, Cole SL, Marcin JP, Nesbitt TS: Clinical management and patient outcomes among children and adolescents receiving telemedicine consultations for obesity, *Telemed J E Health* 14(5):434-440, 2008.

Sinha D, Roy M, Dey S, Siddiqi M, Bhattacharya RK: Modulation of arsenic induced cytotoxicity by tea, *Asian Pac J Cancer Prev* 4(3):233-237, 2003.

Sitorus RS, Abidin MS, Prihartono J: Causes and temporal trends of childhood blindness in Indonesia: study at schools for the blind in Java, *Br J Ophthalmol* 91(9):1109-1113, 2007.

Skog K, Viklund G, Olsson K, Sjöholm I: Acrylamide in home-prepared roasted potatoes, *Mol Nutr Food Res* 52(3):307-312, 2008.

Stimpson JP, Nash AC, Ju H, Eschbach K: Neighborhood deprivation is associated with lower levels of serum carotenoids among adults participating in the Third National Health and Nutrition Examination Survey, *J Am Diet Assoc* 107(11):1895-1902, 2007.

Swami HM, Thakur JS, Bhatia SP: Impact of mass supplementation of vitamin A, *Indian J Pediatr* 74(5):443-447, 2007.

Thundiyil JG, Yuan Y, Smith AH, Steinmaus C: Seasonal variation of arsenic concentration in wells in Nevada, *Environ Res* 104(3):367-373, 2007.

Vanamala J, Cobb G, Turner ND, Lupton JR, Yoo KS, Pike LM, Patil BS: Bioactive compounds of grapefruit (*Citrus paradisi* Cv. Rio Red) respond differently to postharvest irradiation, storage, and freeze drying, *J Agric Food Chem* 53(10):3980-3985, 2005.

Veda S, Platel K, Srinivasan K: Varietal differences in the bioaccessibility of beta-carotene from mango (*Mangifera indica*) and papaya (*Carica papaya*) fruits, *J Agric Food Chem* 55(19):7931-7935, 2007.

Viklund GA, Olsson KM, Sjöholm IM, Skog KI: Impact of harvest year on amino acids and sugars in potatoes and effect on acrylamide formation during frying, *J Agric Food Chem* 56(15):6180-6184, 2008.

Wang SY, Chen CT, Sciarappa W, Wang CY, Camp MJ: Fruit quality, antioxidant capacity, and flavonoid content of organically and conventionally grown blueberries, *J Agric Food Chem* 56(14):5788-5794, 2008.

Wanja M: Suitable nutrients necessary in early years and its later consequences, *Asia Pac J Clin Nutr* 13(Suppl):S129, 2004.

Wasserman GA, Liu X, Factor-Litvak P, Gardner JM, Graziano JH: Developmental impacts of heavy metals and undernutrition, *Basic Clin Pharmacol Toxicol* 102(2):212-217, 2008.

Whitaker RC, Phillips SM, Orzol SM: Food insecurity and the risks of depression and anxiety in mothers and behavior problems in their preschool-aged children, *Pediatrics* 118(3):e859-e868, 2006.

Wyatt SA, Reitz LV, Croley TR, Hawkins D, Barrett E, McKeown A, Powell N, West A, Hamner T, Royster MO: Biological monitoring of uranium exposure in south central Virginia, *J Expo Sci Environ Epidemiol* 18(1):59-75, 2008.

Yuan T, Luo QF, Hu JY, Ong SL, Ng WJ: A study on arsenic removal from household drinking water, *J Environ Sci Health A Tox Hazard Subst Environ Eng* 38(9):1731-1744, 2003.

Zavala YJ, Duxbury JM: Arsenic in rice. I. Estimating normal levels of total arsenic in rice grain, *Environ Sci Technol* 42(10):3856-3860, 2008.

Zavala YJ, Gerads R, Gorleyok H, Duxbury JM: Arsenic in rice: II. Arsenic speciation in USA grain and implications for human health, *Environ Sci Technol* 42(10):3861-3866, 2008.

Zuccato E, Castiglioni S, Bagnati R, Chiabrando C, Grassi P, Fanelli R: Illicit drugs, a novel group of environmental contaminants, *Water Res* 42(4-5):961-968, 2008.

chapter

15

The Nutrition Care Process in the Health Care Setting

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Chapter Topics

Medical Nutrition Therapy and Its Role in the Health Care Setting
Acute Care Issues
Long-Term Care Concerns
Institutional Meal Planning
Nutritional Support Issues
Food and Drug Interactions
Palliative Care
The Role of the Nurse and Other Health Care Professionals in the Nutrition Care Process

Objectives

After completing this chapter, you should be able to:

- Discuss the differences in acute care versus long-term care settings.
- Describe patient risk factors for poor nutritional status.
- Identify risk factors for skin breakdown.
- Discuss institutional meal service concerns.
- Discuss different types, methods, and uses of nutritional support.
- Identify common drug and food interactions.
- Describe differences in nutrition care between palliative and curative care.

Terms to Identify

Acquired immunodeficiency syndrome (AIDS)
AIDS-related complex (ARC)
Aphasia
Aspiration
Braden and Norton Scales
Cardiac cachexia
Cholestasis
Diabetes insipidus
Elemental feeding
Enteral nutrition
Free water
Holistic
Hospice
Human immunodeficiency virus (HIV)
Hypokalemia
Jejunostomy
Kyphosis
Minimum data set (MDS)
Nasogastric (NG) tube feeding
Nothing by mouth (NPO)
Nutrition support
Nycturia
Palliative care
Percutaneous endoscopic gastrostomy (PEG) tube
Peripheral parenteral nutrition (PPN)
Peripherally inserted central catheter (PICC) line
Phlebitis
Physiologic stress
Refeeding syndrome

Suspected Deep Tissue Injury
Syndrome of inappropriate antidiuretic hormone (SIADH)
Tetany
Total parenteral nutrition (TPN)
Tube feeding

INTRODUCTION

Chronic health care concerns are addressed from a preventive approach in a variety of settings and also need to be considered in developing care plans for either acute care needs or for long-term care settings. Acute care has traditionally been provided within a hospital setting, but increasingly home-based or long-term care settings are involved with acutely ill individuals. Understanding the intricacies of health care needs when a person has multiple health conditions and medications is challenging. Added to this are the challenges of altered appetites, food dislikes and intolerances, and need to communicate care plans and services with all relevant health care staff. Further challenges include interacting with various types of personalities, altered levels of cognition, and communication problems such as a person with **aphasia** (inability to speak) due to a stroke. Health care as provided in an institutional setting requires complex thinking on how to meet nutritional needs within limitations of a food service operation.

WHAT IS THE ROLE OF MEDICAL NUTRITION THERAPY IN A HEALTH CARE SETTING?

Prevention and management of chronic health conditions typically occur in outpatient or nonhospital settings. In an acute or long-term care setting, medical nutrition therapy (MNT) may be provided to aid in recovery or to stabilize the health condition.

Medical nutrition therapy may be used to increase nutritional status and prepare for surgery. This reduces surgical risks and helps in the healing process. A temporary stay in a long-term care setting may occur for rehabilitation, such as for a person who needs to recover from a traumatic injury or surgery in which protein and adequate kilocalories (kcalories or kcal) to support healing are needed. In long-term care the prevention and management of skin breakdown is essential, which further includes good hydration. The nurse or certified nursing assistant (CNA) working in home care may need to know how to apply medical nutrition therapy for meal preparation.

In an institutional setting, nutritional status needs to be assessed within 24 to 72 hours depending on written protocol of the institution. An eating skills assessment needs to be determined (see sample form in Figure 15-1). The anthropometric measurements of height and weight are essential to this assessment process. Determining nutritional needs for kcalories, protein, and fluids all require an accurate weight and height measurement. Having height and weight allows for calculating body mass index (BMI) (see Chapter 6 and Appendix 9). If a person is obese, the nutritional needs may be based on adjusted or corrected body weight, which is a calculation aimed at the recognition that adipose tissue has lower nutritional needs than lean muscle tissue. Using actual body weight for an obese individual can overestimate

Nutritional Services
Initial Screening

Name:_____RM#_____DOB_____Age_____DOA_____

Diet confirmation:_____
Ht:_____ Wt:_____ Wt Hx:_____ Usual WT:_____ IBWR:_____
Diet Hx:
_____
_____

Nutritional concerns/ medical history
_____
_____
_____
_____
_____
_____
_____
_____
Labs:_____
_____

Skin assessment: Initial skin score:_____ Skin intact ☐ Yes or No ☐
If *No*, continue: ☐ Pressure ulcer stage_____ Site:_____
Assessed needs: ☐ Using ABW _____/kg_____ ☐ Using CBW_____/kg_____
BEE _____ x (AF) x (SF)_____ _____
Protein needs: ☐ 1-1.2/kg, ☐ 1.2-1.5 kg, ☐ 1.5 + /kg=
Fluid needs: ☐ 25 mL/kg, ☐ 30 mL/kg ☐ 35 mL/kg ☐ Min of 1500 mL=_____
Suggest: ☐ MVI/min ☐ Vit C 500 mg /day ☐ Zinc 220 mg/day 60 days

Usual bowel pattern:_____
Self-help measures:_____

Unable to feed self	No Yes	_____
Chewing with difficulty	No Yes	_____
Swallowing with difficulty	No Yes	_____
Food allergies/ intolerances	No Yes	_____
Cultural, ethnic, religious preferences	No Yes	_____

Plan:
☐ RD will assess within 14 days
☐ Start supplementation:_____
☐ Other recommendations:_____

Screened by:_____Date:_____

FIGURE 15-1 Sample initial nutrition assessment and care plan.

nutritional needs. One simple method of determining ideal body weight (IBW) is the following:

- For women, 100 lb for the first 5 feet, and 5 lb for each additional inch
- For men, 106 lb for the first 5 feet and 6 lb for each additional inch

One accepted formula to calculate adjusted body weight for a person who is obese (BMI greater than 30 or greater than 130% IBW) is as follows:

- Actual body weight – IBW × 25% + IBW

For example, for a 5'5" woman whose IBW is 125 lb, but who weighs 250 lb, the following calculation may be used to determine the adjusted or corrected body weight:

$$250 - 125 = 125 \times 25\% = 31.25 + 125 = 156.2 \text{ lb (Adjusted Body Weight)}$$

Laboratory values are of further importance in assessing nutritional status. Albumin levels can help determine protein status. However, this is not a reliable measure if there is altered hydration status or inflammation. Repeat albumin levels or a prealbumin level may be required to determine an individual's protein needs. An experienced registered dietitian (RD) will be able to review other laboratory values to help verify accuracy of albumin levels. For example, if the blood urea nitrogen (BUN) to creatinine ratio is elevated, it indicates dehydration and the albumin level may be falsely elevated. If the albumin to globulin ratio is less than 1.0, it suggests inflammation and the albumin level may be artificially low. A variety of other laboratory values are used to help determine nutritional goals and meal provisions such as levels of sodium, potassium, calcium, hemoglobin, and hematocrit.

WHAT ARE ISSUES OF ACUTE CARE?

CRITICAL ILLNESS

With critical illness there is often the unique issue of hypermetabolism and acute phase response inflammation leading to biochemical changes. For example, the ferritin level is raised in children with septic shock. This is associated with poorer health outcomes (Garcia and colleagues, 2007). Poor nutritional status can lead to increased risk of infection, but infection also can lead to poor nutritional status. This is due, in part, to a negative nitrogen balance with enhanced breakdown of protein found with inflammation. Infection also can reduce appetite and cause reduced food intake.

With the protein catabolism found in a hypermetabolic state, muscle wasting can develop. Supplementation of the diet with the amino acids cysteine, threonine, serine, aspartate-asparagine, and arginine has been found to help spare body protein catabolism during infection (Breuillé and colleagues, 2006; Mansoor and colleagues, 2007). Another amino acid, lysine, may be beneficial to improve immunity, especially if there is a low intake such as with a vegetarian diet or one that is primarily wheat based (Kurpad, 2006).

An extra 20% to 25% of the recommended nutritional needs for kcalories and protein intake may be needed for most infections. However, based upon length of hospitalization, evidence suggests that the most severely ill persons may not benefit from meeting all of their calculated nutrient needs while in the intensive care unit (ICU). Those who had an intake greater than or equal to 82% of assessed nutritional needs were found to require an increased hospital stay twice as long as those who had a lower intake (Hise and colleagues, 2007). This may be due to the difficulty in accurately assessing needs. The use of indirect calorimetry using metabolic charts (see Figure 4-3) to measure intake and output of gases through breathing is the most reliable method but is often not available or not appropriate for a given person, such as someone who uses oxygen. Avoiding overfeeding is particularly important for a

Box 15-1 Kilocalorie Calculations

HARRIS-BENEDICT FORMULA (BASAL ENERGY EXPENDITURE [BEE])*

Women

655 + 4.34 (weight in pounds) + 4.7 (height in inches) – 4.7 (age)

Men

66 + 6.23 (weight in pounds) + 12.7 (height in inches) – 6.8 (age)

*The BEE is then multiplied by an activity factor, generally 1.2 for bedridden persons and 1.3 for ambulatory persons in a health care setting, and an injury factor, 1.0 for no injury up to 2.0 depending on need. Additional kcalories are added for weight gain need.

malnourished person to prevent the **refeeding syndrome** and to allow weaning from ventilators.

Determining nutritional needs for kcalories is based on mathematical calculations. The available equations may not be correct for a given individual. Of the available mathematical formulas, the Harris-Benedict (Box 15-1) is most likely to be accurate for adults but has a high level of inaccuracy in up to 39% of hospitalized patients (Boullata and colleagues, 2007). The resulting number of the Harris-Benedict equation is then multiplied by an activity factor and injury factor as appropriate.

Clinical judgment may be needed to determine individual needs. It has been found that multiplication by an activity factor may lead to overfeeding of patients on controlled ventilation (Hoher and colleagues, 2008). Other situations of potential error in overestimating kcalorie needs with the Harris-Benedict equation are with obese persons with trauma or burns. Indirect calorimetry estimated 21 kcal/kg for such individuals, less than expected. This reinforces the concept that a hypocaloric regimen may be beneficial for ICU patients. Use of an injury factor of 1.2 with the Harris-Benedict equation may overestimate calorie needs (Stucky and colleagues, 2008). Even lower kcalorie intakes have been observed in medical ICU patients with resulting improved outcomes at approximately 9 to 18 kcal/kg/day (Krishnan and colleagues, 2003).

For children the Schofield-HW equations for resting energy expenditure (REE) studies have the greatest accurate application (Rodríguez and colleagues, 2002). For children with significant burns, it is advised that indirect calorimetry measurements (see Figure 4-3) be used to determine kcalorie needs (Suman and colleagues, 2006).

Plasma concentrations of antioxidant micronutrients have been found to be low during critical illness and infections. This has been attributed to various causes, including loss of body fluids, poor diet, provision of intravenous (IV) fluids, and a systemic inflammatory response that causes micronutrients to leave plasma and enter body cells. Three antioxidant nutrients have demonstrated clinical benefits during critical illness: selenium, glutamine, and the omega-3 fatty acid eicosapentaenoic acid (EPA), in addition to various trace minerals (Berger and Chioléro, 2007). The degree of selenium deficiency has been found to correlate with disease severity (Manzanares Castro, 2007).

Magnesium deficiency has been found to commonly occur in critical illness. It is associated with a higher mortality and worse clinical outcomes in an ICU setting.

Magnesium deficiency has been directly implicated in **hypokalemia** (low serum potassium), hypocalcemia, **tetany** (muscle spasms, cramps, and convulsions resulting from altered calcium metabolism), and dysrhythmia. The diagnosis is difficult to make because of limitations of serum magnesium assessments (Tong and Rude, 2005).

Cardiac cachexia is characterized by inflammation and a hypermetabolic state. There is some evidence that nutritional supplements containing selenium, vitamins, and antioxidants may be beneficial with this condition. The goals with cardiac cachexia include shifting from a catabolic state to an anabolic state, reducing free radicals through increased antioxidant intake, reducing inflammation, and as needed achieving tight glycemic control with intensive insulin therapy (Meltzer and Moitra, 2008). This may require nutritional support to achieve the kcalories needed to promote an anabolic state (see later section).

Nutritional supplements that have been regularly used in surgical and critically ill persons usually include arginine, other proteins, and omega-3 fatty acids. However, for the critically ill there is controversy due to potential for increased mortality. It is thought excess arginine may increase nitric oxide production and lead to worsened health in a person who has a critical illness (Calder, 2007).

The increased need for kcalories in a hypermetabolic state is related to hormonal imbalances. Stress hormones need to be countered by an increased level of insulin. This can be achieved through increasing carbohydrate and kcalorie intake. Because of the increased production of stress hormones, elevated blood glucose levels tend to occur. Achieving tight control of glucose levels by aggressive insulin therapy has been shown to reduce morbidity in critically ill individuals (Andreelli, Jacquier, and Troy, 2006).

DIABETES

Diabetes is a common chronic health condition, found in almost 10% of hospitalized persons (Russell and colleagues, 2005). Tight blood glucose management in an ICU hospital setting has been associated with significant reduction in kidney damage, reduced need for mechanical ventilation, and earlier discharge, thereby lowering hospital costs (Van den Berghe and colleagues, 2006).

Managing blood glucose levels can be challenging in a hospital setting. Issues of a hypermetabolic state with reduced appetite and other factors can cause blood glucose levels to be erratic. Hypoglycemia that may occur has been found to be primarily an issue of excess insulin administration in relation to reduced carbohydrate intake (Hess-Fischl, 2004). Hypoglycemia needs to be avoided for optimal health outcomes.

Available technology also can play an adverse role in attempts to aggressively manage blood glucose. Capillary blood glucose level as measured by finger stick has been found to be inaccurate in critically ill ICU patients and does not meet criteria of the Clinical and Laboratory Standards Institute (CLSI). The actual cause of this is not known. It may be the technique used by staff in performing finger-stick blood glucose measurements. It is advised that finger-stick measurements should be used with great caution in protocols of tight glycemic control (Critchell and colleagues, 2007).

There is limited evidence on what constitutes the optimal diet for hospitalized persons with diabetes (Swift and Boucher, 2006). There is no one diet that works for everyone with diabetes, and because it is now recognized that sugar and starch have identical effects on blood glucose levels, the avoidance of sugar is not necessary. Increasingly hospitals are providing consistent carbohydrate in the meal-planning system that accounts for the total carbohydrate content of the meals. For the person who is not taking insulin, the goal is to test postprandial glucose levels to verify carbohydrate tolerance and adjust intake or diabetes medications as needed. To utilize carbohydrate counting (see Chapter 8), the physician or provider must know how to prescribe insulin based on an insulin to carbohydrate ratio (see Chapter 8), and insulin needs must then be coordinated with actual carbohydrate intake of the hospitalized individual.

For the hospitalized individual with diabetes who will be going home, education on diabetes is important. All nursing staff should know how to reinforce diabetes education as provided by the registered dietitian and/or diabetes educator. A performance-based approach that staff nurses can use is *C-O-U-N-T C-A-R-B-S: A 10-Step Guide to Teaching Carbohydrate Counting*. It has been shown that nurses who reinforce practical guidelines for persons with diabetes produce better behavioral outcomes than the didactic strategies commonly used in hospitals at present (Buethe, 2008).

SURGERY

Persons undergoing surgery should optimally have good nutritional status. Those with malnutrition undergoing surgery have increased risk of postoperative complications, especially impaired wound healing. Albumin level less than 3.5 mg/dL has been associated with postoperative complications and longer hospital stays such as found with cancer surgery (Lohsiriwat and colleagues, 2008). Normal levels of albumin, reflective of good protein status, good nutritional intake of vitamins and minerals, especially vitamin C and zinc, optimal hydration status, and good blood glucose management are all important for good wound healing, whether from surgery or other causes.

A relatively frequent problem after surgery is neuropsychiatric problems. Vitamin B_{12} deficiency has been found to be one cause of cognitive changes following general anesthesia (El Otmani and colleagues, 2007).

BURNS

The exudate of burns results in fluid loss and significant losses of protein. Albumin and prealbumin levels need to be followed to ensure adequate protein intake. Persons with burns average a need of about 5000 kcal/day during the acute phase of the burn injury. Other nutrients affected by the fluid loss at burn sites include zinc and copper, both of which are necessary for healing. Even at intakes three times the Dietary Reference Intake (DRI), the mean plasma concentrations of zinc and copper have been found to remain low (Voruganti and colleagues, 2005). Fluid intake also needs to be increased during the healing of burns to compensate for insensible fluid losses. Enteral feeding with L-arginine supplementation with early stage of burn helps to decrease adverse levels of nitric oxide production (Yan and colleagues, 2007). Glutamine may be of additional value. In addition to the need for zinc and copper,

supplements of vitamins A and C are advised to promote skin healing of burn areas (Grau Carmona, Rincon Ferrari, and Garcia Labajo, 2005).

TRAUMATIC BRAIN INJURY

There is some evidence of a nutritional component in neurologic damage associated with brain injury. Excess zinc has been implicated in the neuronal damage and death that follow traumatic brain injury (TBI) (Levenson, 2005). Vitamin B_3 has shown some therapeutic potential for the treatment of TBI, with improved working memory found in an animal study (Hoane, Akstulewicz, and Toppen, 2003). Hyponatremia is a frequently observed electrolyte abnormality in persons with central nervous system disease. A high rate of hyponatremia after TBI has been observed. Correction may result with increased intake of salt, but in severe cases hydrocortisone treatment is needed (Moro and colleagues, 2007).

HIV AND AIDS

Great strides have been made to limit **human immunodeficiency virus (HIV)** from progressing to **AIDS-related complex (ARC)** or the final **acquired immunodeficiency syndrome (AIDS).** Although the immune system is still functioning in the early infection stage of being HIV positive, maintaining optimal nutritional status will help prevent destruction of the immune system. It is now being found that once a person has AIDS it can regress back to HIV-positive status when antiviral medications are regularly taken, meaning the immune response can regain functioning. Preserving lean body mass through avoidance of weight loss is critical to maintaining a healthy immune system.

Once AIDS has developed, a hypermetabolic state ensues, promoting muscle wasting similar to other hypermetabolic conditions. In advanced HIV-1 infection lower albumin and inflammation are both found with lower serum selenium levels. It was found as serum albumin increases, serum selenium increases as well (Drain and colleagues, 2006). This helps demonstrate the importance of good protein status. Adequate kcalories are needed to maintain positive nutritional status. However, kcalorie needs may be as high as 3500 kcal or more per day because of a fever from an opportunistic infection. A variety of factors interfere with meeting this goal.

Thrush causes a diminished desire to eat because of discomfort in the oral cavity. Medications for treatment of AIDS also may cause nausea. Abdominal discomfort and diarrhea associated with malabsorption of food nutrients compound the lack of desire to eat while increasing the need for additional nutrients. Medical nutrition therapy in this scenario may involve altering the diet to include high-kcalorie cold beverages to prevent weight loss. The cold temperature would be soothing to the mouth. Many liquid supplements are lactose-free, and with the addition of banana flakes or commercial sources of the soluble fiber pectin, may help diarrhea to subside. If antibiotics are used, a trial of yogurt or buttermilk or commercial probiotics for a few days may help control diarrhea.

FLUID NEEDS IN CRITICAL CARE

Assessed fluid need for an adult are generally 30 mL/kg body weight (BW). Increased needs beyond this are required for correction of dehydration and for conditions in which there is excess fluid loss (generally 35 mL/kgBW). This may occur with

diarrhea or from open wounds, especially for burn victims. A reduced amount of fluid may be needed for heart failure (25 mL/kgBW) or end-stage renal disease (500 to 1000 mL plus urine output). Laboratory values can assist in the determination of fluid goals. Severe hyponatremia (less than 130 mg/dL) may warrant a fluid restriction. The BUN to creatinine ratio is an indicator, with a high ratio greater than 25 mg/dL suggestive of mild dehydration and greater than 35 mg/dL indicating severe dehydration. This may be due to aggressive diuretic treatment and not simply inadequate fluid intake.

Fluid and electrolyte disorders such as **diabetes insipidus,** salt-wasting syndrome, and **syndrome of inappropriate antidiuretic hormone (SIADH)** can alter fluid goals. Such conditions have been found within 3 days after surgery for brain tumors. In one review, diabetes insipidus was found to be the most frequent electrolyte disorder after surgery for central nervous system tumors. The salt-wasting syndrome and SIADH requires close monitoring of plasma sodium and fluid intake because of the risk of hyponatremia (Segura Matute and colleagues, 2007).

Risk of dehydration occurs with inadequate oral fluid intake of less than 75% intake per assessed needs; high risk can be considered with less than 50% fluid needs being met. Generally a minimum of 1500 mL daily or 6 cups is advised. Monitoring of clinical signs and symptoms of dehydration when a person is at risk of dehydration is an important role of nursing. Symptoms such as sunken eyes, reduced skin turgor, increased body temperature, low blood pressure, and constipation are important to monitor, along with charting of interventions to increase fluid intake.

WHAT ARE LONG-TERM HEALTH CARE ISSUES?

Once permanent long-term care in a skilled nursing home is required, goals may become more flexible. Issues such as diabetes management may be shifted from the prevention of long-term complications to a focus on short-term complications such as dehydration resulting from hyperglycemia. This might be addressed with a glucose goal below the renal threshold of 180 mg/dL (Hgb A_{1c} of less than or equal to 8%) for persons with a life expectancy of under 5 years with the primary goal to help prevent skin breakdown and dehydration, rather than a stricter goal of less than 7% to reduce long-term complications.

HOW IS THE OLDER ADULT'S NUTRITIONAL STATUS ASSESSED?

Factors such as bone loss and a shortening of the spinal column during later years indicate the need for current height measurement rather than relying on reported measurements from younger years. Height is frequently difficult to determine because of **kyphosis** (hunched shoulders), although knee height can be used to estimate true height (or arm span measurement (see Figure 1-8, *C*).

Protein requirement for an older person is now recognized to be greater than for a younger adult. This is due to inefficient utilization and production of proteins. A protein level of at least 1 g/kgBW is advised for an older adult. More is needed for high-needs conditions such as wound management or to correct a low albumin level. Protein needs are further determined based on tolerance such as with reduced tolerance in hepatic and renal disease, with decreased tolerance evidenced by increased levels of creatinine or ammonia.

MINIMUM DATA SET FORMS

Used in long-term care settings, **minimum data set (MDS)** forms were designed to help promote a total health care team approach to ensure health during long-term care. These forms help to organize critical health information useful in resident care meetings and to reassess intervention strategies in achieving health goals. The areas that need to be addressed in care planning, as identified through the MDS, include issues such as need for a therapeutic diet, weight loss, fluid intake, need for altered consistency of foods and fluids, and skin breakdown.

WEIGHT MONITORING

Monitoring weight to prevent unintended weight loss or excess weight gain is vital. Significant weight loss or gain is a change in weight equal to or greater than 5% in 30 days, 7.5% in 90 days, or 10% weight in 180 days. Chronic weight loss over this time period, even if not of a significant amount, also can indicate a goal of increased kcalorie provision needs. A significant weight loss during a 6-month period has been found to be associated with a nearly twofold increase in mortality (Yamashita and colleagues, 2002).

To promote adequate oral intake of a long-term care resident requires adequate supervision and encouragement to eat. The optimal average amount of staff time required to provide the interventions for the goal of good oral intake was found to be 42 minutes per person per meal and 13 minutes per person per between-meal snack. In contrast, usual care was found to be on average 5 minutes of assistance per person per meal and less than 1 minute per person per snack (Simmons and colleagues 2008).

Residents with dementia-related disorders are more prone to weight loss and malnutrition. Close to 70% in one study were at risk of malnutrition. Food service factors, including timing of meals; difficulty manipulating dishes, lids, and food packages; and therapeutic diets, were all significantly associated with risk of malnutrition (Carrier, West, and Ouellet, 2006).

BOWEL MANAGEMENT

When a person is dehydrated, immobilized, receiving narcotic analgesics for pain, or has altered gastrointestinal function, constipation can lead to bowel obstruction. Bowel movements are needed at least 2 to 3 times weekly to prevent bowel obstruction. Increased fluids and fiber are preferred over laxative use, but the latter also may be required to maintain normal bowel function. A cake made with oat fiber was found to be well accepted and beneficial. Laxatives were able to be reduced by about 60% in the fiber group (Sturtzel and Elmadfa, 2008). Prune juice and prunes (dried prunes) are helpful in bowel management. This is believed to be due to the naturally high content of sorbitol but may also be due to phenolic compounds (Stacewicz-Sapuntzakis and colleagues, 2001).

PRESSURE AND OTHER SKIN ULCERS

Skin breakdown contributes to mortality and morbidity. Long-term care facilities are under strict regulatory control to reduce rates of pressure ulcer occurrence. Hospitals increasingly are being held accountable. To promote this accountability the Centers

for Medicare and Medicaid Services (CMS) will no longer reimburse care for skin breakdown that develops while under care of the facility. Multidisciplinary wound care teams that conduct rounds at the bedside are highly recommended to both prevent skin breakdown and efficiently promote healing as needed.

Development of pressure ulcers in the hospital has been estimated to affect 10% of admissions, with elderly patients at the highest risk (Harris and Fraser, 2004). Even children can have skin breakdown. The prevalence of skin breakdown in acutely ill hospitalized children approaches one in four, although the majority of such occurrences are stage I (Suddaby, Barnett, and Facteau, 2005). Home care nurses also may have to manage pressure ulcers.

More than half of the nursing home population is incontinent of urine or feces, which is a risk factor for skin breakdown. Close monitoring and cleansing with a pH-balanced cleanser and moisture barrier can help maintain skin integrity among persons with incontinence (Zimmaro and colleagues, 2006).

Malnutrition is a risk factor for skin breakdown. One study of older persons found intake of less than or equal to 75% of meals was related to risk along with iron deficiency anemia, inflammation, and low levels of albumin, retinol, selenium, and zinc (Raffoul and colleagues, 2006). Nutritional deficiencies of a variety of vitamins and minerals may go undetected. For this reason, a multivitamin supplement is often recommended for prevention of skin breakdown, especially when there is poor nutritional intake.

The total number of risk factors for skin breakdown is usually given a score to determine level of risk. **Braden and Norton Scales** are examples of scoring systems for determining risk for pressure ulcers (see Appendix 15 on the Evolve website for a sample skin score sheet). Protocols are used to guide preventive strategies such as turning and positioning every 2 hours or more and nutritional guidelines. Some of the risk factors include the following:

- Being elderly
- Immobility
- Malnourishment or less than 75% required intake of solids
- Dehydration or less than 75% assessed fluid needs
- Incontinence
- Fragile skin
- Altered cognition
- Sensory loss
- Polypharmacy

Pressure sores are categorized by severity from stage I to stage IV with two new additional categories:

- Stage I: A nonblanchable area on the skin (does not turn white when pressure is applied). For persons with dark skin, there may be discoloration, edema, or thickening of the skin.
- Stage II: An open sore or blister that involves the epidermis and/or dermis layers.
- Stage III: Damage to the subcutaneous region is present, and a crater forms.
- Stage IV: Damage down to the muscle and bone, and sometimes tendons, occurs.

Two new categories of skin breakdown have been described by the National Pressure Ulcer Advisory Panel:

- **Suspected Deep Tissue Injury:** Discolored intact skin or blood-filled blister due to damage of underlying soft tissue from pressure and/or shear. The area may be preceded by tissue that is painful, firm, mushy, boggy, warmer, or cooler compared with adjacent tissue.
- Unstageable: Full-thickness tissue loss in which the base of the ulcer is covered by slough (yellow, tan, gray, green, or brown) and/or eschar (tan, brown, or black) in the wound bed.

Other common types of chronic skin ulcers include ischemic ulcers, venous ulcers, and neuropathic ulcers. Pressure relief should be provided for both pressure ulcers and neuropathic ulcers. Ischemic ulcers require revascularization. Individuals with venous ulcers need adequate edema control to promote healing (Takahashi, Kiemele, and Jones, 2004). Pressure and venous ulcers are common in the elderly population.

For wound healing a supplement of 500 mg of vitamin C and 220 mg of zinc sulfate (50 mg of elemental zinc) has been standard protocol, especially for more-severe skin breakdown (stage III or IV). However, excess intake of zinc was found to delay the rate of wound healing (Lim, Levy, and Bray, 2004). It also is known to reduce copper levels and can cause a severe form of anemia due to low copper levels. Many enzymes required for protein synthesis of new skin are dependent on copper as well as zinc. Consequently, large doses of zinc are being used less often or for short periods of time.

The upper limit of safety for zinc is 40 mg/day (see the back of the book). The DRI for zinc for persons greater than 70 years of age is 8 mg for women and 11 mg for men. It may be better protocol to use 110 mg zinc sulfate (25 mg elemental zinc). Clinical studies also have shown the beneficial effects of trace elements such as boron and manganese in wound healing (Chebassier and colleagues, 2004).

With regard to macronutrient needs for healing, an increased amount of protein is advised. The guidelines are a range of 1.2 to 2.0 g of protein per kilogram of body weight depending on the severity. Along with standard protocol, the amino acid arginine appears to be of importance in healing stage III and IV pressure ulcers (Frias Soriano and colleagues, 2004). However, there is concern that L-arginine could be detrimental in an inflammatory state (Stechmiller and colleagues, 2005), and it is advised in large doses only in critically ill persons under carefully monitored study conditions (Wilmore, 2004). In a small study, supplementary arginine (9 g), vitamin C (500 mg), and zinc (30 mg) was found to significantly improved the rate of pressure ulcer healing (Desneves and colleagues, 2005).

A higher kcalorie intake of 30 to 35 kcal/kgBW is generally needed for healing. However, in elders with pressure ulcers no increase in energy expenditure was found, and a range of 25 to 30 kcal/kgBW/day is suggested (Dambach, and colleagues 2005). For the malnourished elder, an increased number of kcalories will be needed to promote a gain of body weight, important for wound healing.

A study conducted in Turkey found honey dressings to be effective and practical. The use of honey dressings was four times more effective in promoting healing of stage II and III pressure ulcers compared with a commercial dressing (Yapucu Güneş

and Eser, 2007). This approach is not advised for an institutional setting in the United States, but may have implication in a situation where a commercial dressing is not readily available. However, a commercial honey-based dressing is now available.

DYSPHAGIA

Dysphagia (difficulty swallowing) affects millions of persons and is particularly common in the long-term care setting. As reviewed in Chapter 4, the act of swallowing seems simple but in fact is extremely complex with multiple muscles needing to be coordinated. Good neuromuscular control is essential for safe swallowing to prevent choking and aspiration pneumonia. A person with decreased cognition may need to be reminded to chew and swallow.

Elderly persons with dysphagia need food that requires little or no chewing, is easy to swallow, and is still appealing to eat, both visually and in terms of taste. The production of a sufficient amount of saliva is indispensable for good chewing. The addition of lemon to meals has been shown to invoke saliva production. Adding fluid to foods can significantly reduce the amount of chewing and total muscular work. Adding fluid to breakfast cake type of foods is particularly beneficial for persons with low saliva production (van der Bilt and colleagues, 2007). Buttering the food can reduce the amount of chewing needed before swallowing. This is especially helpful for dry foods such as cake and toast (Engelen, Fontijn-Tekamp, and van der Bilt, 2005).

Thickened liquids are often required, or at least may be advised, with dysphagia. This is because gravity is less able to allow the liquids to flow down the esophageal area, helping to avoid aspiration pneumonia. The various thicknesses include the following, from thinnest to thickest: nectar thick, honey thick, and pudding thick. The speech-language pathologist (SLP) helps to assess swallowing ability and advise on needed alteration of consistency or other strategies to reduce risk of choking and aspiration pneumonia.

Commercial thickeners come in two main forms. One is based on the gum type of fibers, the other is a form of starch. All thickeners have been found to suppress the flavors of beverages and give slight off-flavors (bitter, sour, metallic, or astringent). Starch-based thickeners impart a starchy flavor and grainy texture, whereas gum-based thickeners give added slickness to the beverages. Some beverages do not lend themselves well for thickening, causing lumps to form. Individual decisions must be made about which characteristics are more negative (e.g., slick versus grainy texture) for specific patients (Matta and colleagues, 2006).

Although there are commercially available prethickened liquids, there are a number of issues yet to be resolved. One impact on thickness is the amount of time it takes to consume a thickened liquid. Time and temperature have bearing on how well the thickened liquid maintains its consistency for the starch-based thickeners. The gel-based thickeners maintain their thickness regardless of time or temperature, although their use may be challenging to meet adequate thickness criteria. Simply Thick, the gum-based thickener, typically produced samples that were the least viscous, but they maintained a more consistent level of thickness over time (Garcia and colleagues, 2008).

Commercially prepared beverages can be thinned by accidental addition of saliva to the beverage as it is being consumed. This is more likely to be a problem if the person drinks slowly and uses a starch-based thickener or commercial product

based on a starch base. The gel-based thickeners consist of soluble fiber that is not digestible by salivary enzymes.

Commercial nectar- and honey-consistency beverages were found to be significantly more viscous at various temperatures compared with their individually thickened counterparts. Commercially thickened beverages at nectar and honey consistencies were almost always more viscous, typically more like syrup consistency, than the National Dysphagia Diet Task Force–defined standards (Adeleye and Rachal, 2007). See Table 4-1 regarding considerations for food texture modification.

CARE PLANS

All disciplines working in a long-term care setting need to develop care plans. This is the means by which all members of the health care team communicate with one another. Care plans are developed within 14 days initially upon admission and are reviewed at least quarterly and annually through care plan meetings that include the resident, registered nurse (RN), RD, social work, activities, and others as appropriate such as the occupational therapist (OT) and physical therapist (PT). Nutritional assessments identify the nutritional areas of risk, and a nutritional care plan is developed using measureable objectives and goals with specific care communicated with all nursing staff. The CNAs need to know their daily role with pertinent nutritional goals such as may be written on CNA resident care cards (Figure 15-2).

TOILETING NEEDS ☐ Continent 60% of the time
☐ Incontinent 60% of the time
☐ Attends ☐ Small ☐ Medium ☐ Large ☐ XL
☐ Nights ☐ Days ☐ Eve
☐ Wings ☐ Nights ☐ Days ☐ Eve
☐ Toilet q2-4h ☐ Change q2h

Special toileting needs:

BEHAVIORS ☐ Combative w/care ☐ Resistant to care
☐ Inappropriate behavior ☐ Report to nurse
☐ Yells out ☐ Other:_____
ADL ☐ Set up ☐ Assist
☐ Total care

EATING/ORAL CARE ☐ Feeder ☐ Self
☐ Set up ☐ Adaptive equipment
☐ Encour. & assist. ☐ Diet consistency_____
☐ I&O refer to consumption sheets ☐ Fluid restriction__
☐ Own teeth ☐ Self-care ☐ Total care
☐ Dentures ☐ Both ☐ Upper ☐ Lower
Special instructions:

SKIN NEEDS
☐ Turn & reposition every 2 hours
☐ Barrier cream after incontinence
☐ Geri sleeves ☐ Both ☐ Right ☐ Left
☐ Pressure relief needs
☐ Air mattress ☐ Heel protectors
☐ Elevate heels w/ pillows ☐ Other
☐ Moisturize dry skin

Special skin needs:

SEATING
☐ Recliner ☐ Devices ☐ Wheelchair
☐ Both pedals ☐ R only ☐ L only

Special instructions:

BATH DAY _____ SHIFT _____
☐ Shower ☐ Bedbath ☐ Tub

Special instructions:

SAFETY ☐ Elopement risk
Secure Care/Elopement Transmitter
☐ Yes ☐ No
Attached? ☐ Yes ☐ No
Alarms ☐ Chair ☐ Bed ☐ Seatbelt
☐ Chair & Bed
☐ Restraint (release & reposition q2h)
☐ Side rails ½ or full

Special instructions:

CODE STATUS ☐ Full code ☐ DNR

FUNCTIONAL ABILITY/AMBULATION/THERAPY
Transfers ☐ Self ☐ 1 assist ☐ 2 assist w/gait belt
☐ Lift w/2 ☐ Stand/pivot/lift
☐ Hoyer_____

Special Instructions:

THERAPY/AMBULATION ☐ Therapy
☐ Active rehab Affected limb:_____
☐ Hip precautions ☐ ROM_____
☐ Amb._____

PT/OT INSTRUCTIONS
Splints: _____
Adaptive equip: _____
Assistive devices: _____
OTHER: _____

PATIENT FUNCTIONAL STATUS

Ambulates	Assistance
☐ Crutches	☐ Independent
☐ Walker	☐ Supervised
☐ Cane	☐ Min. Assist.
☐ No device	☐ Mod. Assist.
☐ Weight bearing _____	

WEIGHTS ☐ Daily ☐ Monthly
☐ Weekly ☐ Other _____

Special instructions:

LAUNDRY: ☐ Facility
☐ Family

SLEEP PATTERN
☐ 4 hr or more
☐ 2 hr or more
☐ Other _____

OTHER NEEDS
☐ Glasses all the time
☐ Reading only
☐ Hearing Aid ☐ Both ears
☐ R ear ☐ L ear
☐ Oxygen _____ ☐ Continuous
☐ As needed
☐ TEDS ☐ JOBST
☐ Other

_____

COMMENTS:

FIGURE 15-2 Sample certified nursing assistant care card.

WHAT ARE INSTITUTIONAL MEAL CONCERNS AND CONSIDERATIONS?

Attractive food service plays an important role in stimulating the appetite and enjoyment of food. A good appetite is necessary to ensure adequate nutritional intake. Mealtime is often a major event of the day for the person in a health care setting. Every effort must be made to prepare the room and the resident to receive the meal. Brushing teeth or rinsing of the mouth before eating can stimulate appetite. Ensuring availability of dentures for those who wear them is important. Some individuals eat better if arrangements can be made for the use of china dishware. Holidays are often a time of sadness for residents in an institutional setting. Using colorful napkins and tray decorations at these times can stimulate the appetite.

The person's room should be adjusted for adequate, but not glaring, light and a comfortable temperature. If eyeglasses are worn, they need to be on and clean. If the person is blind, the foods should be described before eating begins. Medication for pain or nausea is sometimes recommended for improved meal intake.

Food will be more appealing if it is served at the proper temperature and as soon as possible after preparation to maintain palatability. It may be necessary to cut meat into bite-size pieces, butter bread, and open containers if the individual is unable to perform those tasks independently because of weakness or pain from arthritis, for example. Certain adaptive equipment may be needed to help maintain independence in eating. Plates and bowls can be stabilized with rubber pads (Dycem mats) and suction cups. Soup can be more easily managed if poured into a cup. Foam-covered spoon and fork handles are useful for individuals who have lost some ability to handle silverware easily (Figure 15-3).

Respect and dignity are important to the elder population. When serving a meal, the health care professional should address the person by the last name preceded by Mr., Miss, or Mrs., unless requested to do otherwise. As the baby boom generation ages and increasingly enters long-term care centers, being referred to by first name is generally preferred.

Napkins and a damp cloth should be close at hand for wiping any spilled food from face or clothing. A vision- or hearing-impaired individual will appreciate patience and understanding. Food items and their location on the plate and at the place setting should be identified for a visually impaired person. For the visually impaired person who needs to be fed, it is vital that each bite of food be explained in advance to promote trust in the caregiver and to help the person distinguish among the foods being eaten.

The delivery of medical nutrition therapy in a health care setting revolves around basic institutional diets. Tables 15-1 and 15-2 list information on common diets used and foods allowed and omitted. Some differences exist from one health care facility to another in the foods permitted in each category, as well as in the number of kinds of diets. When an individual is admitted to a facility, the health care provider will select the type of diet, often with input from a staff dietitian. In some health care facilities the dietitians are responsible for ordering diets. Diets may be changed if and when the individual's condition makes it desirable. The nursing staff often identifies and communicates needed changes in the person's diet. Particularly in long-term care settings, in which the facility is considered the person's home, resident rights may dictate discontinuing diet restrictions.

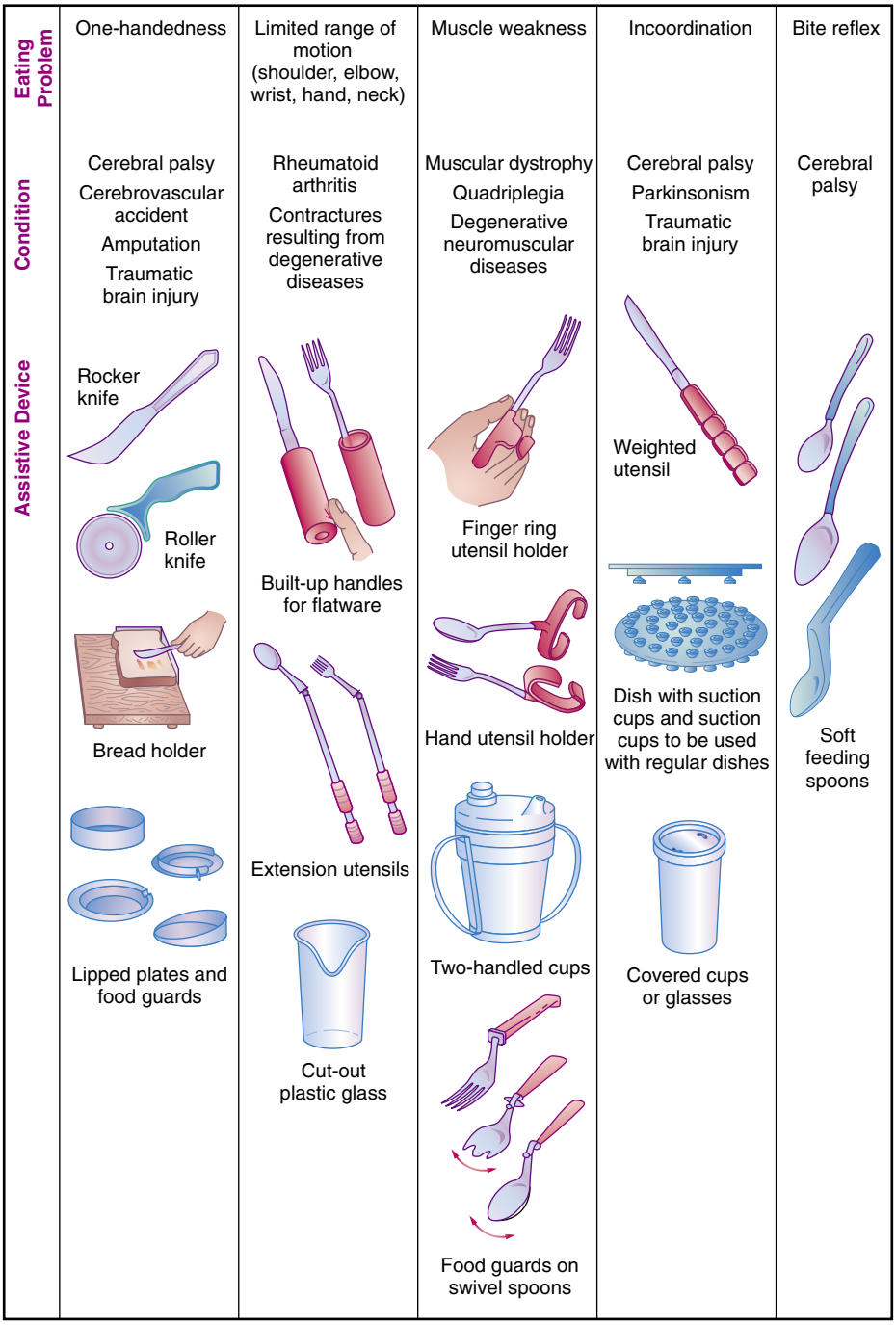

FIGURE 15-3 Assistive devices for eating problems. (From Consultant Dietitians in Health Care Facilities: *Feeding is everybody's business: a manual for health care professionals involved in feeding programs,* Evansville, Ind, Mead Johnson Nutritional Division.)

Assessment of feeding needs is essential. The most frequent nutritional problems identified in relation to meeting nutritional needs have been found to be appetite change, poor positioning while eating, and problems with oral status. Developing individualized nutrition plans includes mealtime feeding needs. This requires interdisciplinary team coordination of efforts (Crogan, Alvine, and Pasvogel, 2006).

Responsibilities of the various health care disciplines in resident feeding are listed in Table 15-3. Proper positioning is essential for good nutritional intake and

Table 15-1 Progressive Basic Hospital Diets

CLEAR LIQUID DIET	FULL LIQUID DIET	SOFT DIET*	REGULAR, HOUSE, GENERAL, OR FULL DIET
Characteristics			
Temporary diet of clear liquids without residue; nonstimulating, non–gas-forming, nonirritating diet; 400-500 kcal	Foods liquid at room temperature or liquefying at body temperature	Normal diet modified in consistency to have limited fiber Liquids and semisolid food; easily digested	Practically all foods Simple, easy-to-digest foods, simply prepared, palatably seasoned; a wide variety of foods and various methods of preparation; individual intolerances, food habits, ethnic values, and food preferences considered
Adequacy			
Inadequate; deficient in protein, minerals, vitamins, and kcalories	Can be adequate with careful planning; adequacy depends on liquids used If used longer than 48 hours, high-protein, high-calorie supplements should be considered	Entirely adequate liberal diet	Adequate and well balanced
Use			
Acute illness and infections Postoperatively Temporary food intolerance To relieve thirst To reduce colonic fecal matter Intolerance for solid food 1- to 2-hour feeding intervals Before certain tests	Transition between clear liquid and soft diets Postoperatively Acute gastritis and infections Febrile conditions 2- to 4-hour feeding intervals	Between full liquid and light or regular diet Between acute illness and convalescence Acute infections Chewing difficulties Gastrointestinal disorders Three meals with or without between-meal feedings	For uniformity and convenience in serving hospital patients Ambulatory patients Bed patients not requiring therapeutic diets

Table 15-1 Progressive Basic Hospital Diets—cont'd

CLEAR LIQUID DIET	FULL LIQUID DIET	SOFT DIET*	REGULAR, HOUSE, GENERAL, OR FULL DIET
Foods			
Water, tea, coffee, coffee substitutes Fat-free broth Carbonated beverages Synthetic fruit juices Ginger ale Plain gelatin Sugar No milk or fats Orange juice may cause distention Salt, plain hard candy, fruit ices, all fruit juices without pulp	All liquids on clear liquid diet plus: All forms of milk Soups, strained Fruit and vegetable juices Eggnog (pasteurized) Plain ice cream and sherbets Junket and plain gelatin dishes Soft custard Cereal gruels Puréed meat and meat substitutes only; for use in soups only Butter, cream, margarine, sugar, honey, hard candy, syrup; salt, pepper, cinnamon, nutmeg, and flavorings; puréed vegetables for use in soups only	All liquids Fine and strained cereals Cooked tender and puréed vegetables Cooked fruits without skin and seeds Ripe bananas Ground or tender meat, fish, and poultry Eggs and mild cheeses Plain cake and puddings Moderately seasoned foods Enriched white, refined whole-wheat bread (no seeds)	All foods from the MyPyramid
Modification			
Liberal clear liquid diet includes fruit juices, egg white, whole egg, thin gruels	Consistency for tube feedings: foods that will pass through tube easily	Low residue—no fiber or tough connective tissue; traditional bland—no chemical, thermal, physical stimulants; cold soft—tonsillectomy; mechanical or "dental" soft—requiring no mastication (diced, chopped, mashed foods in place of purées); light or convalescent diet—intermediate between soft and regular	For a light or convalescent diet, fried foods, rich pastries, foods rich in fats, coarse vegetables, possibly raw fruits and vegetables, and gas-forming vegetables may be omitted

*Because of the trend toward a more liberal interpretation of diets and foods, in some hospitals the soft diet may be combined with the light diet, with cooked low-fiber vegetables allowed in place of purées.

Table 15-2 Menu Modification of Food Groups of the MyPyramid Food Guidance System for Therapeutic Diets

FOOD GROUP	REGULAR	SOFT	LIBERAL BLAND	SODIUM RESTRICTED	LOW FAT	KILOCALORIE RESTRICTED
Breads and cereals	All breads and cereals allowed	All breads and cereals allowed Modify in consistency as needed (milk toast, rice pudding, and so on)	Allowed as tolerated	Avoid instant hot cereals, breads with salted toppings, salted crackers Salt-free products may be used, depending on level of sodium restriction	Avoid products with added fat	Avoid products with added fat
Fruits and vegetables	All fruits and vegetables allowed	Juices, soft, canned, or cooked vegetables and fruits; chop and mash as needed	Allowed as tolerated	Avoid dried fruits with sodium preservatives Avoid high-sodium canned vegetables and juices	Avoid vegetables in cream or cheese sauces	Avoid vegetables in cream or cheese sauces, fruits packed in syrup Limit to amounts prescribed in diet
Milk	All milk and dairy products allowed	All milk and dairy products allowed	Allowed as tolerated	Limit milk depending on level of sodium restriction	Use skim milk and low-fat cheeses	Use skim milk and low-fat cheeses unless calorie level allows use of higher-fat products
Meat	All meat and alternates allowed	Soft, tender, or ground meats plain or in casseroles and soups	No spicy meats or high-fat meats if not well tolerated	Avoid all processed and cured meats	Use lean meats	Use lean meats, limit to amounts prescribed in diet
Fats, sugars, and miscellaneous	Condiments and seasonings as desired Fats, sugar, and alcohol in moderation	Condiments and seasonings as desired Fats, sugar, and alcohol in moderation	*Omit:* Black pepper, chili powder, alcohol, and caffeine-containing beverages	Avoid salt and salt seasonings, salted snack foods, commercially canned soups	Limit use of fats and oils	Limit use of fats, oils, alcohol, and foods high in sugar

Table 15-3 The Team Approach to Health Care in Feeding

HEALTH CARE PROFESSIONAL	RESPONSIBILITY
Dietitian	Plans meals
	Supervises food and modified diet preparation
	Monitors intake of solids and fluids
	Executes diet orders
	Arranges diet modification and needs for supplements and fluid goals
	Offers nutrition counseling
	Performs nutrition assessment and arranges for special needs
Nursing staff	Supervises mealtime
	Performs proper positioning
	Charts food and fluid intake
	Communicates with dietitian and physician regarding acceptance of food served
	Implements and integrates total care plan
Occupational therapist	Assesses oral motor function
	Instructs staff on appropriate alignment for feeding
	Assesses need for assistive devices
	Works with patient on chewing, swallowing, and other functional skills necessary to achieve feeding independence
Physical therapist	Evaluates mobility deficits
	Prescribes appropriate feeding activities
	May assist in evaluating oral motor problems
Speech pathologist	Provides assessment of oral motor functions and recommends appropriate treatment with food and beverage consistency
	May provide help in solving problems and work with problems of bite reflex and tongue thrust
Psychologist	Evaluates specific behaviors that affect nutrition (such as food stealing, pica behavior, obsessive eating, and bizarre eating habits) and plans ways to manage them
Social worker	Collects social history and demographic data regarding patient and family
	Summarizes patient's financial status and reaction to proposed therapy
	Provides financial information if needed by patient in acquiring funds
Dentist	Provides assessment of patient's dental health (condition of gums, oral structure, and sensitivity related to teeth)
Physician	Identifies feeding problems
	Requires consultation in writing to appropriate health care professional
Recreational therapist	Provides premeal activities (music for dining, socialization)

Modified from Consultant Dietitians in Health Care Facilities: *Feeding is everybody's business: a manual for health care professionals involved in feeding programs,* Evansville, Ind, Mead Johnson Nutritional Division.

avoidance of aspiration of food into the lungs (Figure 15-4). An individual is properly positioned for eating if the following are true:

- The head and upper trunk are as upright as possible.
- The feet are adequately supported.
- The hips and knees are flexed to approximately an 85-degree angle.
- The head is tipped slightly forward.

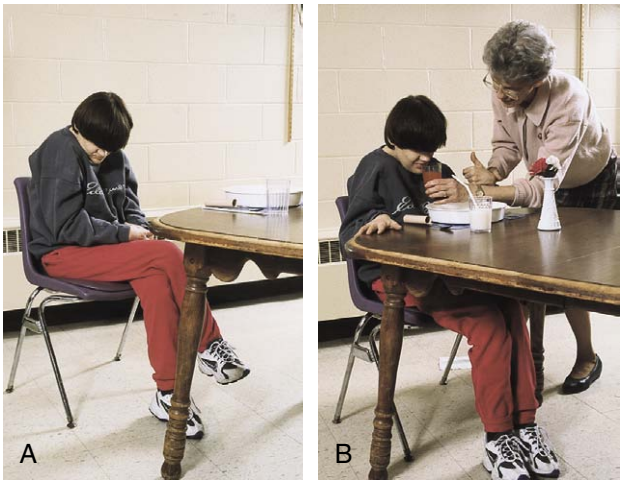

FIGURE 15-4 **A,** Improper, and **B,** proper positioning at mealtimes.

- The table height is appropriate.
- The arms are centered close to the body.
- The person is seated close to the table.
- Feeding techniques that can further help with eating are used (Table 15-4).

It is ideal for the CNA or nurse who is assisting at mealtimes to be relaxed. If an individual must be fed, foods being served should be described. Alternating one food with another and offering liquids frequently while the caretaker is seated in a comfortable position is advised. Pleasant neutral conversation should be used, avoiding discussion of the person's illness or any criticism of the meal.

Adequate staffing is vital to meet these goals. The national Resource Utilization Group System (RUGS) used for reimbursement does not adequately address staff time for feeding. Residents require an average of 35 to 40 minutes of staff time per meal. This was found both among residents who needed only supervision and verbal cueing and among those who were totally fed (Simmons and Schnelle, 2006).

Various meal environments are used in both hospitals and long-term care facilities. Cafeteria style dining, versus individual trays, and a homelike dining environment have been found to increase kcalorie intake in individuals at high risk for malnutrition, particularly those with low body weight and cognitive impairment (Desai and colleagues, 2007).

Meeting nutritional needs includes providing foods free of food poisoning. Although this to date has not been a major problem, risks have been identified. *Listeria* is a bacteria found in deli meats (see Chapter 14). Survey results from over 1500 long-term care centers indicated only three facilities completely followed national recommendations for prevention of *Listeria* contamination. Areas of weakness included serving soft cheeses made from unpasteurized milk, serving ready-to-eat deli meats without taking the precautionary step of steaming until hot before consumption, and using unpasteurized eggs and nonirradiated meats (Nelson and colleagues, 2008).

Table 15-4 Feeding Techniques for Resolving and Improving Feeding Problems

POSSIBLE ABNORMAL REFLEX OR PROBLEM	FEEDING TECHNIQUE
Rooting Reflex	
Mouth opens and head turns in the direction of the stimulus when cheeks or lips are touched beyond 3 months of age.	Avoid stimulation to face between swallows or bites, such as wiping face with a cloth.
Suck-Swallow	
Rhythmic suck and simultaneous swallowing movement that continues as long as stimulus is present.	Occupational therapy (OT) program for oral normalization such as mouth and tongue stimulation, lip closure, stroking the throat, and so on. Follow OT program to progress from sucking to chewing. When using stimulation techniques, use firm, deep pressure rather than light pressure, which may tickle or irritate. Gradually increase texture and thickness of food.
Tonic Neck Reflex	
Develops at 4 weeks. Stimulated by receptors in the neck, it aids in eye-hand coordination. Position of the arms depends on position of the head.	
Asymmetric Tonic Neck Reflex	
When the head is turned toward the right, the right arm extends outward. If to the left, the left arm extends. Prevents individual from keeping the head in position to be fed and interferes with jaw control. When self-feeding, it prevents proper hand-to-mouth coordination.	Position head and whole body in midline. (Refer to Positioning, discussed previously.)
Gag Reflex	
Prevents passage of food into the windpipe. Present from birth on through life, although it weakens in later life. In hypertonicity, a gag is elicited by tactile stimulation to the anterior half of the tongue. Caused by hypersensitive tongue and difficulty in swallowing. In hypotonicity, no gag response occurs regardless of what part of the tongue is prodded.	Gagging is a "yellow light, not a red light." The feeder may think that gagging on a new food means that the individual is not ready for more complicated textures. This may not be so but just a warning to take things more slowly. To prevent behavioral problems, handle gagging in a very matter-of-fact way. Simply place hand over the child's mouth and close it until he swallows. Be careful to prevent food from entering the windpipe. Keep the head forward. Neck extension can cause aspiration. Tongue stimulation at other than mealtime to decrease hypersensitivity to touch. To control tongue activity, place food on the middle of the tongue with a slightly downward pressure of the spoon. Feeder must be extremely careful in feeding this individual to prevent choking. Feed slowly. Walk the tongue with a tongue depressor or fingers in small steps to the point of gag, then withdraw depressor, close patient's mouth, and wait for a swallow.

Continued

Table 15-4 Feeding Techniques for Resolving and Improving Feeding Problems—cont'd

POSSIBLE ABNORMAL REFLEX OR PROBLEM	FEEDING TECHNIQUE
Bite Reflex Rapid rhythmic opening and closing of the jaw as long as the stimulus is present. This reflex is integrated by 4 months.	Use small plastic spoon, without sharp edges, when feeding to prevent injury to oral structures. Wait for relaxation before removing spoon (do not try to pull spoon out).
Lip Closure Necessary for removing food from the spoon and for preventing drooling.	Prefeeding stimulation of lips and jaw control in which the index finger is above the upper lip, pulling downward slightly as the spoon is removed. Never scrape food off the spoon with the patient's teeth. A spoon with a flat bowl will work better than a deep-bowled spoon. Do not try to scrape any excess food from the lips with the spoon or wipe the patient's mouth or chin after every bite. This may give the patient the wrong signal to open the mouth rather than keeping it closed to masticate and swallow. Allow for a little messiness while the patient learns that the touch of the spoon means to open the mouth and withdrawal of the spoon means to close it
Tongue Mobility Used in moving food to the back of the mouth for swallowing and relocating food from the sides of the mouth.	Encourage lip licking with the tongue by placing something tasty on the lips such as peanut butter. Also place small pieces of cereal between the lips and gums.
Drooling Caused by ineffective swallowing of saliva. It is evident when there is poor jaw and tongue control and poor lip closure.	The therapist must solve the drooling problem indirectly by correcting the other feeding problems first.
Refusal to Eat Solid Food Hypersensitivity to touch. Dislikes change. May have very tight mouth.	Eliminate canned puréed food. Introduce wide variety of regular table food that has been puréed. Gradually introduce thickened consistency, then food with general lumpiness such as rice pudding rather than discrete lumps. When introducing vegetables, initially avoid vegetables with an outer shell such as corn, peas, and lima beans.
Refusal to Drink From a Cup Poor coordination to suck-swallow. Previous experience from choking on liquids.	Begin cup drinking by using thickened liquids that flow more slowly and give the patient more time to swallow. Alternate spoonfuls of thickened liquid with spoonfuls of patient's other food at the meal. Gradually increase the number of spoonfuls of liquid given in succession but give patient enough time to swallow between spoonfuls. Gradually thin down liquid. For example, add apricot nectar to pureed apricots. Then reduce strained fruit gradually until the patient is drinking juice alone. Use jaw control to close lips and jaw and reinforce "normal" swallowing pattern.

Information approved by an occupational therapist of Broome Developmental Services, Ithaca, NY.

Table 15-5 Physiologic Responses to Stress

TYPE OF STRESS	POSSIBLE PHYSIOLOGIC RESPONSE
Surgery	Blood loss, shock, hemorrhage
	Depletion of protein or increase in protein metabolism
	Negative nitrogen balance
	Dehydration
	Edema
	Nausea, vomiting, diarrhea
	Electrolyte imbalance
Fractures of long bones and other trauma	Increase in protein metabolism
	Loss of phosphorus, potassium, sulfur
	Development of osteoporosis because of immobilization and loss of calcium
	Electrolyte imbalance
	Loss of fluids
	Renal failure and uremia
Burns	High loss of nitrogen
	Anorexia
	Fluid loss
	Weight loss
	Electrolyte imbalance
	Mineral losses
Infection	Increased metabolism
	Dehydration
	Fever
	Body tissue breakdown
	Nausea and vomiting
	Anorexia
	Poor synthesis of vitamin K related to antibiotics given
	Loss of sodium and potassium if fever is present
Fevers, including those of short and long duration	Increased protein metabolism
	Depletion of body's energy stores
	Lowered sodium, chloride, and potassium levels
	Disturbance of appetite, digestion, and absorption

WHAT ARE INDICATIONS FOR NUTRITION SUPPORT?

Nutrition support is the provision of macronutrients (carbohydrate, protein, and/or fat) to promote healthy weight management and nutritional status. It is used during times of **physiologic stress** (a state in which increased amounts of stress-related hormones are present—see Table 15-5), when the oral intake from standard meals cannot keep pace with the increased metabolic needs of the stress state. It is also used to improve nutritional status for individuals with malnutrition. Figure 15-5 shows how the type of nutritional support is determined. Because of the complexity of enteral or parenteral nutrition and concerns about the refeeding syndrome (see below), nutrition support should always have input from an RD. The RD may deter-

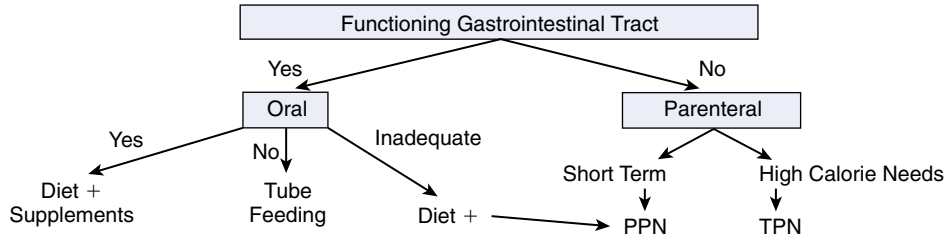

FIGURE 15-5 Determining the type of nutritional support for the patient. *PPN*, Partial parenteral nutrition; *TPN*, total parenteral nutrition.

mine the needed nutrients and logistics of delivery; however, a health care provider generally needs to sign off on the planned individual protocol for delivery of commercial nutrition supplements whether oral or through **tube feeding.**

Nutritional support is essential for anyone who has had an unplanned weight loss of 10% or more within 6 months; shows a significant loss of muscle mass; has a serum albumin level of less than 3 g/dL, a serum transferrin level of less than 150 mg/dL, or both; or is scheduled for major surgery that may interfere with the ability to consume adequate nourishment.

Nutrition support may be via oral intake, which is the simplest form. However, nutrition assessment of need should still be undertaken by a registered dietitian who has special training in this area. Monitoring is essential. In the short run the refeeding syndrome or the nutrition recovery syndrome can occur when nutritional support is provided too aggressively, particularly in the malnourished person. As the cells begin to be renourished, they take nutrients from the extracellular plasma first. The growth of new cells also will deplete serum levels of electrolytes. Low serum potassium, phosphorus, and magnesium levels are common when nutritional support is undertaken too aggressively, and death can result from hypokalemia. Monitoring potassium levels needs to be done on a daily basis initially. Serum magnesium level should be measured initially and rechecked weekly for the first 3 weeks of refeeding at a minimum with aggressive nutritional support (Birmingham, Puddicombe, and Hlynsky, 2004).

Any form of nutritional support can lead to the refeeding syndrome. Case reports of refeeding syndrome continue to be published, particularly in the anorexia nervosa population. Stressed, critically ill patients may be at risk of refeeding following short periods of fasting (Miller, 2008). One case of refeeding syndrome involved a 70-year-old woman who had not been eating well for 4 months due to ill health and dysphagia with need for mechanical ventilation. Twelve hours after starting nasogastric tube feeding, she developed a cardiac arrest from which she was successfully resuscitated. After the diagnosis of refeeding syndrome was made, she was started on a high-protein, high-fat, low-carbohydrate diet, including multivitamin and minerals, and was subsequently weaned from the ventilator (Gariballa, 2008).

Glucose levels need to be monitored at least daily by finger stick, but preferably via serum laboratory values. In any physiologic stress condition, glucose intolerance is common and carbohydrate intake may need to be reduced or insulin provided. Another indicator of excess carbohydrate and kcalorie intake is increased carbon

dioxide production. Respiratory therapists can play a role in identifying tolerance to nutrition support.

Daily weights initially are recommended to ensure appropriate kcalories for weight needs are provided and to help avoid development of edema or dehydration. Hydration status can be partly determined by the BUN to creatinine ratio. A low value is generally a result of excess fluid intake, whereas a high value generally indicates dehydration.

High-kcalorie, high-protein foods such as milkshakes, custards, and puddings are often used initially in nutrition support and in tandem with between-meal nourishments may be adequate to meet nutritional needs. In most health care facilities, fortified foods are available and should be tried if regular foods are not sufficient. Fortified foods contain extra kcalories and protein and may be made on the premises or purchased commercially. Examples are fortified puddings, ice cream, cookies, mashed potatoes, hot cereals, and milk with the addition of extra milk powder or other sources of kcalories and protein. With poor intake of food, a multivitamin and mineral supplement is usually advisable unless sufficient commercial liquid supplements are used. Whenever possible the individual should be encouraged to ingest a normal diet by mouth. This is the preferred and most natural method of nutritional support. It has the psychologic advantage of giving the person control over at least one aspect of treatment.

Through records of food intake, an estimate of kcalories and nutrients consumed in relation to requirements can be determined. Meal intake is recorded as 100%, 75%, 50%, 25%, or refused. Fluids are recorded in cubic centimeters (cc) or milliliters (mL). This is a very important role for CNAs. Unless an accurate assessment of meal and beverage intake is recorded, determining if a resident has adequate intake of kcalories, protein, and fluids is not possible. This can result in undernutrition of residents, leading to issues of skin breakdown, reduced immunity, and other complications.

If fortified foods are not adequate to meet an individual's nutritional needs or are not readily tolerable because of the higher content of lactose and milk protein in most of these products, liquid supplements should be tried. A variety of liquid supplements is available, including lactose-free, gluten-free, special renal formulas that are low in protein, potassium, and sodium or those designed for children (see Appendix 1 on the Evolve website for websites of pharmaceutical companies that provide nutritional supplements). Liquid supplements usually provide 1 kcal/mL, but higher-kcalorie supplements are available that provide 1.5 to 2 kcal/mL, useful when fluid intake needs to be limited because of the health condition of the resident. Supplements also are available with higher protein content. Elemental supplements are those providing nutrients in their elemental form and require minimal if no digestion. **Elemental feedings** are commonly used for short bowel syndrome or intestinal malabsorption, depending on the severity of the condition.

WHAT ARE GUIDELINES FOR USE OF ENTERAL NUTRITION?

If there are oral-intake problems, the delivery of a liquid supplement may be through a feeding tube. This is referred to as **enteral nutrition.** One form of short-term or intermittent use of enteral nutrition is with **nasogastric (NG) tube feeding,** in which a tube is passed through the nose into the stomach. An example of use of short-term

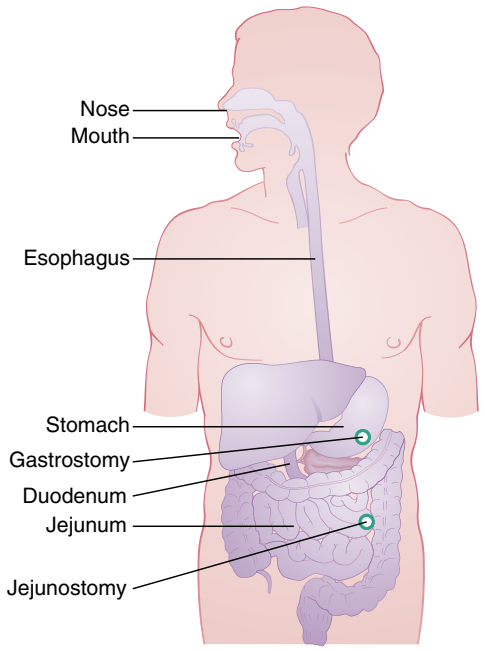

FIGURE 15-6 Tube feeding routes.

(up to 4 weeks) enteral nutrition support is postoperatively. If the gastrointestinal tract is functioning, enteral nutrition support is the preferred method. The rule of thumb is, "When the gut works, use it."

When long-term use of enteral nutrition delivery is needed, implantation of a tube is generally performed. The use of a **percutaneous endoscopic gastrostomy (PEG) tube**—a permanent feeding tube implanted through the stomach—has become commonplace with children and adults who have neurologic damage resulting in dysphagia (see Chapter 4). Erythromycin or metoclopramide can enhance gastric motility if needed (MacLaren and colleagues, 2008).

The use of a **jejunostomy** (Figure 15-6), in which the PEG tube is placed into the jejunum, may be warranted if **aspiration** (food or liquid entering the lungs) cannot be avoided. However, this leads to the reduction of pancreatic secretion, leading to impaired digestion. Jejunostomy also increases risk of trace mineral deficiency. This is due to bypassing the absorptive surface of the duodenum, where minerals are primarily absorbed (see Chapter 4). One case study involved a man who developed severe ataxia, myelopathy, and peripheral neuropathy due to copper deficiency after having a jejunostomy years earlier. This was despite using a commercial enteral product that met the Recommended Dietary Allowance (RDA) for copper (Tan, Burns, and Jones, 2006). Although not always necessary, predigested formulas may be helpful with jejunal feeding (Silk, 2008).

Research continues to develop regarding the benefits and drawbacks of enteral and parenteral nutrition. **Nothing by mouth (NPO)** with enteral tube feeding has been widely practiced for several days after major upper gastrointestinal surgery. Other abdominal operations have shown normal food at will to be safe and to

improve gut function. Research is now indicating this holds true for upper gastrointestinal surgery (Lassen and colleagues 2008).

For children who are likely to return to oral feeding as their main source of nourishment, oral feeding needs to be encouraged, whether it is by using a pacifier, drinking water, or eating small amounts of food. It has been found that infants who receive only enteral feeding for an extended period have significant and persistent difficulty making the transition to oral feeding. These children need to be slowly retrained how to chew and swallow.

Palliative care (comfort care versus treatment approach) physicians and nurses believe that medically assisted nutrition and hydration at the end stage of life rarely benefits patients, and as long as adequate mouth care is given, patients do not suffer (van der Riet and colleagues, 2008). However, total parenteral nutrition (TPN) or enteral tube feedings cannot be ruled out. Each person's case is unique and must be handled individually. The institution should have written guidelines for feeding the terminally ill individual. Thorough review of benefits versus risks of enteral nutrition should be discussed with the individual and/or family members and the rest of the health care team before deciding on its use.

OTHER BENEFITS OF ENTERAL NUTRITION

Provision of immediate enteral nutrition containing omega-3 fatty acids within 24 hours of surgery can reduce risk of clot formation. A formula with omega-3 fatty acids, the amino acid arginine, and ribonucleic acid (RNA) may have further benefit with reduced risk of developing infectious complications. This was demonstrated after radical surgery for esophageal cancer (Aiko and colleagues, 2008). In medical patients with sepsis, early enteral pharmaconutrition with dipeptides of the amino acid glutamine, vitamin C and E, beta-carotene, selenium, and zinc in combination with an immunonutrition formula was found to result in significantly faster recovery of organ function compared with control (Beale and colleagues, 2008). Fish oil was found to improve the outcome of medical ICU patients with systemic infection (sepsis) or acute respiratory distress. Formulas supplemented with the amino acid arginine with or without additional glutamine or fish oil do not appear to offer an advantage over standard enteral formulas in trauma and burn patients (Marik and Zaloga, 2008).

There is no known cure for Crohn's disease. Exclusive enteral nutrition is recommended as the first-line treatment to induce remission in children with this disease. Recent evidence also suggests that long-term enteral nutritional supplementation providing half of daily calorie requirements as enteral nutrition may be an effective strategy for the maintenance of remission in Crohn's disease (Akobeng, 2008).

WHAT ARE GUIDELINES FOR DELIVERY OF ENTERAL NUTRITION?

A feeding system that uses gravity can be used by hanging a bag of the liquid supplement near the person with use of a clamp to control delivery rate or a pump system (Figure 15-7). The supplement may be a "closed system"—one in which the liquid supplement is not exposed to the air and is commercially available in a ready-to-hang bag. This helps reduce risk of contamination. All formulas should be refrigerated once they are mixed or opened to prevent bacterial contamination. Any unused

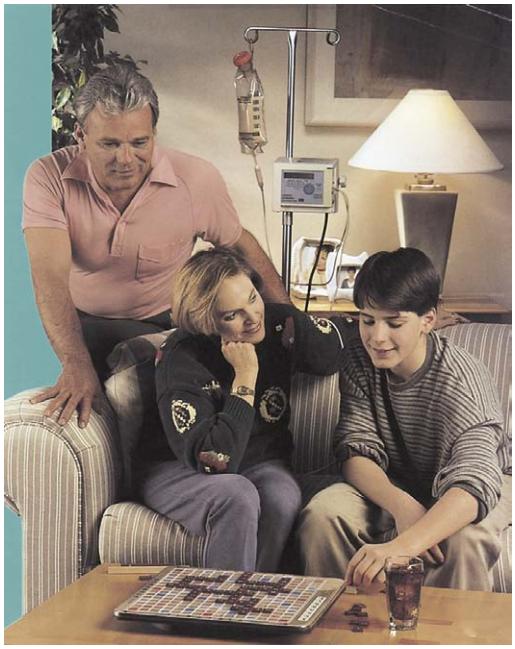

FIGURE 15-7 Tube feeding systems have been developed so that patients are not confined to a hospital bed. Some may even be used in the home. (Used with permission of Ross Products Division, Abbott Laboratories, Columbus, Ohio. From *Tube feeding at home,* Ross Products Division, Abbott Laboratories.)

portion of the formula should be discarded after 24 hours. Hang-time at room temperature for open systems (bags that are filled with formula on site) should be a maximum of 8 hours (4 hours if the formula is diluted or additives have been incorporated). Closed-system delivery may be used for up to 48 hours at room temperature.

The amount of liquid supplement is determined by assessing the person's need for kcalories, proteins, fluids, vitamins, and minerals. The actual water content of commercial liquid supplements, referred to as **free water,** can be obtained from the manufacturer (see Appendix 1 on the Evolve website for websites of the major suppliers) but usually is about 75% to 80% of the total formula volume. Most supplements are based on 1 kcal/mL. Therefore the volume of a 2000-kcal solution is generally 2000 mL, but only about 1600 mL of that is actual water content.

The rate of delivery of the formula varies based on individual need. The standard approach is to start at a slow rate and increase the rate over a period of a few days as tolerated. There is controversy and conflicting evidence on the best approach. Dilution of formula is generally not indicated. If manual delivery is used through a PEG tube, it is generally advised to do so slowly (at least 3 minutes for small amounts, and 10 to 20 minutes for larger amounts of bolus feedings). Bolus delivery is not recommended with a jejunostomy.

One study examining the issue of initial flow rate using a pump found no significant difference regarding complications for immediate delivery of full nutrition requirements versus a gradual rate of increase over a few days. In this study the goal of 25 kcal/kgBW daily with the use of motility medication agents and starting at the full flow rate allowed nutritional needs to be met rapidly. A higher residual gastric

volume of 300 mL was more frequent with the immediate full flow rate, but complications were no different than with a slower introduction (Desachy and colleagues, 2008). A residual gastric volume of greater than 500 mL or greater than 250 mL on two occasions warrants reduced delivery rate.

Another study aimed at determining safe flow rates involved 12 male volunteers who participated in three separate studies (oral bolus, tube bolus, and nasogastric drip) using 220 mL Ensure Plus (1.5 kcal/mL). The oral and tube bolus were given over 5 minutes, and the infusion rate for the drip was 55 mL/hr. Gastric emptying times for the bolus deliveries were about 30 to 45 minutes. Emptying times were similar for the drip rate, and both approaches were found to be safe in regard to aspiration risk (Bowling and colleagues, 2008). Studies with a PEG tube found an increased risk of aspiration and vomiting if there was hiatal hernia or severe reflux esophagitis (Nishiwaki and colleagues, 2006).

The rate of flow when a pump is used can be calculated by a mathematic equation to meet the needs. For example, if the person can easily have the pump run for 12 hours and the supplement desired contains 1 kcal/mL, 125 mL/hr for 12 hours would be required to meet 1500 kcal (divide 1500 mL by 12 hours to equal 125 mL/hr). However, this is thought too high an amount to start. Therefore a steady progression in flow rate is generally recommended, and 40 mL/hr to start is usually tolerated. The rate of delivery can usually be increased by about 25 mL every 4 to 12 hours until the desired rate is achieved. Alternatively, the length of time of tube feeding could be increased to allow for a slower rate of delivery while meeting the kcalorie needs sooner. There is no consensus regarding daytime versus nighttime feeding or around-the-clock feeding regimens. It appears the duration is best determined based on tolerance and lifestyle decisions. Persons who want to be free of the pump during the day can have a faster rate at night. Generally, a plan for 24-hour delivery is discouraged because there are times of being off the pump that are unavoidable, such as for bathing. The exception to this is the critically ill, bedridden hospitalized patient in whom a slower, but continuous delivery is likely best tolerated.

Error of delivery rate can be human based, but there also is evidence there are problems with some enteral nutrition feeding pumps. About one dozen commercially available enteral nutrition feeding pumps were tested in a variety of conditions with variation from the delivery rate resulting in a range of excess 65 mL to a deficit of 270 mL over the course of 24 hours (Tepaske and colleagues, 2006).

Water flushes to keep the tube clean are strongly recommended before and after medications if given through the tube to help prevent tube occlusion. If a clot forms, instill a 5- to 10-mL warm water flush, and then use a small syringe plunger (30 to 50 mL) with back-and-forth motion for 1 minute to help dislodge the clot, and then clamp the feeding tube for 5 minutes. If needed, one crushed pancreatic enzyme tablet and one crushed sodium bicarbonate tablet (325 mg) dissolved in 5 mL of water can be used (Macranid, Stegall, and Trogden, 1989).

Water flushes should be provided every 4 hours for continuous feeding or anytime the feeding is interrupted. Generally 30 mL for each flush is a good protocol. The amount of water for flushing and medication purposes needs to be calculated into the person's nutritional support regimen. The goal is generally 30 mL/kg of body weight. For individuals who have high kcalorie needs but require fluid restrictions, liquid supplements that have 2 kcal/mL are useful. There will be a lower water content per volume with the higher-kcalorie supplements.

Possible complications of enteral feeding are listed in Table 15-6, with suggested solutions if problems arise. Complications can occur from tube blockage and hyperglycemia or gastrointestinal side effects, which are the most common, with up to 65% of patients experiencing such problems as vomiting and diarrhea (Hoepffner, Schroder, and Stein, 2004).

The ideal quantity of dietary protein for formula-fed low-birth-weight infants less than 2.5 kg remains controversial. A higher protein intake greater than or equal to 3.0 g/kg/day but less than 4.0 g/kg/day accelerates weight gain but can induce elevated BUN levels and adverse problems (Premji, Fenton, and Sauve, 2006). One study looking at this used an early and aggressive nutritional regimen among very low-birth-weight (VLBW) infants. Amino acids were administered at the rate of 1.5 g/kg/day along with 5.6 mg/k/min of glucose flow on day 1 of life and progressively increased to 4 g/kg/day and 13 mg/kg/min. Intravenous lipids were started at 0.5 g/kg/day at 24 hours from birth and increased to 3.5 g/kg/day. In this aggressive group there was a 66% reduction in the risk of postnatal malnutrition at 40 weeks of postmenstrual age. There was better growth in weight, length, and head circumference (Dinerstein and colleagues, 2006).

Monitoring nutritional status is important when delivering enteral nutrition. Review of the nutritional content of the liquid supplement is necessary to ensure that the correct amount of macronutrients is being provided based on individual needs and tolerance and that all vitamins and minerals are being provided. Because of bioavailability issues, nutritional deficiencies of trace minerals such as copper can occur with long-term enteral feeding (Oliver, Allen, and Taylor, 2005). Vitamin A toxicity can occur with enteral nutrition. One man who had used a commercially prepared enteral feeding formula for 2 years developed asymptomatic hypercalcemia and had serum vitamin A levels several-fold above normal. Ultimately, an enteral supplement was developed that was low in vitamin A, and after several months vitamin A and calcium levels returned to normal (Bhalla, Ennis, and Ennis, 2005).

Fact & Fallacy

FALLACY If diarrhea develops with tube feeding, the feeding must stop immediately.

FACT The cause of diarrhea may be unrelated to formula use, especially if the formula is isotonic and lactose-free. Other problems, such as the presence of hyperosmolar electrolyte solutions or sorbitol in some medications, should be ruled out (see Table 15-6). ■

Use of medications and interactions need to be considered (see following section for more guidelines). Levodopa as used by persons with Parkinson's disease needs to be coordinated with timing of enteral feeding. One case study was of a 77-year-old man with Parkinson's disease who was admitted to an intensive care unit, received 1.4 g/kg of protein administered continuously, and developed severe rigidity. The amount of protein in the enteral nutrition was then decreased to 0.9 g/kg/day with a change to bolus feeding. This resulted in marked improvement of parkinsonian symptoms (Cooper, Brock, and McDaniel, 2008). Continuous enteral nutrition should

Table 15-6 Enteral Feeding Complications and Problem Solving

PROBLEM	CAUSE	PREVENTION AND TREATMENT
Mechanical		
Aspiration pneumonia	Delayed gastric emptying, gastroparesis Gastroesophageal reflux Diminished gag reflex	Feed beyond the pylorus or ligament of Treitz. Reduce administration rate. Select isotonic or lower-fat formula. Regularly check gastric residuals, tube placement, and abdominal girth. Keep head of bed elevated 30-45 degrees during and after feeding. Use small-bore feeding tubes to minimize compromise of lower esophageal sphincter. Initially and regularly check tube placement.
Pharyngeal irritation, otitis	Prolonged intubation with large-bore nasogastric tubes	Use small-bore feeding tubes whenever possible. Consider gastrostomy or jejunostomy sites for long-term feeding.
Nasolabial, esophageal, and mucosal irritation and erosion	Prolonged intubation with large-bore nasogastric tubes Use of rubber or plastic	Use small-caliber feeding tubes made of biocompatible materials. Tape feeding tube properly to avoid placing pressure on the nostril. Consider gastrostomy or jejunostomy sites for long-term feeding.
Irritation and leakage at ostomy site	Drainage of digestive juices from stoma site	Attend to skin and stoma care. Use gastrostomy tubes with retention devices to maintain proper tube placement.
Tube lumen obstruction	Thickened formula residue Formation of insoluble formula-medication complexes	Irrigate feeding tube frequently with clear water or use an enteral pump that provides a water flush. Avoid instilling medications into feeding tubes, when possible. Use liquid forms. Irrigate tubes with clear water before and after delivering medications and formula and after aspirating gastric contents.
Gastrointestinal		
Diarrhea	Low-residue formulas Rapid formula administration Hyperosmolar formula Bolus feeding using syringe force Hypoalbuminemia Nutrient malabsorption Microbial contamination Disuse atrophy of the gastrointestinal (GI) tract Rapid GI transit time Prolonged antibiotic treatment or other drug therapy	Rule out non–formula-related causes. Select fiber-supplemented formula. Initiate feedings at low rate. Temporarily decrease rate. Reduce rate of administration. Select isotonic formula or dilute formula concentration and gradually increase strength. Reduce rate of administration. Select alternate method of administration. Use hydrolyzed, peptide-based formulas or parenteral nutrition until absorptive capacity of small intestine is restored. Select a hydrolyzed, peptide-based formula that restricts offending nutrients. Avoid prolonged hang times. Use sanitary handling and administration techniques. Use enteral nutrition support whenever possible. Select fiber-supplemented formula. Review medication profile and eliminate causative agent if possible.

Continued

Table **15-6** Enteral Feeding Complications and Problem Solving—cont'd

PROBLEM	CAUSE	PREVENTION AND TREATMENT
Cramping, gas, abdominal distention	Nutrient malabsorption Rapid, intermittent administration of refrigerated formula Intermittent feeding using syringe force	Select a hydrolyzed formula or one that restricts offending nutrients. Administer formula by continuous method. Administer formula at room temperature. Advance administration rate according to patient tolerance. Reduce rate of administration. Select alternate method of administration.
Nausea and vomiting	Rapid formula administration Gastric retention	Initiate feedings at low rate and gradually advance to desired rate. Temporarily decrease rate. Select isotonic or dilute formula. Reduce rate of administration. Select low-fat formula. Consider need for postpyloric feeding.
Constipation	Inadequate fluid intake Insufficient bulk Inactivity	Supplement fluid intake. Select fiber-supplemented formula. Encourage ambulation, if possible.
Metabolic		
Dehydration	Elevated fluid needs or losses of GI fluid and electrolytes	Supplement intake with appropriate fluids. Monitor and intervene to maintain hydration status.
Overhydration	Rapid refeeding Excessive fluid intake	Use a calorically dense formula. Reduce rate of administration, especially in patients with severe malnutrition or major organ failure.
Hyperglycemia	Inadequate insulin production for the amount of formula being given Metabolic stress Diabetes mellitus	Select low-carbohydrate formula. Initiate feedings at low rate. Monitor blood glucose. Use insulin if necessary.
Hypernatremia	Inadequate fluid intake or excessive losses	Assess fluid and electrolyte status. Increase water intake.
Hyponatremia	Fluid overload Syndrome of inappropriate antidiuretic hormone secretion (SIADH) Excessive GI fluid losses from diarrhea, vomiting Chronic feeding with relatively low-sodium enteral formulas as the sole source of dietary sodium	Assess fluid and electrolyte status. Restrict fluids, if necessary. Use diuretics, if necessary. Use a rehydration solution such as EquaLYTE Enteral Rehydration Use solution to replace water and electrolytes. Supplement sodium intake, if necessary.
Hypophosphatemia	Aggressive refeeding of malnourished patients Insulin therapy	Monitor serum levels. Replenish phosphorus levels before refeeding.
Hypercapnia	Excessive carbohydrate loads given patients with respiratory dysfunction and CO_2 retention	Select low-carbohydrate, high-fat formula.
Hypokalemia	Aggressive refeeding of malnourished patient	Monitor serum levels. Provide adequate potassium.
Hyperkalemia	Excessive potassium intake Decreased excretion	Reduce potassium intake. Monitor serum levels.

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be withheld for 1 hour before and after warfarin administration to prevent enteral nutrition–associated warfarin resistance (Dickerson and colleagues, 2008).

WHAT ARE GUIDELINES FOR DELIVERY OF PARENTERAL NUTRITION?

A short-term use of nutritional support may be with **peripheral parenteral nutrition (PPN).** This involves intravenous dextrose (a 5% sugar solution—D5W—delivered into a vein of the arm). It is used in addition to oral intake and is often used in conjunction with the delivery of a saline solution to treat dehydration. It can provide only minimal amounts of nutrition because the route of access is a small vein. The maximum osmolarity or concentration of the formula that can be delivered is 900 mOsm. With new technology the PPN line may stay in place up to 3 to 6 weeks if positioned accurately with an extended-dwell catheter (advanced 5 to 7 inches through an appropriate-size vein).

The most complex form of nutritional support is **total parenteral nutrition (TPN).** This form of nutritional support involves feeding complete nutritional needs through large central veins. Such a line may be fed into the carotid artery and fed into the superior vena cava near the heart. For long-term placements, procedures have been developed with a tunnel catheter. One placement is through the subclavian vein, with the catheter then being fed into the superior vena cava. Another option is the **peripherally inserted central catheter (PICC) line** that is inserted into a vein in the arm and then fed into the superior vena cava. A person receiving TPN sometimes is still able to eat or may do so in the transition to an oral diet.

The TPN solution consists of dextrose monohydrate in water, such as D50W or D70W. D50W stands for 50% dextrose in water; however, the final concentration going through the vein is 25% to 35%. The American Society for Parenteral and Enteral Nutrition (ASPEN) has published guidelines for "Safe Practices for Parenteral Nutrition." One guideline is to order amounts of macronutrients needed (i.e., grams of carbohydrates, protein, and fat) rather than percentage (e.g., 20% dextrose) (Seres and colleagues, 2006).

A protein solution—and vitamins, minerals, and trace elements in liquid form—is also provided with the dextrose on a daily basis. The protein source is amino acids. The supplementation of intravenous amino acid glutamine in critically ill patients on total parenteral nutrition is currently the standard of care (Wernerman, 2008). Fat emulsions are generally given about twice a week or daily to provide essential fatty acids and supplement the kcalories provided by carbohydrate (dextrose) and protein (amino acids). Olive oil as the lipid emulsion used in parenteral nutrition for premature infants appears to have a neutral effect on inflammatory response compared with soybean oil (Gawecka and colleagues, 2008). Whether using enteral nutrition or parenteral nutrition, most patients should receive intravenous selenium and may also need zinc and copper supplementation (Davies, 2007).

HOW IS NUTRITION SUPPORT MONITORED?

Monitoring for medical complications such as **phlebitis** (inflammation of a vein) is needed with use of PPN. The nursing staff is called on to pay strict attention to the care of the TPN catheter, using aseptic techniques, to avoid sepsis at the site of the catheter, which is one of the more common problems associated with TPN.

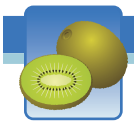
For long-term parenteral feeding, issues of nutritional deficiencies can occur. Parenteral multivitamin supplements are available. Persons receiving TPN need to have essential trace minerals with chromium, copper, manganese, and zinc being advised at a minimum. Trace-metal monitoring is critical in infants and those on long-term TPN to prevent deficiency or toxicity. High losses through excretion should be minimized by infusing micronutrients slowly, over as long a period as possible. To avoid interactions, it would be ideal to infuse trace elements and vitamins separately: the trace elements over an initial 12-hour period and the vitamins over the next 12-hour period (Berger and Shenkin, 2006).

One complication of long-term TPN is liver damage, which develops in about one half of infants who require long-term TPN for intestinal failure and 15% to 40% of adults on home parenteral nutrition. Lipid emulsions, choline deficiency, manganese toxicity, and sepsis are associated (Kelly, 2006). Provision of excess calories in the TPN solution, along with lipids administered greater than 1 g/kg are thought to increase the risk of parenteral nutrition–related liver disease (Raman and Allard, 2007). Neonates who developed **cholestasis** (reduced bile flow) were found to be more immature, had lower birth weight, were exposed to parenteral nutrition for a longer period, had a higher cumulative dose of amino acids, and had no enteral nutrition by 1 week of age (Steinbach and colleagues, 2008).

Liver disease associated with long-term TPN is reduced or less severe in persons who also are receiving oral feeding (Guglielmi and colleagues, 2006). Cyclical rather than continuous parenteral feeding also may be beneficial (Lloyd and Gabe, 2007).

Premature infants are at particular risk of aluminum toxicity with current parenteral nutrition solutions providing excess amounts of aluminum. Only those persons weighing over 110 lb are able to avoid excess intake of aluminum through current TPN commercial solutions. Health care professionals should be reviewing nutritional content of parenteral solutions to minimize aluminum toxicity to help maintain health of the central nervous system and bone (Poole and colleagues, 2008).

Excess of trace minerals also may occur with long-term use of commercial nutritional support products. Excessive manganese accumulation in the central nervous system can lead to the clinical condition known as manganism. It resembles Parkinson's disease with adverse neurologic effects found both in laboratory animals and humans. Parenterally fed neonates may be exposed to excessive amounts of manganese in parenteral nutrition solutions (Aschner and Aschner, 2005). Autopsies after long-term TPN use (average 14 years) found major elevations of manganese, copper, and chromium. Reformulation of TPN solutions is advised (Howard and colleagues, 2007).



Cultural Considerations

Home parenteral nutrition has many benefits from fewer line infections and more normal lives. However, having a child at home on home parenteral nutrition is commonly associated with physical and psychologic stresses, including depression, loneliness, and social isolation (Johnson and Sexton, 2006). A nurse who works with such families can play a positive role by assessing coping skills of the family and the child and making referrals as necessary to a mental health professional. ■

WHY ARE FOOD AND DRUG INTERACTIONS CONSIDERED IN THE NUTRITIONAL CARE PLANNING PROCESS?

The health care team must be aware of the many factors that can adversely affect a person's nutritional status, including the effects of drugs on nutrient absorption, excretion, and metabolism, especially when long-term and multiple-drug therapy is necessary. With the vast array of medications used, it is beyond the scope of this text to review specific food-drug interactions. Health care professionals may want to purchase manuals or computer software on food and drug interactions (see Appendix 1 on the Evolve website). Children, elders, chronically ill persons, and those with a marginal or inadequate nutrient intake are most susceptible to drug-induced nutritional deficiencies. A good nutritional status and a nutritious diet can reduce this risk. A proper diet can also reduce the risk of any altered effectiveness of drugs.

Drugs may affect absorption of nutrients by damaging the intestinal lining, by binding with nutrients, or by decreasing the availability of bile acid, which can inhibit absorption of the fat-soluble vitamins. Folate absorption is decreased by the use of the antiinflammatory agent sulfasalazine, but, rather than the use of folate supplements, a varied and adequate diet should be encouraged. Pyridoxine supplementation should be considered in persons with tuberculosis drug therapy including isoniazid (Visser, Texeira-Swiegelaar, and Maartens, 2004).

In the reverse, food, beverages, and some specific nutrients can adversely affect drug action. For example, natural licorice in large quantities can complicate antihypertensive treatment because licorice causes sodium retention with potential for edema and worsening hypertension. Magnesium increases the analgesic effect of morphine (Begon and colleagues, 2002). Although this may be a positive benefit for decreased reliance on morphine, its impact needs to be recognized. Calcium inhibits the action of the antibiotic tetracycline. It is well known that vitamin K reduces the effectiveness of anticoagulants such as Coumadin. It is now advised that vitamin K intake remain stable such that the Coumadin dose can be based on a person's preference and need for vitamin K foods. When Coumadin is initiated in the person who is critically ill, close monitoring of blood coagulation is necessary to avoid fatal hemorrhage regardless of the dose, especially if the individual is vitamin K deficient (Konishi and colleagues, 2004). Cranberry juice has been found to increase the action of Coumadin, and intake may need to be moderated or consistent while the dose that is needed is determined (Grant, 2004). The use of the selective serotonin reuptake inhibitor (SSRI) antidepressants in combination with Coumadin can lead to nongastrointestinal bleeding (Schalekamp and colleagues, 2008).

Certain drugs such as diuretics (medications that cause fluid loss) can deplete potassium (e.g., furosemide [Lasix] and thiazides), and potassium chloride (KCl) is often included therapeutically. An increased intake of high-potassium foods is another means to offset the adverse impact of potassium-depleting diuretics (Box 15-2). Diuretics also can lead to an increased urinary loss of vitamin B_1. Evidence suggests that heart failure can be improved by the additional administration of thiamin. It is advised that older individuals undergoing chronic diuretic therapy should use an oral vitamin B_1 supplement (Suter, 2004).

When a diuretic and digitalis are given together, hypokalemia and hypomagnesemia may result and digitalis toxicity must be guarded against. An important aspect

Box 15-2 Foods High in Potassium

VERY HIGH POTASSIUM SOURCES (>300 MG POTASSIUM)	MODERATELY HIGH POTASSIUM SOURCES (>200 MG POTASSIUM)
Milk, 1 c	Grapefruit, 1 whole
Yogurt, 1 c	Oranges, 1 whole or 4 oz juice
Apricots, 3 whole or 6 halves	Green beans, 1 c
Banana, 1 small	Tomato, 1 whole or ½ c juice
Broccoli, 1 stalk or 1 c cooked	Peanut butter, 2 tbsp
Cantaloupe, 1 quarter	Molasses, 1 tsp blackstrap or 4 tsp "green label"
Carrots, 1 c cooked	
Potatoes, ½ c	
Spinach, ½ c cooked	
Turnips, 1 c cooked	
Winter squash, ½ baked	
Legumes (dried beans and peas), ½ c cooked	

to remember, however, is that other diuretics such as spironolactone and the newer angiotensin-converting enzyme (ACE) inhibitors (a type of blood pressure medication) are potassium conserving, in which case extra dietary potassium is not necessary and may even create a problem. Salt substitutes containing potassium should be avoided with ACE inhibitors.

Certain drugs bind with enzymes and affect the metabolism of some nutrients. For example, long-term ingestion of pyrimethamine, an antimalarial drug, will likely produce megaloblastic anemia because it antagonizes folacin. Phenobarbital and phenytoin, which are used in the treatment of epilepsy, can increase bone demineralization. Ingestion of adequate dietary vitamin D should be encouraged to promote the absorption of calcium with these medications.

Reduced renal function increases the risk of adverse events from pharmaceutical medications. This is due, in part, to reduced renal clearance, allowing medications to remain in the body longer. This is observed with individuals with diabetes on insulin. The complication of renal disease may have been promoted by chronic hyperglycemia. Once renal disease develops, hypoglycemia may become problematic. The person in the situation initially may be relieved to have hyperglycemia under control and may even think he or she has been cured of diabetes. However, the lowered blood glucose level is likely due to retention of insulin in the system.

A study of renal function found almost half of older persons with hypertension or diabetes and over half of those with coronary artery disease or congestive heart failure have renal impairment (Joseph, Koka, and Aronow, 2008). With renal impairment, intake of vitamin A via a multivitamin can lead to hypercalcemia. One case study of an 86-year-old woman who had consumed up to 3600 International Units of retinol palmitate presented with anorexia, thirst, and **nycturia** (the condition in which the voiding of urine is greater at night than during the day). Laboratory results

revealed hypercalcemia, elevated serum vitamin A, and renal failure. The hypercalcemia caused by chronic vitamin A ingestion is due to the promotion of calcium loss from bone associated with retinol metabolites (Beijer and Planken, 2001). Excess vitamin A levels reduce bone mineral density, leading to an increased risk for fracture (Jackson and Sheehan, 2005).

Improved immunity develops with normal serum zinc concentrations. In nursing home elderly a decreased incidence and duration of pneumonia, a decreased number of new antibiotic prescriptions, and a decrease in the days of antibiotic use were associated with normal zinc status. Zinc supplementation may be required to raise deficient levels of zinc (Meydani and colleagues, 2007).

Other immunity factors include vitamin D and L-arginine, the precursor of nitric oxide. Vitamin D and L-arginine are now recognized as antibacterial agents and may help reduce infection and improve response in drug-resistant tuberculosis (Ralph, Kelly, and Anstey, 2008).

Vitamin D needs are generally not met by long-term care residents. A number of studies have been conducted to determine optimal dosing of vitamin D. Nursing home residents in the highest vitamin D group (800 International Units) had a lower number of falls over 5 months than those taking lower doses (Broe and colleagues, 2007). This effect of vitamin D is attributed to improved neuromuscular function.

Research conducted in both Canada and the United States supports the need for older persons living in long-term care facilities to have a minimum daily supplement of 800 International Units of vitamin D (Lister, 2008). Some advise physicians to consider prescribing at least 2000 International Units of vitamin D per day to all elderly persons (Cherniack, Levis, and Troen, 2008). The average increase in 25(OH)D level per 100 International Units of vitamin D_3 in a 70-kg resident was found to be 2.1 ng/mL versus 1.8 ng/mL for vitamin D_2 with optimal levels being over 30 ng/mL (Drinka and colleagues, 2007).

Concerns about vitamin D toxicity have limited recommendations for increased vitamin D intake. Research is now being aimed at this issue. In a 28-week protocol, doses of vitamin D_3 from 4000 to 40,000 International Units daily resulted in the level of 25(OH)D rising to 386 +/- 157 nmol/L without eliciting hypercalcemia or hypercalciuria (Kimball and colleagues, 2007). Two case studies indicate safety with massive amounts of vitamin D. One individual took 4000 International Units of vitamin D daily, and serum 25(OH)D concentrations averaged 130 nmol/L with optimal level greater than 80 nmol/L (a different method of measurement of vitamin D status). This individual then increased intake to 80,000 International Units of vitamin D_3 daily with average serum 25(OH)D concentrations of 260 nmol/L, and no hypercalcemia or hypercalciuria developed over the 6 years of vitamin D_3 intake. The second individual was a 39-year-old man diagnosed with multiple sclerosis. He initiated his own increasing dose. His vitamin D_3 intake increased from 80,000 to 880,000 International Units/day over 4 years. The first evidence of a potential adverse effect was that urinary calcium to creatinine ratios showed an increasing trend, which preceded his development of hypercalcemia. His serum 25(OH)D concentration was 1126 nmol/L. After he discontinued the vitamin D_3 supplementation, serum 25(OH)D concentrations fell by about one half (Kimball and Vieth, 2008).

HERBAL MEDICATIONS

Many individuals are turning to herbal medications as a presumed safe alternative. What many fail to realize is that many pharmaceutical medications are based on natural substances found in the environment. Toxic alkaloids may be found in some naturally growing plant material. For example, the wild plant that was introduced from Asia, jimson weed, has been used in recent years as a hallucinogen, but, because all parts of this plant are poisonous, its use has resulted in hospitalization with some users going into a coma or having renal damage.

The National Registry of Drug-Induced Ocular Side Effects received over 250 reports of side effects from a number of herbs and vitamins. Over 60 case reports were noted in the literature. These included canthaxanthin as used in tanning products, which can cause retinopathy; and chamomile, *Echinacea purpurea, Ginkgo biloba,* licorice, niacin, and vitamin A, all of which are associated with clinically significant ocular side effects (Fraunfelder, 2004).

The herb butterbur naturally contains toxic alkaloids. It is widely used in Germany (known there as petasites) and has shown antiinflammatory actions because it inhibits the synthesis of leukotrienes and antispasmodic properties through its role in decreasing intracellular calcium levels. With current extraction processes of the active ingredient, the toxic alkaloids of this plant have been found to be low with minimal risk of hepatotoxicity (Kalin, 2003). Use of wild butterbur should be avoided.

Teaching Pearl

You might remind an individual who believes "all natural" ingredients are risk free that poison ivy is all natural. ■

WHAT IS PALLIATIVE CARE?

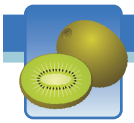
The provision of high-quality palliative care (noncurative care) is the essence of long-term care medicine (Winn and Dentino, 2005). Treatment goals change as desired by the resident and/or family via the individual who has been designated as the health care proxy. Such changes may entail stopping of medications, no tube feeding, and discontinuing weight monitoring. The focus may be shifted to a consumption of balanced meals and appropriate food consistency rather than diet restrictions. Honoring resident preferences is vital.

HOSPICE

Hospice programs offer supportive services for terminally ill individuals and their families. There is medical, nursing, spiritual, and social work support. Palliative care and support are the primary goals of hospice care. The services may be provided in an institutional setting or based at home. Services are offered if a person has less than 6 months to live; family support can continue for 1 year after the family member's death. The hospice movement is probably the best example of the change in attitude toward the **holistic** approach (one that takes into account all aspects of a

person's health, such as emotional and spiritual needs, in addition to medical and nutritional needs).

In providing services for terminally ill persons, emphasizing quality and not quantity of life, hospice has embraced the view espoused by Dr. Elisabeth Kübler-Ross that death is an integral part of life. Kübler-Ross was a pioneer in recognizing that terminally ill individuals and their families go through five stages of grief, which include denial, anger, bargaining, depression, and acceptance. Nutritional goals promote palliative care of the patient as opposed to a curative approach. Therapeutic dietary restrictions are usually discontinued in order to offer the widest selection of foods to promote comfort and well-being. Nutritional needs take second place to enjoyment of eating. If a terminally ill person chooses not to eat, he or she should never be forced to do so. However, if a family member is in denial of the impending death, modifications to the patient's usual diet may not be readily accepted.



Cultural Considerations

Working in a health care setting is often not conducive to good nutritional status for the nurse or other health care professional. Families of residents often bring boxes of chocolate or other treats to show appreciation. In the offices of health care providers, pharmaceutical representatives tend to bring foods that may not have been properly refrigerated, increasing the risk of food poisoning. Limited mealtimes can occur because of acute care concerns of residents or in office settings. It is especially important that the nurse providing medications be adequately nourished for optimal brain function in calculating doses and for increased awareness of actions. ■

WHAT IS THE ROLE OF THE NURSE AND OTHER HEALTH CARE PROFESSIONALS IN PROMOTING NUTRITIONAL CARE IN THE HEALTH CARE SETTING?

Whenever possible, the nurse or other health care professional can assess a person's need and benefit by seeking a thorough medical nutrition therapy consult with a registered dietitian. Once a need is identified, such as with uncontrolled diabetes, an in-house referral to a staff dietitian can be made. Nurses or other health care professionals working in a physician's office or other setting can encourage a consult or referral. A comment that has shown effectiveness in motivating a person to seek MNT from a registered dietitian is to say, "It is your right to have a nutrition consult." This allows a positive focus rather than what is often perceived by the general public to be a potentially negative experience to see an RD. Many insurance companies now cover the services of a registered dietitian because of the demonstrated positive outcomes of MNT as provided by an RD. The WAVE (Weight, Activity, Variety, and Excess) pocket guide was developed by RDs to serve as a quick method to facilitate appropriate referral for medical nutrition therapy that can be readily incorporated into practice settings (see Appendix 1 on the Evolve website).

The nurse also can reinforce positive nutritional messages. To be successful in helping an individual accept a certain dietary regimen for the goal of prevention, the nurse or other health care professional must display warmth and understanding, establish a rapport, and have a positive perspective. Acknowledging the strengths in the person's dietary history is helpful. For example, if breakfast is routinely

consumed and a variety of foods from the food groups of the MyPyramid are included over the course of the day, the nurse or other health care professional can build on those important features in the meal pattern and compliment the individual's efforts in making good food choices. Specific problems can be focused on, making it easier to attain realistic goals, such as eating low-salt snacks versus salty ones. Repeated counseling sessions may be necessary for the development of permanent behavioral modification. It is critical for any health care professional to be well informed before appropriate nutritional guidance can be provided. The role of the health care professional is to be positive and supportive in the context of the total health care team.

Helping to identify persons at high nutritional risk is a critical role of all health care professionals. This includes measuring heights and weights, rather than using verbal statements from an individual. Being aware of how a person may benefit from medical nutrition therapy based on clinical or laboratory problems is important to determining who would benefit with comprehensive MNT consultation. In a hospital setting or long-term care setting the nurse or other nursing staff serve as the eyes and ears to alert the staff RD of issues such as noncompliance to diet order or poor acceptance of nutritional supplements or other issues that may adversely affect a person's nutritional status and general well-being. The health care team can be extremely effective in facilitating a person's health and well-being when all members of the team are working in a coordinated, and documented, manner.

Chapter Challenge Questions & Classroom Activities

1. Identify local RDs in private practice and interview them regarding insurance coverage and their particular expertise.
2. Calculate expected fluid needs for a man who is 6′2″ and weighs 275 lb based on actual body weight and adjusted body weight; what is his BMI?
3. List three possible reasons a person may develop diarrhea while receiving tube feeding; what solutions might be helpful?
4. Interview a local hospital RD; identify hospital diets used in the facility
5. Visit a local long-term care facility; brainstorm ideas on how to encourage fluid intake.

Case Study

She recognized the voices of her family. She felt her current husband holding her hand; he had been through this before. She heard her son tell the hospice person he wanted more tests done. He was speaking louder than he normally did, as he got a few more cookies and a glass of punch from the hospital cart the staff had brought for the family. He wanted to ask the doctor if his mother's sepsis could be managed with antibiotics and should they consider tube-feeding. His wife was gently telling him that Nanna had always said she didn't want any heroic efforts when the time came. The form had previously been signed for no tube feeding, and she wasn't eating or drinking enough to live much longer. Her oldest grandson was asking if they should arrange a priest. Her granddaughter was comforting the great-grandchildren, telling them stories of how wonderful it was growing up with Nanna as a grandmother. Nanna smiled to herself. She was ready. She just needed to hear her son say he was ready to let her go.

She thought back to her arrival at Ellis Island after the long boat trip. She had been a young girl, but she remembered. She had been born before the war, and they arrived in America just before the Great Depression. Her family hadn't suffered too badly because her father was a stone mason in the city. Her mother cooked all the time. Having grown up eating beans helped them through the tough times when meat was too expensive to buy. She had raised a good family despite her husband, Joseph Bernardo, dying on D-Day. That was so long ago. She had dealt with the grief of losing her husband and having to raise her son on her own. They both had developed diabetes, and she had tried to have the whole family eat smaller portions and lots of vegetables as she had done as a young child in Italy. And then the stroke. How awful it was not to be able to speak and say what she wanted or needed.

She wished she could have seen her youngest grandson get married. But there were too many wars. She just wanted to remember the good times and was glad to hear the youngest children in the room laughing because they didn't understand death. She felt her son kiss her cheek as she began to let go of life.

Critical Thinking Applications

1. Describe the stages of grief Nanna's family is experiencing.
2. What might a nurse do for the family; for Nanna?
3. How might hospice have been helpful to this family?
4. Discuss as a class beliefs and opinions regarding the use of tube feeding at the end of life; how would students feel if Nanna's family wanted enteral nutrition, and what might they say to her family?
5. Using the following form, write a sample nutrition care plan stating one problem and goal, and the measureable objectives for Nanna that may have been done in this scenario.

Nutritional Assessment and Care Plan

Nutritional Problem:

Nutritional Goal:

Nutritional Objectives:

REFERENCES

Adeleye B, Rachal C: Comparison of the rheological properties of ready-to-serve and powdered instant food-thickened beverages at different temperatures for dysphagic patients, *J Am Diet Assoc* 107(7):1176-1182, 2007.

Aiko S, Yoshizumi Y, Ishizuka T, Horio T, Sakano T, Kumano I, Kanai N, Maehara T: Enteral immuno-enhanced diets with arginine are safe and beneficial for patients early after esophageal cancer surgery, *Dis Esophagus* 21(7):619-627, 2008.

Akobeng AK: Crohn's disease: current treatment options, *Arch Dis Child* 93(9):787-792, 2008.

Andreelli F, Jacquier D, Troy S: Molecular aspects of insulin therapy in critically ill patients, *Curr Opin Clin Nutr Metab Care* 9(2):124-130, 2006.

Aschner JL, Aschner M: Nutritional aspects of manganese homeostasis, *Mol Aspects Med* 26(4-5):353-362, 2005.

Beale RJ, Sherry T, Lei K, Campbell-Stephen L, McCook J, Smith J, Venetz W, Alteheld B, Stehle P, Schneider H: Early enteral supplementation with key pharmaconutrients improves Sequential Organ Failure Assessment score in critically ill patients with sepsis: outcome of a randomized, controlled, double-blind trial, *Crit Care Med* 36(1):131-144, 2008.

Begon S, Pickering G, Eschalier A, Dubray C: Magnesium increases morphine analgesic effect in different experimental models of pain, *Anesthesiology* 96(3):627-632, 2002.

Beijer C, Planken EV: [Hypercalcemia due to chronic vitamin A use by an elderly patient with renal insufficiency], *Ned Tijdschr Geneeskd* 145(2):90-93, 2001.

Berger MM, Chioléro RL: Antioxidant supplementation in sepsis and systemic inflammatory response syndrome, *Crit Care Med* 35(9 Suppl):S584-S590, 2007.

Berger MM, Shenkin A: Vitamins and trace elements: practical aspects of supplementation, *Nutrition* 22(9):952-955, 2006.

Bhalla K, Ennis DM, Ennis ED: Hypercalcemia caused by iatrogenic hypervitaminosis A, *J Am Diet Assoc* 105(1):119-121, 2005.

Birmingham CL, Puddicombe D, Hlynsky J: Hypomagnesemia during refeeding in anorexia nervosa, *Eat Weight Disord* 9(3):236-237, 2004.

Boullata J, Williams J, Cottrell F, Hudson L, Compher C: Accurate determination of energy needs in hospitalized patients, *J Am Diet Assoc* 107(3):393-401, 2007.

Bowling TE, Cliff B, Wright JW, Blackshaw PE, Perkins AC, Lobo DN: The effects of bolus and continuous nasogastric feeding on gastro-oesophageal reflux and gastric emptying in healthy volunteers: a randomised three-way crossover pilot study, *Clin Nutr* 27(4):608-613, 2008.

Breuillé D, Béchereau F, Buffière C, Denis P, Pouyet C, Obled C: Beneficial effect of amino acid supplementation, especially cysteine, on body nitrogen economy in septic rats, *Clin Nutr* 25(4):634-642, 2006.

Broe KE, Chen TC, Weinberg J, Bischoff-Ferrari HA, Holick MF, Kiel DP: A higher dose of vitamin D reduces the risk of falls in nursing home residents: a randomized, multiple-dose study, *J Am Geriatr Soc* 55(2):234-239, 2007.

Buethe M: C-O-U-N-T C-A-R-B-S: a 10-step guide to teaching carbohydrate counting, *Diabetes Educ* 34(1):67-74, 2008.

Calder PC: Immunonutrition in surgical and critically ill patients, *Br J Nutr* 98(Suppl 1):S133-S139, 2007.

Carrier N, West GE, Ouellet D: Cognitively impaired residents' risk of malnutrition is influenced by foodservice factors in long-term care, *J Nutr Elder* 25(3-4):73-87, 2006.

Chebassier N, El Houssein O, Viegas I, Dreno B: In vitro induction of matrix metalloproteinase-2 and matrix metalloproteinase-9 expression in keratinocytes by boron and manganese, *Exp Dermatol* 13(8):484-490, 2004.

Cherniack EP, Levis S, Troen BR: Hypovitaminosis D: a widespread epidemic, *Geriatrics* 63(4):24-30, 2008.

Cooper MK, Brock DG, McDaniel CM: Interaction between levodopa and enteral nutrition, *Ann Pharmacother* 42(3): 439-442, 2008.

Critchell CD, Savarese V, Callahan A, Aboud C, Jabbour S, Marik P: Accuracy of bedside capillary blood glucose measurements in critically ill patients, *Intensive Care Med* 33(12):2079-2084, 2007.

Crogan NL, Alvine C, Pasvogel A: Improving nutrition care for nursing home residents using the INRx process, *J Nutr Elder* 25(3-4):89-103, 2006.

Dambach B, Salle A, Marteau C, Mouzet JB, Ghali A, Favreau AM, Berrut G, Ritz P: Energy requirements are not greater in elderly patients suffering from pressure ulcers, *J Am Geriatr Soc* 53(3):478-482, 2005.

Davies AR: Practicalities of nutrition support in the intensive care unit, *Curr Opin Clin Nutr Metab Care* 10(3):284-290, 2007.

Desachy A, Clavel M, Vuagnat A, Normand S, Gissot V, François B: Initial efficacy and tolerability of early enteral nutrition with immediate or gradual introduction in intubated patients, *Intensive Care Med* 34(6):1054-1059, 2008.

Desai J, Winter A, Young KW, Greenwood CE: Changes in type of foodservice and dining room environment preferentially benefit institutionalized seniors with low body mass indexes, *J Am Diet Assoc* 107(5):808-814, 2007.

Desneves KJ, Todorovic BE, Cassar A, Crowe TC: Treatment with supplementary arginine, vitamin C and zinc in patients with pressure ulcers: a randomised controlled trial, *Clin Nutr* 24(6):979-987, 2005.

Dickerson RN, Garmon WM, Kuhl DA, Minard G, Brown RO: Vitamin K-independent warfarin resistance after concurrent administration of warfarin and continuous enteral nutrition, *Pharmacotherapy* 28(3):308-313, 2008.

Dinerstein A, Nieto RM, Solana CL, Perez GP, Otheguy LE, Larguia AM: Early and aggressive nutritional strategy (parenteral and enteral) decreases postnatal growth failure in very low birth weight infants, *J Perinatol* 26(7):436-442, 2006.

Drain PK, Baeten JM, Overbaugh J, Wener MH, Bankson DD, Lavreys L, Mandaliya K, Ndinya-Achola JO, McClelland RS: Low serum albumin and the acute phase response predict low serum selenium in HIV-1 infected women, *BMC Infect Dis* 6:85, 2006.

Drinka PJ, Krause PF, Nest LJ, Goodman BM: Determinants of vitamin D levels in nursing home residents, *J Am Med Dir Assoc* 8(2):76-79, 2007.

El Otmani H, El Moutawakil B, Moutaouakil F, Gam I, Rafai MA, Slassi I: [Postoperative dementia: toxicity of nitrous oxide], *Encephale* 33(1):95-97, 2007.

Engelen L, Fontijn-Tekamp A, van der Bilt A: The influence of product and oral characteristics on swallowing, *Arch Oral Biol* 50(8):739-746, 2005.

Fraunfelder FW: Ocular side effects from herbal medicines and nutritional supplements, *Am J Ophthalmol* 138(4):639-647, 2004.

Frias Soriano L, Lage Vazquez MA, Maristany CP, Xandri Graupera JM, Wouters-Wesseling W, Wagenaar L: The effectiveness of oral nutritional supplementation in the healing of pressure ulcers, *J Wound Care* 13(8):319-322, 2004.

Garcia JM, Chambers E IV, Matta Z, Clark M: Serving temperature viscosity measurements of nectar- and honey-thick liquids, *Dysphagia* 23(1):65-75, 2008.

Garcia PC, Longhi F, Branco RG, Piva JP, Lacks D, Tasker RC: Ferritin levels in children with severe sepsis and septic shock, *Acta Paediatr* 96(12):1829-1831, 2007.

Gariballa S: Refeeding syndrome: a potentially fatal condition but remains underdiagnosed and undertreated, *Nutrition* 24(6):604-606, 2008.

Gawecka A, Michalkiewicz J, Kornacka MK, Luckiewicz B, Kubiszewska I: Immunologic properties differ in preterm infants fed olive oil vs soy-based lipid emulsions during parenteral nutrition, *JPEN J Parenter Enteral Nutr* 32(4): 448-453, 2008.

Grant P: Warfarin and cranberry juice: an interaction? *J Heart Valve Dis* 13(1):25-26, 2004.

Grau Carmona T, Rincon Ferrari MD, Garcia Labajo D: Nutritional support in burnt patients, *Nutr Hosp* 20(Suppl 2):44-46, 2005.

Guglielmi FW, Boggio-Bertinet D, Federico A, Forte GB, Guglielmi A, Loguercio C, Mazzuoli S, Merli M, Palmo A, Panella C, Pironi L, Francavilla A: Total parenteral nutrition–related gastroenterological complications, *Dig Liver Dis* 38(9):623-642, 2006.

Harris CL, Fraser C: Malnutrition in the institutionalized elderly: the effects on wound healing, *Ostomy Wound Manage* 50(10):54-63, 2004.

Hess-Fischl A: Practical management of patient with diabetes in critical care: from a diabetes educator's perspective, *Crit Care Nurs Q* 27(2):189-200, 2004.

Hise ME, Halterman K, Gajewski BJ, Parkhurst M, Moncure M, Brown JC: Feeding practices of severely ill intensive care unit patients: an evaluation of energy sources and clinical outcomes, *J Am Diet Assoc* 107(3):458-465, 2007.

Hoane MR, Akstulewicz SL, Toppen J: Treatment with vitamin B_3 improves functional recovery and reduces GFAP expression following traumatic brain injury in rats, *J Neurotrauma* 20(11):1189-1199, 2003.

Hoepffner N, Schroder O, Stein J: Enteral nutrition by endoscopic means. II. Complications and management, *Z Gastroenterol* 42(12):1393-1398, 2004.

Hoher JA, Zimermann Teixeira PJ, Hertz F, da S Moreira J: A comparison between ventilation modes: how does activity level affect energy expenditure estimates? *JPEN J Parenter Enteral Nutr* 32(2):176-183, 2008.

Howard L, Ashley C, Lyon D, Shenkin A: Autopsy tissue trace elements in 8 long-term parenteral nutrition patients who received the current U.S. Food and Drug Administration formulation, *JPEN J Parenter Enteral Nutr* 31(5):388-396, 2007.

Jackson HA, Sheehan AH: Effect of vitamin A on fracture risk, *Ann Pharmacother* 39(12):2086-2090, 2005.

Johnson T, Sexton E: Managing children and adolescents on parenteral nutrition: challenges for the nutritional support team, *Proc Nutr Soc* 65(3):217-221, 2006.

Joseph J, Koka M, Aronow WS: Prevalence of moderate and severe renal insufficiency in older persons with hypertension, diabetes mellitus, coronary artery disease, peripheral arterial disease, ischemic stroke, or congestive heart failure in an academic nursing home, *J Am Med Dir Assoc* 9(4):257-259, 2008.

Kalin P: The common butterbur *(Petasites hybridus)*—portrait of a medicinal herb, *Forsch Komplementarmed Klass Naturheilkd* 10(Suppl 1):41-44, 2003.

Kelly DA: Intestinal failure–associated liver disease: what do we know today? *Gastroenterology* 130(2 Suppl 1):S70-S77, 2006.

Kimball S, Vieth R: Self-prescribed high-dose vitamin D_3: effects on biochemical parameters in two men, *Ann Clin Biochem* 45(Pt 1):106-110, 2008.

Kimball SM, Ursell MR, O'Connor P, Vieth R: Safety of vitamin D_3 in adults with multiple sclerosis, *Am J Clin Nutr* 86(3):645-651, 2007.

Konishi H, Eguchi Y, Fujii M, Saotome T, Sasaki T, Takahashi K, Sudo M, Morii H, Minouchi T, Yamaji A: Unusual hypersensitivity to warfarin in a critically ill patient, *J Clin Pharm Ther* 29(5):485-490, 2004.

Krishnan JA, Parce PB, Martinez A, Diette GB, Brower RG: Caloric intake in medical ICU patients: consistency of care with guidelines and relationship to clinical outcomes, *Chest* 124(1):297-305, 2003.

Kurpad AV: The requirements of protein and amino acid during acute and chronic infections, *Indian J Med Res* 124(2):129-148, 2006.

Lassen K, Kjaeve J, Fetveit T, Tranø G, Sigurdsson HK, Horn A, Revhaug A: Allowing normal food at will after major upper gastrointestinal surgery does not increase morbidity: a randomized multicenter trial, *Ann Surg* 247(5):721-729, 2008.

Levenson CW: Zinc supplementation: neuroprotective or neurotoxic? *Nutr Rev* 63(4):122-125, 2005.

Lim Y, Levy M, Bray TM: Dietary zinc alters early inflammatory responses during cutaneous wound healing in weanling CD-1 mice, *J Nutr* 134(4):811-816, 2004.

Lister T: Should long-term care residents be supplemented with vitamin D? *Can J Diet Pract Res* 69(1):28-31, 2008.

Lloyd DA, Gabe SM: Managing liver dysfunction in parenteral nutrition, *Proc Nutr Soc* 66(4):530-538, 2007.

Lohsiriwat V, Lohsiriwat D, Boonnuch W, Chinswangwatanakul V, Akaraviputh T, Lert-Akayamanee N: Preoperative hypoalbuminemia is a major risk factor for postoperative complications following rectal cancer surgery, *World J Gastroenterol* 14(8):1248-1251, 2008.

MacLaren R, Kiser TH, Fish DN, Wischmeyer PE: Erythromycin vs metoclopramide for facilitating gastric emptying and tolerance to intragastric nutrition in critically ill patients, *JPEN J Parenter Enteral Nutr* 32(4):412-419, 2008.

Macranid, SP, Stegall KL, Trogden S: Clearing obstructed feeding tubes, *JPEN J Parenter Enteral Nutr* 13:81-83, 1989.

Mansoor O, Breuillé D, Béchereau F, Buffière C, Pouyet C, Beaufrère B, Vuichoud J, Van't-Of M, Obled C: Effect of an enteral diet supplemented with a specific blend of amino acid on plasma and muscle protein synthesis in ICU patients, *Clin Nutr* 26(1):30-40, 2007.

Manzanares Castro W: [Selenium in critically ill patients with systemic inflammatory response], *Nutr Hosp* 22(3):295-306, 2007.

Marik PE, Zaloga GP: Immunonutrition in critically ill patients: a systematic review and analysis of the literature, *Intensive Care Med* 34(11):1980-1990, 2008.

Matta Z, Chambers E IV, Mertz Garcia J, McGowan Helverson JM: Sensory characteristics of beverages prepared with commercial thickeners used for dysphagia diets, *J Am Diet Assoc* 106(7):1049-1054, 2006.

Meltzer JS, Moitra VK: The nutritional and metabolic support of heart failure in the intensive care unit, *Care* 11(2):140-146, 2008.

Meydani SN, Barnett JB, Dallal GE, Fine BC, Jacques PF, Leka LS, Hamer DH: Serum zinc and pneumonia in nursing home elderly, *Am J Clin Nutr* 86(4):1167-1173, 2007.

Miller SJ: Death resulting from overzealous total parenteral nutrition: the refeeding syndrome revisited, *Nutr Clin Pract* 23(2):166-171, 2008.

Moro N, Katayama Y, Igarashi T, Mori T, Kawamata T, Kojima J: Hyponatremia in patients with traumatic brain injury: incidence, mechanism, and response to sodium supplementation or retention therapy with hydrocortisone, *Surg Neurol* 68(4):387-393, 2007.

Nelson JM, Bednarczyk R, Nadle J, Clogher P, Gillespie J, Daniels A, Plantenga M, Ingram A, Edge K, Furuno JP, Scallan E: FoodNet Emerging Infections Program Working Group: FoodNet survey of food use and practices in long-term care facilities, *J Food Prot* 71(2):365-372, 2008.

Nishiwaki S, Araki H, Goto N, Niwa Y, Kubota M, Iwashita M, Onogi N, Hatakeyama H, Hayashi T, Maeda T, Saitoh K: Clinical analysis of gastroesophageal reflux after PEG, *Gastrointest Endosc* 64(6):890-896, 2006.

Oliver A, Allen KR, Taylor J: Trace element concentrations in patients on home enteral feeding: two cases of severe copper deficiency, *Ann Clin Biochem* 42(Pt 2):136-140, 2005.

Poole RL, Hintz SR, Mackenzie NI, Kerner JA Jr: Aluminum exposure from pediatric parenteral nutrition: meeting the new FDA regulation, *JPEN J Parenter Enteral Nutr* 32(3):242-246, 2008.

Premji SS, Fenton TR, Sauve RS: Higher versus lower protein intake in formula-fed low birth weight infants, *Cochrane Database Syst Rev* (1):CD003959, 2006.

Raffoul W, Far MS, Cayeux MC, Berger MM: Nutritional status and food intake in nine patients with chronic low-limb ulcers and pressure ulcers: importance of oral supplements, *Nutrition* 22(1):82-88, 2006.

Ralph AP, Kelly PM, Anstey NM: L-Arginine and vitamin D: novel adjunctive immunotherapies in tuberculosis, *Trends Microbiol* 16(7):336-344, 2008.

Raman M, Allard JP: Parenteral nutrition related hepatobiliary disease in adults, *Appl Physiol Nutr Metab* 32(4):646-654, 2007.

Rodríguez G, Moreno LA, Sarría A, Fleta J, Bueno M: Resting energy expenditure in children and adolescents: agreement between calorimetry and prediction equations, *Clin Nutr* 21(3):255-260, 2002.

Russell LB, Valiyeva E, Roman SH, Pogach LM, Suh DC, Safford MM: Hospitalizations, nursing home admissions, and deaths attributable to diabetes, *Diabetes Care* 28(7):1611-1617, 2005.

Schalekamp T, Klungel OH, Souverein PC, de Boer A: Increased bleeding risk with concurrent use of selective serotonin reuptake inhibitors and coumarins, *Arch Intern Med* 168(2):180-185, 2008.

Segura Matute S, Balaguer Gargallo M, Cambra Lasaosa FJ, Zambudio Sert S, Martín Rodrigo JM, Palomeque Rico A: [Fluid and electrolyte disorders following surgery for brain tumors], *An Pediatr (Barc)* 67(3):225-230, 2007.

Seres D, Sacks GS, Pedersen CA, Canada TW, Johnson D, Kumpf V, Guenter P, Petersen C, Mirtallo J: Parenteral nutrition safe practices: results of the 2003 American Society for Parenteral and Enteral Nutrition Survey, *JPEN J Parenter Enteral Nutr* 30(3):259-265, 2006.

Silk DB: Formulation of enteral diets for use in jejunal enteral feeding, *Proc Nutr Soc* 67(3):270-272, 2008.

Simmons SF, Keeler E, Zhuo X, Hickey KA, Sato HW, Schnelle JF: Prevention of unintentional weight loss in nursing home residents: a controlled trial of feeding assistance, *J Am Geriatr Soc* 56(8):1466-1473, 2008.

Simmons SF, Schnelle JF: Feeding assistance needs of long-stay nursing home residents and staff time to provide care, *J Am Geriatr Soc* 54(6):919-924, 2006.

Stacewicz-Sapuntzakis M, Bowen PE, Hussain EA, Damayanti-Wood BI, Farnsworth NR: Chemical composition and potential health effects of prunes: a functional food? *Crit Rev Food Sci Nutr* 41(4):251-286, 2001.

Stechmiller JK, Langkamp-Henken B, Childress B, Herrlinger-Garcia KA, Hudgens J, Tian L, Percival SS, Steele R: Arginine supplementation does not enhance serum nitric oxide levels in elderly nursing home residents with pressure ulcers, *Biol Res Nurs* 6(4):289-299, 2005.

Steinbach M, Clark RH, Kelleher AS, Flores C, White R, Chace DH, Spitzer AR; Pediatrix Amino-Acid Study Group: Demographic and nutritional factors associated with prolonged cholestatic jaundice in the premature infant, *J Perinatol* 28(2):129-135, 2008.

Stucky CC, Moncure M, Hise M, Gossage CM, Northrop D: How accurate are resting energy expenditure prediction equations in obese trauma and burn patients? *JPEN J Parenter Enteral Nutr* 32(4):420-426, 2008.

Sturtzel B, Elmadfa I: Intervention with dietary fiber to treat constipation and reduce laxative use in residents of nursing homes, *Ann Nutr Metab* 52(Suppl 1)5:54-56, 2008.

Suddaby EC, Barnett S, Facteau L: Skin breakdown in acute care pediatrics, *Pediatr Nurs* 31(2):132-138, 148, 2005.

Suman OE, Mlcak RP, Chinkes DL, Herndon DN: Resting energy expenditure in severely burned children: analysis of agreement between indirect calorimetry and prediction equations using the Bland-Altman method, *Burns* 32(3): 335-342, 2006.

Suter PM: Forgotten metabolic side effects of diuretics: lipids, glucose and vitamin B_1 (thiamin) metabolism, *Schweiz Rundsch Med Prax* 93(20):857-863, 2004.

Swift CS, Boucher JL: Nutrition therapy for the hospitalized patient with diabetes, *Endocr Pract* 12(Suppl 3):61-67, 2006.

Takahashi PY, Kiemele LJ, Jones JP Jr: Wound care for elderly patients: advances and clinical applications for practicing physicians, *Mayo Clin Proc* 79(2):260-267, 2004.

Tan JC, Burns DL, Jones HR: Severe ataxia, myelopathy, and peripheral neuropathy due to acquired copper deficiency in a patient with history of gastrectomy, *JPEN J Parenter Enteral Nutr* 30(5):446-450, 2006.

Tepaske R, Binnekade JM, Goedhart PT, Schultz MJ, Vroom MB, Mathus-Vliegen EM: Clinically relevant differences in accuracy of enteral nutrition feeding pump systems, *JPEN J Parenter Enteral Nutr* 30(4):339-343, 2006.

Tong GM, Rude RK: Magnesium deficiency in critical illness, *J Intensive Care Med* 20(1):3-17, 2005.

Van den Berghe G, Wilmer A, Hermans G, Meersseman W, Wouters PJ, Milants I, Van Wijngaerden E, Bobbaers H, Bouillon R: Intensive insulin therapy in the medical ICU, *N Engl J Med* 354(5):449-461, 2006.

van der Bilt A, Engelen L, Abbink J, Pereira LJ: Effects of adding fluids to solid foods on muscle activity and number of chewing cycles, *Eur J Oral Sci* 115(3):198-205, 2007.

van der Riet P, Good P, Higgins I, Sneesby L: Palliative care professionals' perceptions of nutrition and hydration at the end of life, *Int J Palliat Nurs* 14(3):145-151, 2008.

Visser ME, Texeira-Swiegelaar C, Maartens G: The short-term effects of anti-tuberculosis therapy on plasma pyridoxine levels in patients with pulmonary tuberculosis, *Int J Tuberc Lung Dis* 8(2):260-262, 2004.

Voruganti VS, Klein GL, Lu HX, Thomas S, Freeland-Graves JH, Herndon DN: Impaired zinc and copper status in children with burn injuries: need to reassess nutritional requirements, *Burns* 31(6):711-716, 2005.

Wernerman J: Role of glutamine supplementation in critically ill patients, *Curr Opin Anaesthesiol* 21(2):155-159, 2008.

Wilmore D: Enteral and parenteral arginine supplementation to improve medical outcomes in hospitalized patients, *J Nutr* 134(10 Suppl):2863S-2867S, 2004.

Winn PA, Dentino AN: Quality palliative care in long-term care settings, *J Am Med Dir Assoc* 6(3 Suppl):S89-S98, 2005.

Yamashita BD, Sullivan DH, Morley JE, Johnson LE, Barber A, Olson JS, Stevens MR, Reinhart SP, Trotter JP, Olave XE: The GAIN (Geriatric Anorexia Nutrition) Registry: the impact of appetite and weight on mortality in a long-term care population, *J Nutr Health Aging* 6(4):275-281, 2002.

Yan H, Peng X, Huang Y, Zhao M, Li F, Wang P: Effects of early enteral arginine supplementation on resuscitation of severe burn patients, *Burns* 33(2):179-184, 2007.

Yapucu Güneş U, Eşer I: Effectiveness of a honey dressing for healing pressure ulcers, *J Wound Ostomy Continence Nurs* 34(2):184-190, 2007.

Zimmaro Bliss D, Zehrer C, Savik K, Thayer D, Smith G: Incontinence-associated skin damage in nursing home residents: a secondary analysis of a prospective, multicenter study, *Ostomy Wound Manage* 52(12):46-55, 2006.

Glossary

Absorption The passage of liquids and end products of digestion into the villi of the intestine.

Acanthosis nigricans A skin condition related to obesity and the insulin resistance syndrome that gives the skin a velvety texture and brown color; usually found on the back of the neck or in skinfolds such as the armpits.

Acculturation Adopting the culture traits of another group, such as food habits.

Acetylcholine A neurotransmitter.

Achalasia A condition in which the esophagus and gastrointestinal tract fail to relax, causing a feeling of fullness, vomiting, and possible aspiration of esophageal contents into the respiratory passages.

Acid-base balance A state of equilibrium between acidity and alkalinity of body fluids; problems with acidosis or alkalosis are determined by pH and blood gas analysis.

Acquired immunodeficiency syndrome (AIDS) The condition that develops after exposure to the human immunodeficiency virus (HIV); contracted through exposure to body fluids containing the virus; causes destruction of the immune system.

Acrodermatitis enteropathica A genetic disorder of defective zinc uptake with symptoms including pustules on the head, elbows, hands, knees, and feet, also with gastrointestinal involvement such as diarrhea and hair loss.

Acrylamide A newly recognized product caused by high heat on starchy foods.

Active listening A form of communication that uses open-ended questions to help elicit feelings and emotions or more detailed information than can be elicited with "yes" or "no" questions.

Activities of daily living (ADL) Activities that the average person performs routinely during a day.

Addison's disease A syndrome related to inadequate hormone secretion of the adrenal glands; may be associated with fluid and electrolyte imbalance and profound hypoglycemia unless treated with steroids.

Adenosine triphosphate (ATP) The form of energy used by the body cells.

Adequate intake (AI) A term under the umbrella term of Dietary Reference Intake; the level of nutrients presumed to be adequate, but with insufficient research to set a Recommended Dietary Allowance (RDA).

Adipocytokines Inflammatory hormones produced by adipose tissue and related to increased risk of clot formation and free-radical production.

Adipokinin Substance produced by adipose tissue and related to insulin resistance; includes leptin and adiponectin.

Adiponectin An antiinflammatory hormone that helps regulate metabolism; found in reduced quantities with obesity.

Adipose tissue Body fat.

Adrenaline A hormone that works to raise blood sugar levels; also causes increased heart rate. Also called epinephrine.

Adult Treatment Panel (ATP III) The Third Report of the Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults; the panel report sponsored by the National Cholesterol Education Program (NCEP) and the National Heart, Lung, and

Blood Institute (NHLBI) of the National Institutes of Health (NIH).

Advanced glycosylated end products (AGEs) Products formed due to hyperglycemia and related to complications of uncontrolled diabetes.

Aerobic exercise Any form of exercise that requires an increased intake of oxygen such as brisk walking or running.

Affective Pertaining to emotions.

Aflatoxin Toxins formed from fungus or mold; in food, such as nuts, are carcinogenic.

Aging The changes that occur in cellular metabolism related to diminished ability to manufacture new cell growth as related to increasing age.

AIDS enteropathy A condition related to AIDS that causes malabsorption and resultant diarrhea.

AIDS-related complex (ARC) An interim stage between infection with the HIV virus and full-blown AIDS.

Alanine transferase (ALT) A liver enzyme; high levels indicate liver damage.

Albumin A plasma protein responsible for regulating the osmotic force of blood.

Albuminuria A condition of albumin in the urine.

Alimentary enzymes Enzymes in the digestive tract, such as sucrase, lactase, maltase, lipase, and others.

Alkali A chemical substance with a pH greater than 7.

Allergen A substance that induces hypersensitivity.

Alopecia Hair loss.

α-Glucosidase inhibitors A form of medication used in controlling diabetes, interferes with disaccharide digestion; treatment of hypoglycemia using this medication requires a monosaccharide (glucose or fructose).

Alpha-linolenic acid A plant form of omega-3 fatty acid found in flaxseed, canola oil, walnuts, and soybean oil.

Alzheimer's disease An irreversible condition found in aging persons and characterized by intellectual decline, changes in personality, and inability to carry out normal daily activities.

Ambulatory care Health care provided generally in the home or outside of an institution such as a hospital.

Amenorrhea The lack of menses.

American Heart Association (AHA) An organization with headquarters in Dallas with 15 affiliate offices in the United States that promotes health initiatives to lower heart disease.

Amino acids The substances that make protein. Essential amino acids must be supplied by the diet; nonessential amino acids can be synthesized by the body.

Amylase An enzyme that hastens the hydrolysis of starch into sugar.

Amyotrophic lateral sclerosis (ALS) A progressive neurodegenerative disease of the motor neurons ultimately leading to quadriplegia and death usually within 5 years of onset. Also referred to as Lou Gehrig disease; generally develops after age 40 and affects more men than women.

Anabolism The constructive phase of metabolism, resulting in growth and repair; adj. anabolic.

Anaerobic exercise Any exercise that does not increase the intake of oxygen, such as weight lifting.

Anaphylactic shock A condition in which the airways close because of severe inflammation related to an allergic reaction.

Anasarca Generalized massive edema.

Androgens Male hormones such as testosterone.

Anemia A condition of reduced oxygen delivery to body cells.

Anemia of chronic disease A form of anemia related to an inflammatory condition, not treated with iron.

Angiogenesis The production of blood vessels; may be a precursor to cancer development.

Ankyloglossia Referred to as tongue-tie, caused by excess attachment of the tongue to the floor of the mouth, resulting in limited movement of the tongue.

Anorexia A condition of loss of appetite.
Anorexia nervosa A serious chronic condition with severe restriction of food intake unrelated to appetite and refusal to accept a normal weight as desirable; often associated with adolescent girls but also occurs with boys and athletes requiring a low body weight.
Anthropometry The science that deals with body measurements, such as size, weight, and proportion.
Antibodies Substances synthesized in the body that destroy bacteria or antigens.
Antidiuretic hormone A hormone that suppresses the excretion of urine; stored and released by the pituitary gland.
Antigens Substances that react with antibodies or help in the formation of antibodies.
Antioxidants Vitamins and minerals that reduce oxidative injury to body cells; nutrients that decrease the amount of free radicals.
Anuria A condition of lack of urinary excretion.
Aphasia Impaired speech and communication due to brain injury.
Apple shape A term used to describe excess abdominal weight with larger waist than hips or a high waist-to-hip circumference.
Apoptosis Cell death.
Arachidonic acid An essential fatty acid that can be produced if there is adequate linoleic acid in the diet.
Arteriosclerosis The hardening and thickening of the walls of the arteries.
Arthralgia Joint pain.
Arthritis A condition related to inflammation of body joints.
Ascites An accumulation of excess fluids in the abdomen.
Aspiration Inhalation of food or liquid into the lungs; can cause pneumonia.
Asterixis A motor disorder, often related to liver disease, impairing the ability to maintain normal posture due to contraction of muscle groups.
Asthma An inflammatory condition of the lungs.
Ataxia Lack of muscle coordination or irregularity of muscular action.
Atherosclerosis A buildup of plaque inside the arteries and blood vessels that leads to heart disease.
Atonic constipation Reduced bowel movements due to poor muscle tone.
Attention-deficit/hyperactivity disorder (ADHD) The official term of the American Psychiatric Association that relates to a condition generally found in children who have an inability to pay attention and to sustain effort.
Autism A syndrome beginning in infancy characterized by extreme withdrawal from the external environment and an obsessive desire to avoid change; the cause is unknown, and affected children rarely recover.
Autoimmune disease A disease in which the immune system mistakenly attacks healthy tissue.
Autonomic neuropathy Nerve disease of the autonomic or involuntary system, such as the digestive or respiratory system.
Available carbohydrates Forms of carbohydrate that are readily digested and absorbed for use with cellular metabolism.
Azotemia Abnormally increased levels of nitrogen in the blood.
Baby-bottle tooth decay Also known as nursing-bottle mouth, in which the two upper front teeth are decayed because of frequent exposure to sugars found in milk or other beverages.
Baby-led weaning A term used to describe cessation of breastfeeding that is initiated by the infant.
Bariatric surgery Weight loss surgery generally involving formation of a small stomach pouch and bypassing of sections of the small intestines, with reduced absorption.
Barrett's esophagus Stricture of the lower esophagus typically caused by ulceration as induced by acid reflux.

Basal metabolism The lowest level of metabolism to support life; does not take into account physical activity.

Beriberi A deficiency disease caused by lack of thiamin.

Beta-carotene The precursor to vitamin A; found in plant products that are deep orange or dark green and leafy. An antioxidant that is believed to lower the risk of cancer and heart disease.

Beta cells The insulin-producing cells in the islets of Langerhans of the pancreas.

Bifidobacteria A form of bacteria useful in digestion of food and a healthy intestinal tract, also referred to as probiotic.

Biguanide A type of diabetes medication that promotes insulin sensitizing.

Bile A yellow fluid produced by the liver and stored in the gallbladder until needed in the small intestine for digestion of dietary fat.

Biologic value of protein Refers to the amount of essential amino acids in relation to the total quantity of protein. Animal protein sources (meat, eggs, milk) have a high biologic value of protein.

Biopsychosocial The interplay among forces of biology, psychology, and social factors on one's health and health decisions.

Bipolar disorder Formerly called manic depression, a condition marked by alternating periods of depression and mania (elation and agitation).

Bitot's spot A white spot on the eye indicating vitamin A deficiency.

Blood urea nitrogen (BUN) The urea nitrogen concentration found in blood; an indicator of renal functioning.

Body mass index (BMI) Originally called the Quetelet Index, weight in kilograms divided by the square of the height in meters; felt to give a better indicator for appropriate height and weight measures than Metropolitan Life weight charts. Alternative formula weight in lbs divided by height in inches divided again by height in inches and multiplied by 705.

Bone growth Growth of bones both longitudinally and structurally.

Botulism An often fatal form of food poisoning caused by a poisonous endotoxin.

Braden and Norton Scales Tools to assess risk of skin breakdown.

Bulimorexia A condition in which a person vacillates between anorexic and bulimic eating patterns.

Bulimia A condition of overeating, with purging or laxative abuse being common.

Calcium channel blocker A form of blood pressure medication that interferes with cellular uptake of calcium; also used to prevent migraine headaches.

Cancer A condition of rapid abnormal cell growth leading to tumors and death of healthy cells.

Cancer cachexia A condition of malnutrition associated with cancer.

Capillaries The small blood vessels connecting arteries and veins.

Carbohydrate counting A meal-planning strategy used in diabetes management.

Carbohydrate loading A strategy used by athletes to increase the amount of stored glycogen available to the muscles.

Cardiac cachexia A condition of malnutrition related to heart disease.

Cardiomyopathy A general term referring to heart disease.

Cardiovascular disease Disease of the cardiovascular system.

Cariogenic Describing a substance or factor contributing to dental caries.

Carnitine A substance primarily synthesized in the kidneys that has a role in fatty acid oxidation in tissue cells, especially those of cardiac and skeletal muscles.

Carotene Also referred to as beta-carotene; the precursor to vitamin A found in dark green, leafy and deep orange vegetables and fruits.

Casein A form of milk protein.

Catabolism A destructive process that releases energy; adj. catabolic.

Catecholamines May be referred to as stress hormones; include epinephrine and

norepinephrine and cause increased metabolism with rise in heart rate, release of glucose from glycogen stores, and catabolism of fat.

Celiac disease An inflammatory condition of the villi of the small intestine related to gluten or gliadin found in wheat, American oats, rye, barley, and triticale (a new hybrid grain); found more commonly among persons with British heritage.

Cellulose Structural fiber in fruits, vegetables, and grains.

Central obesity A condition of carrying excess weight in the abdominal area; defined as greater than 35 inches for women or 40 inches for men or a waist-to-hip ratio greater than 0.8 for women and 1.0 for men.

Cerebral palsy A motor disorder caused by brain damage beginning in infancy that can involve muscle spasms, uncontrollable movements, or poor balance with a staggering gait.

Cerebrovascular accident (CVA) An embolus or blood clot; often called a stroke.

Certified diabetes educator (CDE) A health professional who has an advanced degree and 2000 hours of direct patient care related to diabetes and who has passed an examination every 5 years or the equivalent continuing education.

Change agent An individual who facilitates the development of positive health behaviors.

Cheilosis A condition characterized by dry, scaly lips and cracks at the corners of the mouth; seen in riboflavin deficiency or vitamin A toxicity.

Chemotherapy A treatment for cancer; the provision of toxic chemicals to the system to destroy cancer cells.

Cholecystectomy Surgical removal of the gallbladder.

Cholecystitis A condition of inflammation of the gallbladder.

Cholecystokinin A hormone believed to be involved with the recognition of satiety.

Cholelithiasis The presence of gallstones.

Cholestasis A condition related to blockage or impaired bile flow.

Cholesterol A fat-related compound that is produced in the livers of animals; found in animal fats but does not provide kilocalories.

Chronic disease A disease that can be managed but cannot be cured.

Chronic kidney disease (CKD) A condition of the kidneys in which they have lost most of their function; also known as chronic renal failure (CRF) or chronic renal insufficiency.

Chronic kidney disease-mineral and bone disorder (CKD-MBD) A newer term related to altered body chemistry found with kidney disease and leading to bone disorders.

Chylomicrons A form of lipoprotein that allows transfer of ingested dietary fats from the small intestine to body tissues.

Chyme The semiliquid form of digested food that passes from the stomach into the duodenum after undergoing the action of gastric juice.

Cirrhosis A disease of the liver often associated with alcoholism.

Class I, II, and III obesity A classification of obesity, with Class I signifying 20% overweight or BMI greater than 30; Class II signifying BMI greater than 35; and Class III signifying BMI greater than 40 and referred to as extreme obesity.

Cleft palate A condition in which there is an opening or hole in the roof of the mouth, sometimes extending to the lip, which needs to be surgically repaired.

Clostridium botulinum A type of bacteria that causes a form of food poisoning that is usually fatal and is related to eating canned foods that were inadequately processed to completely destroy the botulism spore.

Clostridium perfringens A type of bacteria that causes food poisoning.

Cognitive Having to do with cognition or ability of the brain to process information.

Colostrum The nutritious substance that precedes breast milk production in the first few days after delivery.

Commodity Supplemental Food Program (CSFP) A government program designed to provide foods to at-risk populations and help farmers.

Communicable disease Any disease that is contagious.

Complete protein Protein containing all of the essential amino acids.

Congenital diaphragmatic hernia A condition of newborns in which the diaphragm does not fuse adequately, allowing abdominal contents to rise into the chest cavity; may cause severe hypoxia because of the inability for lung expansion, and requires surgical intervention.

Congestive heart failure (CHF) An older term for heart failure.

Conjugated linoleic acid A slightly altered form of the essential fatty acid linoleic acid; made from sunflower oil.

Constipation A condition in which fecal material is too hard to pass easily or in which bowel movements are so infrequent that abdominal discomfort is present.

Continuous ambulatory peritoneal dialysis (CAPD) An alternative form of dialysis used in renal failure to filter toxins from the blood; a dialysis method that a renal patient can do at home in which a dialysate fluid is injected into the abdominal cavity and regularly changed to remove blood toxins.

Coronary heart disease (CHD) A term often used interchangeably with cardiovascular disease; relates directly to the heart.

Coronary thrombosis A condition of severe arteriosclerosis that cuts off blood supply to a part or parts of the heart due to formation of a clot; often fatal.

Cortisol A hormone, produced in the adrenal glands, that works in a manner opposite to the way insulin works; raises blood sugar levels.

Counterregulatory hormones Hormones that work in a manner opposite to the way insulin does; hormones that raise blood sugar levels principally through the release of stored glycogen in the liver or through the inhibition of insulin action.

C-peptide An indirect measure of insulin production.

Craniotabes Reduced mineral deposition in the skull, resulting in soft tissue.

C-reactive protein (CRP) A protein that can be measured through laboratory values that indicate inflammation.

Creatine A substance naturally found in muscle and sometimes used by athletes to maintain higher levels of ATP in body cells.

Creatinine A nitrogen compound used in a laboratory test to indicate renal function.

Cretinism A condition of childhood caused by lack of thyroid gland secretion that leads to a dwarf size and is accompanied by mental retardation and sterility if not treated with thyroid extract for life.

Critical period A term used to describe the first trimester of pregnancy, when organ formation occurs.

Crohn's disease A chronic condition of intermittent inflammation of the terminal portion of the ileum or other portion of the intestinal tract; usually treated with steroids, but attention to good nutrition is important. Also referred to as regional enteritis.

Cutaneous papilloma Also called skin tag. Found with the metabolic syndrome.

Cystic fibrosis A hereditary disease with dysfunction of the exocrine glands resulting in thick mucus and abnormal secretion of sweat and saliva.

Daily Reference Values (DRVs) A system developed for use on food labels to indicate recommended nutrient intakes for 2000 and 2500 kcal; also referred to as Daily Values (DVs).

DASH eating plan (Dietary Approaches to Stop Hypertension) A recommended diet strategy to prevent and manage hypertension.

Dawn phenomenon Early morning phenomenon involving counterregulatory hormones that results in increased blood glucose levels.

Decalcification The condition in which bone and dental tissue lose calcium.
Decubitus ulcer A bed or pressure sore.
Dehydroepiandrosterone (DHEA) An androgen hormone synthesized from cholesterol.
Dementia A state of impaired mental functioning.
Dental caries Tooth decay.
Dental enamel The outside hard protective covering of teeth.
Dental erosion The condition of loss of dental enamel.
Dental plaque A calcified coating on teeth that provides a perfect growing medium for bacteria; plaque needs to be removed regularly to prevent dental decay.
Denver Developmental Screening Test A screening test for young children to assess behavioral and cognitive milestones expected based on age.
Deoxyribonucleic acid (DNA) Part of the genetic material of body cells.
Depapillation The smooth appearance of the papilla (elevations on the surface of the tongue containing taste buds) resulting from vitamin B deficiency.
Dermatitis herpetiformis A skin condition characterized by extreme itching with lesions; found with gluten intolerance and believed to have immunogenic factors as a cause.
Desirable weight A body mass index (BMI) between 20 and 25; or a realistic weight that allows for good health for an individual.
DETERMINE checklist A tool to identify elderly persons who are at nutritional risk.
Development A term used to describe integration of muscles and body functions.
Developmental disability A condition that is related to impaired development that is present before age 21 years.
DXA or DEXA scan Dual energy x-ray absorptiometry; helps determine bone density and risk or presence of osteoporosis.
Diabetes Control and Complications Trial (DCCT) The study conducted by NIH that showed that normalization of blood glucose levels reduces complications 50% to 70%; carbohydrate counting was developed in the study.
Diabetes insipidus A condition related to excess urination because of the inability of kidneys to reabsorb water, resulting in loss of 2 to 10 L of fluids daily.
Diabetes mellitus Literal meaning, "sweet urine"; a condition related to high blood glucose levels.
Diabetic coma A condition of hyperglycemia with ketonuria; usually found in type 1 diabetes. Also referred to as diabetic ketoacidosis.
Diabetic ketoacidosis (DKA) A condition generally of lack of insulin in type 1 diabetes, causing excess body fat to be broken down into ketones, resulting in reduced pH of body fluids; type 2 diabetes can be associated with DKA with extreme stressors such as infection. Treatment needs to be prompt because of inability to exhale carbon dioxide.
Diabetic nephropathy Kidney disease related to uncontrolled diabetes.
Diabetic retinopathy An eye disease found in persons with long-standing diabetes; usually prevented through good diabetes management.
Diarrhea Rapid transit of food matter through the gastrointestinal tract; related to watery stools caused by inadequate absorption of water in the large intestine.
Diastolic blood pressure The lower number of the blood pressure reading; indicates the ability of the blood vessels to relax.
Dietary Approaches to Stop Hypertension (DASH) eating plan See DASH eating plan.
Dietary fiber The form of carbohydrate that is virtually indigestible in the human gastrointestinal tract.
Dietary reference intakes (DRIs) An umbrella term that includes a variety of levels of recommended vitamin and mineral intakes for the goal of optimal intake.
Digestion The breakdown of food matter by mechanical and chemical means to allow for absorption of food nutrients.

Digestive enzymes Protein-based substances that allow digestion of food matter into small particles for absorption through the intestinal tract.

Diglyceride A form of fat with two fatty acids attached to a glycerol base.

Disaccharides Double sugars such as sucrose and lactose.

Distal gastric bypass biliopancreatic diversion (DBP) A form of bariatric surgery.

Diuresis The condition of increased excretion of the urine.

Diuretic A substance that promotes urine secretion.

Diverticulitis A condition of inflammation of the diverticula or outpouchings in the intestinal tract.

Diverticulosis A permanent condition of the intestinal tract characterized by small pockets protruding from the intestinal wall; often associated with advancing age.

Docosahexaenoic acid (DHA) Omega-3 fatty acid.

Dopamine A neurotransmitter of the central nervous system and an intermediary product in the synthesis of norepinephrine.

Down syndrome A congenital condition characterized by physical malformations and some degree of mental retardation; caused by an extra chromosome. Also referred to as trisomy 21 syndrome because of the defect at chromosome 21; formerly referred to as mongolism because persons with this condition have facial characteristics resembling persons of the Mongolian race.

Dumping syndrome A condition characterized by nausea, weakness, sweating, palpitation, fainting, often a warm feeling, and sometimes diarrhea. These symptoms occur after eating in people who have had a partial gastrectomy.

Duodenal switch (DS) A form of bariatric surgery with the DBP surgery.

Duodenum The first portion of the small intestine, about 10 inches long, connecting the pylorus to the jejunum.

Dysgeusia An impaired sense of taste.

Dyslipidemia A condition of elevated triglycerides with low high-density–lipoprotein (HDL) cholesterol levels.

Dyspepsia Impaired digestion related to epigastric discomfort after meals.

Dysphagia A condition of difficulty in swallowing.

Eclampsia A severe condition of pregnancy that may occur a few weeks before or after delivery; characterized by convulsions, hypertension, edema, and proteinuria. This convulsive form of preeclampsia may result in coma, neurologic damage, and death.

Edema A condition of excess fluid buildup in the body.

Edentulous Having no teeth.

Eicosanoids Substances derived from 20-carbon polyunsaturated fatty acids, mainly from arachidonic acid; include prostaglandins, thromboxanes, and leukotrienes.

Eicosapentaenoic acid (EPA) An omega-3 fatty acid.

1800 rule (see 1500 rule).

Electrolyte A mineral that disassociates into ions when fused or in solution so that electricity can be conducted.

Elemental diet A type of diet that relies on commercial liquid supplements used for a variety of reasons such as to rest the gastrointestinal tract in Crohn's disease, for severe food allergies, or for conditions of impaired digestion.

Elemental feeding A complete liquid nutrition supplement that does not require digestion.

Elimination diet A diet that restricts foods to a few that are least likely to cause allergic reactions; used as a test for allergens through the addition of foods one at a time to identify tolerance or intolerance.

Embryo The fertilized ovum during the first 3 months after conception.

Empty kilocalories Foods that provide sugar or fat but few vitamins and minerals and little protein.

Encephalopathy Any degenerative disease of the brain, such as caused by alcoholism or vitamin B_{12} deficiency.

Encopresis Incontinence of fecal material; often caused by a "plug" of solid fecal material that allows liquid fecal material to pass around the solid material.

Endocrine system The glands that secrete hormones directly into the circulation; a major control system of body functioning and metabolism.

Endocrinology The study of hormones.

Endometrial Pertaining to the lining of the uterus.

Endometrial hyperplasia An increase in the thickness of the lining of the uterus.

Endothelial Pertaining to the lining of blood vessels and other sections of the body.

End-stage renal disease (ESRD) A period in which BUN and creatinine levels are very high, with impairment of all body systems. Also known as uremia.

Energy balance The level of energy taken in (kilocalories) that equals that amount of energy expended (basal metabolism plus activity needs).

Enrichment The replacement of nutrients lost in processing.

Enteral nutrition A form of nutrition support usually with liquid nutrition supplements by way of the small intestine.

Enzyme A protein that can hasten or produce a change in a substance.

Epidemiologic research Research based on populations with correlational evidence, not research design based on cause and effect; often used in cancer research.

Epilepsy A group of signs and symptoms related to abnormal electrical activity of the brain resulting in periodic seizure activity.

Epinephrine Also known as adrenaline, a counterregulatory hormone that causes increased heart rate, physical tremors, and increased blood glucose level from breakdown of glycogen stores in the liver and muscles.

Epithelial tissue Pertaining to the cellular covering of the internal and external surfaces of the body.

Ergogenic The term used to describe supplements of vitamins, minerals, amino acids, or other substances touted to build muscle or improve athletic performance.

Ergosterol With ultraviolet rays, produces vitamin D in foods.

Erythrocyte A red blood cell.

Erythropoietin A hormone produced by kidneys and essential for production of red blood cells; commercially produced form is known as epoetin.

Escherichia coli A type of bacteria commonly associated with food poisoning; referred to as *E. coli.*

Esophageal reflux A chronic disease with reflux of the stomach contents; may be associated with hiatal hernia.

Esophageal sphincter The muscular connection between the esophagus and the stomach.

Esophageal varices Enlargement of veins in the esophagus.

Esophagitis Inflammation of the esophagus.

Essential amino acids The substances that are turned into protein that must be supplied in the diet; found in animal protein sources but can be obtained from plant sources with careful food selection.

Essential fatty acids Forms of fat needed for health that must be supplied by the diet; found in vegetable oils.

Estimated average requirements (EARs) A relatively new term used to describe the average amount of nutrients needed to prevent nutrient deficiency.

Estrogen A female sex hormone produced primarily in ovaries, but also in the adrenal glands and testes of males; allows for implantation of a fertilized egg.

Expanded Food and Nutrition Education Program (EFNEP) A program within Cooperative Extension that assists low-income families in food resource management.

Extreme obesity Formerly referred to as morbid obesity; class III obesity.

15:15 rule Treatment and reevaluation of hypoglycemia; treatment with 15 g of

carbohydrates for someone who is still conscious, with a recheck of blood sugar levels in 15 minutes (procedure continues if blood sugar remains low).

1500 rule The mathematical formula used to estimate point drop in blood glucose per one unit of regular insulin; the number 1500 divided by the total amount of insulin units regularly injected. The number 1800 is used if Humalog or Novalog insulin is used.

Fad diet A diet that is not meant to be followed long-term and that usually is imbalanced in nutrient content.

Failure to thrive A medical diagnosis that includes lack of physical growth (below the 3rd percentile for weight and height for age); may be related to maternal deprivation.

Fanconi syndrome An autosomal recessive genetic disorder involving reduced blood constituents, musculoskeletal and urinary tract complications, and patchy brown skin pigmentation due to melanin.

Fat-soluble vitamins The vitamins A, D, E, and K; vitamins that require dietary fat for maximum absorption in the small intestines.

Fatty acids An organic compound of carbon, hydrogen, and oxygen that combines with glycerol to form fat.

Female athlete triad A triad of osteoporosis, amenorrhea, and eating disorders that occurs in some female athletes.

Ferritin A storage form of iron.

Fetal alcohol syndrome A group of signs and symptoms characterized by mental and physical abnormalities of the infant linked to maternal alcohol intake during pregnancy.

Fetus The unborn baby during the second and third trimesters of pregnancy.

Fight BAC! A national public health measure aimed at reducing foodborne illness.

Fixed eruption Skin eruptions that reoccur at the same sites, generally due to use of certain medications.

Flatus Gas from the gastrointestinal tract; mainly produced by intestinal bacteria feeding on undigested dietary fiber.

Fluoride A mineral that promotes uptake of calcium by teeth and bones; currently used as a preventive measure against dental caries.

Food additives Substances added to food for stabilization or to increase shelf life and safety of food.

Food allergens Protein substances in foods that cause an immune-based allergic reaction.

Food allergy An abnormal hypersensitivity reaction to foods containing protein material called allergens.

Food antigens The protein in various foods that are allergenic.

Food distribution system The system in which food is grown, processed, and delivered to individuals.

Food exchange lists A food guide that groups food based on equivalent amounts of carbohydrates, proteins, and fats.

Food fads Diets or supplements designed to provide a "quick fix" that is not based on scientific theory or appropriate meal planning.

Food insecurity Inadequate food availability, usually as a result of inadequate purchasing power.

Food intolerance A nonimmune intolerance to certain foods related to poor digestion or other factors.

Food irradiation A process of radiation used to destroy harmful organisms in food to reduce the likelihood of food poisoning.

Food jags A term applied to childhood eating habits in which a few foods are eaten for days or weeks at a time.

Food quack An untrained person who espouses potentially harmful nutritional practices.

Food resource management The management of food choices and preparation to allow maximum nutrient intake for the least amount of food dollars.

Fore milk Breast milk that is released from the front of the breasts; has a lower fat content than hind milk.

Fortification The addition of nutrients to greater than the natural level found in a food; milk and margarine are often fortified.
Free radicals The remnants left after oxygen is used in metabolism, which can cause cellular damage; also referred to as reactive oxygen species.
Fructose intolerance Inability to absorb fructose.
GAD antibody Glutamic acid decarboxylase antibody associated with the autoimmune destruction of islet cells in the pancreas, found with type 1 diabetes.
Galactocele Milk-filled cyst of the mammary gland.
Galactorrhea Excessive or spontaneous milk flow even without lactation.
Gastrectomy Total or partial removal of the stomach.
Gastric banding A form of weight loss, or bariatric, surgery involving placing a temporary band around the stomach to reduce its ability to expand with eating.
Gastritis Inflammation of the stomach.
Gastroesophageal reflux disease (GERD) Commonly known as heartburn; condition in which stomach acid (HCl) enters the esophagus.
Gastrojejunostomy Surgical formation of a connection of the stomach to the jejunum; also called Billroth II procedure.
Gastroparesis A condition in which autonomic neuropathy of the stomach results in partial paralysis such that digestion and the propulsion of food through the digestive tract are impaired.
Gastrostomy The creation of an opening into the stomach; procedure used for tube feeding.
Gavage feeding A form of feeding by tube.
Generally Recognized as Safe (GRAS) list The list of substances added to foods, such as preservatives and flavorings, that are felt to be generally safe.
Genetically modified foods Foods that have their genes altered to allow for altered characteristics such as pesticide resistance.
Geriatrics The branch of medicine concerned with the treatment and prevention of diseases affecting elderly individuals.
Gerontology The study of the problems of aging.
Gestational Of or related to pregnancy.
Gestational diabetes A form of diabetes occurring during pregnancy, usually beginning between the twenty-fourth and twenty-eighth weeks of gestation.
Gestational hypertension-preeclampsia A condition of pregnancy occurring after the twentieth week of pregnancy that involves hypertension and proteinuria.
Ghrelin An appetite-enhancing hormone produced in the stomach.
Giardia Parasite found in the intestines of animals and humans; transmitted by contaminated water. Infection can cause signs and symptoms suggestive of malabsorption.
Gingiva The part of the oral lining that covers the tooth-bearing border of the jaw; the gums.
Gingival disease Disease of the part of the oral mucosa that surrounds the tooth; also referred to as the gum.
Gingivitis An inflammation of the gums.
Gliadin A component of gluten that needs to be avoided in celiac disease.
Glomerular filtration rate (GFR) Amount of glomerular filtrate in milliliters cleared through the kidneys in 1 minute. Rates less than 60 mL/min indicate that kidney disease may be present; lower rates call for aggressive management.
Glomerulonephritis An inflammatory condition of the capillary loops of the glomeruli of the nephrons.
Glomerulosclerosis Also called nephrosclerosis; hardening of the kidney associated with hypertension.
Glomerulus The main part of the nephron of the kidneys consisting of a small, convoluted mass of capillaries.
Glossitis Inflammation of the tongue.
Glucagon A counterregulatory hormone that is given by injection during severe bouts of

hypoglycemia in an unconscious diabetic person.

Glucocorticoids Any substance that promotes gluconeogenesis and has counterregulatory effects on insulin use; the principal source is cortisol.

Gluconeogenesis The formation of glucose from protein.

Glucose Blood sugar.

Glucose intolerance A condition of hyperglycemia related to carbohydrate intake; associated with prediabetes.

Glutathione (GSH) A naturally produced substance in the body, synthesized from cysteine, glutamate, and glycine; has antioxidant properties and other functions.

Gluten The protein portion of wheat, rye, barley, and triticale (a hybrid grain); complete avoidance is often necessary in the control of celiac disease.

Glycated The process in which glucose attaches to protein throughout body cells.

Glycemia Blood glucose level.

Glycemic index A means of rating food based on predictive impact on blood sugar levels; fats have the lowest glycemic index, and sugars have the highest.

Glycemic load Rapidly absorbed carbohydrates in large quantities per meal or serving.

Glycerol A component of fats.

Glycogen The storage form of carbohydrate found in the liver and muscle tissues; released in the form of sugar as needed for energy or during times of physiologic stress.

Glycogen loading A process by which the glycogen stores in the liver are increased beyond normal levels to allow for the demands for endurance in athletic competition.

Glycogenolysis The breakdown of stored carbohydrate in the liver from glycogen to glucose.

Glycosuria Glucose in the urine; an outdated means of diabetes management; sometimes used for a simple means of diabetes screening.

Goiter A swelling of the thyroid gland on the neck caused by iodine deficiency.

Gout A hereditary form of arthritis in which uric acid is built up in the blood and may be deposited in joints and other tissues; usually treated with medication.

GRAS list Generally Recognized as Safe list; standards for acceptable levels of food additives.

Grazing A manner of continuous eating throughout the day rather than eating three meals.

Growth Related to the increased size of body components such as organs and bones that occurs with adequate intake of food nutrients and kilocalories.

Growth hormone A substance that stimulates growth; works in the opposite manner as insulin to raise blood sugar levels.

Health A relative state that includes physical, mental, social, and spiritual functioning such that an individual can meet his or her full potential.

Health belief model A theory that stresses that an individual's perceived level of health risk and "cost" of behavior change contribute to health decisions.

Health care provider A trained medical professional who can prescribe medications. This includes all medical doctors and, depending on the state license authorization, may include nurse practitioners and physician assistants.

Healthy People 2010 (www.HealthyPeople.gov) A statement of national health goals for which data are collected to measure outcomes of health objectives.

Healthy weight A weight that is healthy for a given individual, which may be higher than standard weight standards.

Heart failure The newer term for congestive heart failure.

Heat exhaustion The condition resulting from excessive loss of body fluids and electrolytes.

HELLP syndrome A condition occurring in 10% of pregnancies with preeclampsia or

eclampsia. H = hemolytic anemia; EL = elevated liver enzymes; LP = low platelet count. Untreated, it causes maternal liver damage.

Hematocrit The volume percentage of red blood cells in whole blood.

Hematuria Blood in the urine.

Heme iron The form of iron found in meat; is readily absorbed.

Hemeralopia Daytime-related blindness.

Hemochromatosis An iron storage disease that can cause liver cirrhosis and a form of diabetes mellitus; may cause bronze skin pigmentation.

Hemodialysis A procedure used to remove toxic wastes from the blood of a patient with acute or chronic renal failure.

Hemoglobin The oxygen-carrying pigment of the blood; the principal protein in the red blood cell.

Hemoglobin A_{1c} (Hgb A_{1c}) A test used to determine long-term diabetes management; indicates an average blood sugar reading over a 3-month time.

Hemorrhage The loss of blood from a ruptured vessel.

Hepatic coma Coma resulting from cerebral damage caused by liver disease.

Hepatitis An inflammatory liver disease that has many forms and causes.

Hiatal hernia Protrusion of part of the stomach through the opening of the esophageal hiatus of the diaphragm.

High–biologic value protein A term used to describe foods that contain all essential amino acids required for liver production of proteins (e.g., animal-based sources such as meat, milk, and eggs).

High-density–lipoprotein cholesterol (HDL-C) The form of cholesterol referred to as "good cholesterol" because its high protein content allows transfer of cholesterol out of the bloodstream.

High glycemic index A food or meal that raises the blood glucose levels rapidly, primarily being a carbohydrate source.

High glycemic load Related to glycemic index, but includes total volume of carbohydrate and the rapid rise of glucose.

Hind milk Milk released from the upper part of the breast in response to the hormone oxytocin; very rich in fat.

Hirsutism A condition in which women have male pattern hair growth or loss; commonly found with hyperinsulinemia.

Histidinemia A hereditary metabolic defect marked by excessive level of the amino acid histidine in the blood and urine.

HMG-CoA reductase The enzyme that allows production of cholesterol by the liver; the statin cholesterol medications are HMG-CoA reductase inhibitors.

Holistic health Having to do with the whole of one's health; considering all factors affecting one's state of health.

Homeostasis The condition in which the body remains at a constant, such as body temperature or blood levels of nutrients and toxins.

Homocysteine A type of protein that is related to cardiovascular risk.

Homocystinuria A lack of enzyme resulting in homocystine in the urine.

Homogenization The process by which fat particles become so finely dispersed that they do not rise in a liquid.

Honeymoon period Usually the first year after diagnosis of type 1 (insulin-dependent) diabetes mellitus; before the complete destruction of the beta cells.

Hormone Chemicals produced by cells of the body to stimulate or retard certain life processes such as growth and reproduction.

Hospices Organizations that support a natural process of death in one's home or in an institutional setting in which death and the grieving process are openly discussed.

Human immunodeficiency virus (HIV) The virus that causes AIDS.

Huntington's disease An autosomal dominant genetic neurodegenerative disorder that leads to choreic movements, nerve damage,

and decline in mental functioning. The children of a person with Huntington's disease have a 50% chance of inheriting this disease. Age of onset varies with the number of repeat Huntington's genes, with high number of repeat genes associated with onset at a younger age, potentially in childhood, and low numbers with age of onset as late as 80 years. Most persons with Huntington's disease have onset of symptoms in their 40s. Everyone has the Huntington's gene (CAG repeats); those with up to the mid-30s repeats of CAG remain symptom free.

Hydrogenated fat A liquid vegetable oil that has the element hydrogen added to make a solid fat.

Hydrolysis The chemical reaction of cellular metabolism involving the addition of water to larger water-based molecules to make them available for cell function.

Hyperalimentation Administration of all nutrients directly into the blood system. Also referred to as total parenteral nutrition (TPN).

Hyperbilirubinemia A condition of high bilirubin levels in the blood.

Hypercalcemia An excess of calcium in the blood.

Hypercalciuria An excess of calcium in the urine.

Hyperchlorhydria An excess of hydrochloric acid in gastric juice.

Hypercholesterolemia An elevation of cholesterol in the blood.

Hyperemesis A condition of excessive vomiting.

Hyperglycemia An elevation of glucose in the blood.

Hyperglycemic, hyperosmolar nonketotic (HHNK) syndrome A condition often associated with diabetes in an older person; blood sugar levels in the 500 mg/dL range or higher, with severe dehydration and confusion evident, may lead to coma.

Hyperhomocysteinemia Excess homocysteine (a protein) in the blood; linked with cardiovascular disease and other health conditions.

Hyperinsulinemia High levels of insulin in the blood; often associated with obesity and insulin resistance.

Hyperkalemia High serum (blood) potassium level.

Hyperkinesis Abnormally increased motor activity or movement.

Hyperlipidemia An elevation of specific lipoproteins, cholesterol, and triglycerides.

Hyperlipoproteinemia An excess of lipoproteins in the blood.

Hyperosmotic diarrhea A type of diarrhea caused by a high solute load that draws excess water into the intestinal tract.

Hyperparathyroidism Abnormally increased activity of the parathyroid gland.

Hyperphagia An increased hunger.

Hyperplasty A term related to the fat cell theory; a situation in which a person has an excess number of fat cells.

Hypertension High blood pressure.

Hypertriglyceridemia High levels of triglycerides in the blood; often associated with excess alcohol intake or the insulin resistance syndrome.

Hypertrophy A term related to the fat cell theory; a situation in which a person has large fat cells.

Hypoalbuminemia Abnormally low levels of albumin in the blood.

Hypocalcemia Low serum calcium levels.

Hypochlorhydria A deficiency of hydrochloric acid in gastric juice.

Hypocholesterolemia A condition of low cholesterol levels that may be related to underlying disease; defined as total cholesterol level less than 160 mg/dL.

Hypochromic A lack of color in red blood cells as a result of decrease in hemoglobin.

Hypocupremia Low copper levels in the blood.

Hypoglycemia A condition of low blood glucose level; defined as blood glucose level less than 70 mg/dL.

Hypoglycemic unawareness Low blood sugar level without symptoms; generally occurs after years of uncontrolled diabetes.
Hypokalemia Low serum potassium level.
Hyponatremia Low level of serum sodium.
Hypoparathyroidism A condition of greatly reduced functioning of the parathyroid glands.
Hypotension Low blood pressure.
Hypothalamus A portion of the thalamus that promotes release or inhibition of pituitary hormones related to the metabolism of carbohydrates, proteins, and fats and to other functions.
Hypothyroidism A condition of underfunctioning of the thyroid gland; generally treated with oral intake of the thyroid hormone, such as Synthroid.
Hypovitaminosis D A condition of vitamin D deficiency.
Ideal body weight (IBW) Generally equates to a body mass index of 19 to 25. For a person with extreme obesity, IBW equates to a lower weight that can be achieved realistically and can be maintained. The higher range is optimal for the elder population.
IgE antibody The immune factor related to food and other allergies.
Ileum The lower part of the small intestine.
Immunoglobulin A (IgA) Known to have antiviral properties; produced in nonvascular fluids such as saliva and intestinal secretions.
Immunoglobulin E (IgE) antibody Protein substance that is part of the immune system; the antibody that is elevated with allergies.
Impaired fasting glucose (IFG) A condition of elevated fasting levels of glucose; defined as fasting glucose level greater than 110 mg/dL.
Impaired glucose tolerance Elevated blood glucose level with an oral glucose tolerance test greater than or equal to 140 mg/dL up to 200 mg/dL.
Inborn errors of metabolism Conditions resulting in a lack of a hormone or other metabolic chemical that results in a buildup of toxic by-products in the system; often causes mental retardation unless the diet is altered beginning in infancy.
Incomplete protein A food that is missing an essential amino acid.
Incretin Hormones that allow increased insulin secretion and use.
Inflammatory bowel disease (IBD) A condition of inflammation, generally of the colon area.
Ingestion The process of eating; taking food into the digestive tract.
Insoluble fiber A form of dietary fiber that does not dissolve in water; referred to as roughage. Whole wheat contains this type of fiber.
Insulin A protein hormone formed in the pancreas and secreted into the blood for the purpose of regulating carbohydrate, lipid, and amino acid metabolism.
Insulin-dependent diabetes mellitus (IDDM) A form of diabetes that usually develops in children and young adults; once known as juvenile onset diabetes. Now referred to as type 1 diabetes (with Arabic numeral rather than Roman numeral).
Insulin reaction A condition of severe hypoglycemia; usually associated with unconsciousness.
Insulin resistance A condition in which the body cells resist the action of insulin; often found with obesity and with a high–saturated-fat diet; usually a genetic predisposition exists.
Insulin resistance syndrome A diagnosis made by correlates, including central obesity, dyslipidemia, hypertension, type 2 diabetes, gout, and polycystic ovary syndrome.
Insulin shock Condition in which excess amounts of injected insulin result in profound hypoglycemia; glucose is needed to treat, either orally if the person is in a conscious state or via a venous route (intravenous [IV] dextrose).
Insulin to carbohydrate ratio The amount of carbohydrate for which 1 unit of short-acting insulin will allow the postmeal blood

glucose level to return to the premeal glucose level ±30 points 4 hours after injection; most persons with type 1 diabetes require a 1:15 ratio or 1 unit for every 15 g of carbohydrate (e.g., 30 g of carbohydrate would require 2 units, and so on). Children and lean, physically active adults generally need a 1:30 ratio, whereas overweight persons with insulin resistance may need as much as a 1:3 ratio.

Interdialytic weight gain Weight gain between dialysis sessions; excess gain indicates excess fluid intake in relation to the body's ability to handle fluids.

Interleukin 6 (IL-6) A proinflammatory substance that has an important role in immunity.

Intermediate care facility (ICF) A group home for persons with developmental disabilities; ICFs were developed in response to the deinstitutionalization of such persons.

International Unit (IU) A measure used in describing vitamin content of foods or recommendations of intake.

Intracellular Inside the body cells.

Intracellular hypoxia Abnormally reduced oxygen content of body cells.

Intrauterine growth retardation (IUGR) Another term for low birth weight (less than 5.5 lb).

Intrinsic factor A substance produced in the stomach that helps absorption of vitamin B_{12}.

Iron overload A rare disease of unknown origin characterized by widespread iron deposits in the body; can lead to pancreatic cirrhosis and other problems.

Irritable bowel syndrome (IBS) A noninflammatory condition of the bowel, with altered bowel habits often alternating between diarrhea and constipation and with abdominal pains generally treated with increased soluble fiber such as psyllium seed (Metamucil).

Islets of Langerhans The areas of the pancreas that produce insulin.

"I" versus "You" statements A form of communication in which the speaker uses statements that express personal feelings rather than accusations to another person.

Jaundice A condition related to hyperbilirubinemia, with the deposit of yellow bile pigments causing yellowness of skin.

Jejunostomy A permanent opening created by surgery between the jejunum and the surface of the abdominal wall.

Jejunum The middle portion of the small intestine connecting the duodenum and the ileum.

Ketoacidosis An accumulation of excess ketones (acid) that changes the pH of the blood; seen in uncontrolled diabetes mellitus.

Ketogenic diet A diet containing large amounts of fat and minimal amounts of protein and carbohydrate; sometimes used in treating certain types of epilepsy in children.

Ketonuria Ketones found in the urine; a test to help with diabetes management during illness, when blood sugar is over 240 mg/dL, or during pregnancy.

Ketosis The accumulation in the blood and tissues of large quantities of ketone bodies as a result of a complete oxidation of fats.

Kilocalorie (kcalorie or kcal) A unit of measure used to describe food energy. One pound of body fat is equivalent to 3500 kcal of food.

Krebs cycle The chemical process found at the cellular level that converts food matter into energy.

Kwashiorkor A protein-deficiency disease.

Kyphosis Also called hunchback; an abnormal curvature of the spine often related to osteoporosis.

Lactalbumin A form of milk protein.

Lactase The enzyme required to break down the disaccharide lactose; normally produced in the intestinal tract but low levels of production common among persons of non-European heritage; may be taken in capsule form or added commercially to milk products.

Lactation Production of milk, also known as the breastfeeding period.

Lactic acidosis A form of acidosis that alters body chemistry and is found with low pH levels.

Lactobacillus culture A culture containing a beneficial form of bacteria normally found in a healthy intestine; used in making yogurt.

Lactose The disaccharide found in milk; through digestion from lactase, glucose and galactose are formed.

Lactose intolerance The inability to digest the milk sugar lactose because of inadequate amounts of the lactase enzyme; common symptoms are bloating of the abdomen with flatus and diarrhea.

La Leche League An organization, usually of women, that promotes the art and success of breastfeeding.

Latent autoimmune diabetes in adults (LADA) A form of diabetes that is similar to type 1 diabetes; often confused with type 2 diabetes in adults and may be referred to as type 1½ diabetes. Involves an immune-mediated loss of pancreatic beta cells.

Lean tissue Muscle tissue.

Learned food aversion An aversion to food that is learned through a negative association such as an illness.

Legumes The fruit or seeds of pod-bearing plants such as peas, beans, lentils, and peanuts.

Leptin A hormone believed to help promote satiety, thereby regulating body weight.

Let-down reflex The process whereby the hormone oxytocin allows the hind milk to flow during breastfeeding; characterized by a gentle "pins and needles" sensation.

Linoleic acid The principal essential fatty acid for humans.

Linolenic acid An essential fatty acid.

Lipase An enzyme that hastens the splitting of fats into glycerol and fatty acids.

Lipids A term relating to all forms of fat.

Lipogenesis The formation of adipose tissue or body fat.

Lipogenic Related to substances that induce the promotion of body fat; insulin is a hormone that is lipogenic.

Lipolysis The breakdown of body fat.

Lipoprotein Lipid (fat) attached to protein; lipoproteins are the form of fats found in the blood.

Lipoprotein lipase An enzyme that is needed to break down triglycerides.

Listeria A pathogen that is related to food poisoning.

Lou Gehrig disease Also known as amyotrophic lateral sclerosis (ALS); named after the famous baseball player who developed this disease.

Low birth weight Birthweight less than 5.5 lb.

Low-density–lipoprotein cholesterol (LDL-C). The form of cholesterol referred to as the "bad cholesterol" and strongly associated with heart disease; consists of low levels of protein in the composition.

Low glycemic index Refers to foods that have little impact on blood glucose levels; proteins and fats have a low glycemic index, and high-fiber carbohydrate foods have a lower glycemic index than low-fiber carbohydrates, especially those of liquid texture, which have the highest glycemic index.

Macroalbuminuria A condition of large amounts of protein in the urine; associated with chronic renal failure.

Macrobiotic diet A diet progressing in stages and consisting mainly of rice in the last stage. The diet is deficient in many nutrients, including some amino acids.

Macronutrient The energy (kilocalorie) sources in food: carbohydrate, protein, and fat. Alcohol is also an energy source.

Macrosomic Large body size.

Macular degeneration A common cause of old-age blindness in which the macula, at the back of the eye, degenerates.

Maillard reaction The reaction of browning of foods at high temperatures; only occurs in cooking conditions without water.

Malnutrition A state of inadequate nutrient intake (such as marasmus) or an excess nutrient intake (such as obesity).

Maple syrup urine disease (MSUD) A genetically inherited condition related to altered enzyme functioning resulting in impaired metabolism of branched-chain amino acids; characterized by a maple syrup odor of urine with growth and mental retardation.

Marasmus A condition of protein-calorie malnutrition.

Masticated Well chewed, in reference to food.

Maturity-onset diabetes of youth (MODY) A form of diabetes that resembles type 2 diabetes.

Meals on Wheels A program of meal delivery to homebound or ill individuals in their homes.

Meals Ready to Eat (MREs) Meals planned for military use in the field; required to be planned for 3500 to 5000 kcal and have a long shelf life.

Medical genealogy Field of study related to the understanding and recognition of genetically linked health conditions within families.

Medical nutrition therapy (MNT) A diet modified in nutrients and used as therapy for diabetes, renal and cardiovascular disease, and other diseases and conditions. Previously referred to as diet therapy or therapeutic diet.

Medicare A health program primarily for persons after retirement age.

Medium-chain triglycerides (MCTs) A type of fat that does not require digestion; often used as a form of enteral nutrition support in conditions of fat malabsorption.

Megadose A large dose; generally ascribed to supplements of vitamins and minerals that are greater than 10 times the RDA.

Megaloblastic anemia A form of anemia characterized by enlarged erythrocytes (MCV >100) in the bone marrow or blood. Common causes include deficiency of vitamin B_{12} and folic acid.

Ménière's disease A disorder of the labyrinth of the inner ear that is treated with a low-sodium diet.

Mental retardation An older term used for developmental disability; related to impaired cognition.

Metabolic Having to do with metabolism; related to the physical and chemical processes, including the building or breakdown of body substances.

Metabolic acidosis A reduction in pH levels; found with diabetic ketoacidosis, renal disease, and other conditions.

Metabolic enzymes Protein-based substances produced by the body to allow complex biochemical activities to occur, generally intracellularly. Various minerals and vitamins are required for proper functioning of the enzymes.

Metabolic obesity A term coined to describe persons who are of normal weight but who tend to carry excess in the abdominal region.

Metabolic rate The rate at which metabolism occurs; influenced by such factors as exercise and body temperature.

Metabolic syndrome Also known as the insulin resistance syndrome; at least three health conditions found together: central obesity, hypertension, dyslipidemia, gout, polycystic ovary syndrome (PCOS), and type 2 diabetes. Other conditions such as some forms of cardiovascular disease, cancer, and other health conditions are often found with this syndrome.

Metabolism The anabolic (constructive) and catabolic (breakdown) processes of the body.

Methylation An important biochemical process involving the addition of a methyl group to a molecule.

Microalbuminuria Small amount of protein found in the urine; precedes macroalbuminuria.

Micronutrient A substance in food that is needed in small amounts; vitamins and minerals are examples.

Midarm circumference A measurement used in anthropometry to help determine body fat percentage.

Milk anemia A form of iron deficiency anemia attributable to an excess intake of milk, which replaces other iron sources such as meat.

Minimum Data Set (MDS) An assessment of health risk criteria, including nutritional status, compiled in a form and submitted for Medicare reimbursement of long-term care institutions.

Mitochondria The furnaces within body cells where metabolism occurs.

Monoglycerides A form of fat with one fatty acid attached to a glycerol base.

Monosaccharides The simplest form of carbohydrate; one unit of sugar molecules; glucose and fructose.

Monounsaturated fats A form of food fat that is referred to as a "good fat"; found in high amounts in olives, olive oil, canola oil, avocados, and most nuts.

Morbidity Sickness rate.

Morbid obesity A condition of being greater than 30% overweight; body mass index greater than 40. Now referred to as class III obesity or extreme obesity.

Morning sickness Nausea and vomiting of a low severity generally limited to the first trimester of pregnancy.

Mortality Death rate.

Multiple sclerosis A chronic neurologic disease involving demyelination of the central nervous system; symptoms often begin between the ages of 20 and 40 now associated with Vitamin D deficiency.

Myelopathy Damage or pathologic change to the spinal cord.

Myocardial infarction (MI) Heart attack.

Myoclonus Shocklike contractions of a muscle as found with epilepsy.

Myopathy Any disease of muscle.

Nasogastric tube feeding Feeding via a tube extending from the nose to the stomach.

Nasojejunal tube feeding Feeding via a tube extending from the nose to the jejunum.

National Cholesterol Education Program (NCEP) A program that was initiated in 1985 by the National Heart, Lung, and Blood Institute (NHLBI) aimed at reducing illness and death from coronary heart disease through lowering serum cholesterol levels.

Necrotizing dermatitis Necrosis, or death, of skin cells.

Neonatal hypoglycemia Low blood glucose level near the time of birth; defined as blood glucose level less than 45 mg/dL less than 24 hours of delivery, less than 50 mg/dL greater than 24 hours after delivery.

Nephritic syndrome A disorder of the glomeruli involving edema, hypertension, and hematuria; the acute form can result in renal failure and may be caused by an infectious agent, often streptococcus bacteria.

Nephrologist A medical doctor specializing in renal disease.

Nephron The functional part of the kidney that produces urine; about 1 million nephrons make up each kidney.

Nephropathy Any disease of the kidneys.

Nephrosclerosis Hardening of the kidney; related to chronic hypertension.

Nephrosis A general term for kidney disease.

Nephrotic syndrome A condition involving edema, proteinuria, hypoalbuminuria, and susceptibility to infections.

Neural tube defect A congenital defect with impaired bony enclosure of the spinal column or skull.

Neurologic impairment Impairment related to a low level of consciousness or sensory or motor function.

Neuropathy A condition characterized by functional disturbances and pathologic changes outside the central region of the nervous system.

Neuropeptides Molecules composed of short chains of amino acids.

Nicotinamide Another term for vitamin B_3.

Nitric oxide (NO) A gas synthesized from arginine and oxygen; allows smooth muscle to relax, resulting in lowered blood pressure;

deficiency of NO can cause cardiovascular disease; also serves as a neurotransmitter.

Nitrogen balance A state in which nitrogen intake through protein ingestion equals the amount being excreted through the kidneys.

Nitrogenous wastes Waste products of the body that contain nitrogen.

Nitrosamines A substance formed from nitrites and considered a carcinogen.

Nonalcoholic fatty liver disease (NAFLD) A disease of fat accumulation in the liver; related to obesity, diabetes, and hyperlipidemia; affects more women than men and can occur at any age.

Nonalcoholic steatohepatitis (NASH) A form of liver disease.

Non–insulin-dependent diabetes mellitus (NIDDM) A form of diabetes that is typically found in overweight adults. Insulin injection is sometimes necessary for good blood sugar control but is not required for survival. Now referred to as type 2 diabetes (Arabic numeral rather than Roman numeral).

Nontropical sprue Another term for celiac disease.

Nonverbal communication Communication done without speech, such as with facial expressions.

Norepinephrine A type of hormone that functions as a neurotransmitter; produces vasoconstriction, increased heart rate, and increase in blood pressure.

NPO (Nothing by mouth) Acronym based on the Latin expression *nil per os* (nothing by mouth/opening); a form of diet order that precludes oral intake; may be used temporarily for certain tests or acute illness; long-term NPO status requires nutritional support via supplementation provided directly into the stomach or other placements.

Nursing-bottle mouth Another term for baby-bottle tooth decay.

Nursing process A goal-directed series of activities aimed at alleviating or preventing health problems; includes five components: assessment, nursing diagnosis, planning, implementation, and evaluation.

Nutrient A substance found in food that is essential for good health.

Nutrient density The amount of nutrients per kilocalorie; high nutrient density means a large amount of nutrients per serving of food.

Nutrigenics A new term used to describe genetic susceptibility to disease as influenced by diet.

Nutrigenomics A new term used to describe how diet affects gene expression.

Nutrition The sum of the processes by which the body uses food to support health.

Nutritional status The level at which a person meets nutritional needs without deficiency or excess. People have good nutritional status when they have met all their nutritional needs.

Nutrition care process Similar to the nursing process, excluding the component of nursing diagnosis, but with a nutrition diagnosis.

Nutritionist A term that has no legal definition. Registered dietitians are nutritionists in the sense that they are trained in the science of nutrition. Qualified nutritionists include persons with at least a 4-year degree in the science of nutrition.

Nutrition Program for the Elderly A federal program designed to provide one third of the RDA for vitamins A and C, calcium, protein, and kilocalories for elderly persons; meals either provided at congregate meal sites such as in churches or other community settings or home delivered for those in need.

Nutrition Screening Initiative A project of the American Academy of Family Physicians, the American Dietetic Association, and the National Council on the Aging; the initiative that developed the nutritional screening tool for older adults called the DETERMINE Checklist.

Nutrition support A term generally denoting the provision of enteral and parenteral nutrition;

also includes the provision of liquid supplements for weight gain.

Nycturia Voiding larger amounts of urine during the night than daytime.

Nystagmus Involuntary, rapid, and rhythmic movements of the eyeball.

Obesity The condition of weighing more than 20% over ideal body weight; a body mass index greater than 30.

Obstetrician A physician who specializes in the delivery of babies.

Obstipation A condition of intractable constipation.

Older Americans Act Federal legislation that enacted assistance to maintain the health of the elderly population such as the Nutrition Program for the Elderly.

Oligohydramnios A condition of inadequate quantity of amniotic fluid

Oligomenorrhea Sparse or infrequent menstruation.

Oligosaccharides A simple form of carbohydrate having 3 to 9 monosaccharides in the chain.

Oliguria A condition of decreased urinary output.

Omega-3 fatty acids The type of fat found in fish oil and some plant products.

Oncology The study of tumors.

Ophthalmoplegia Paralysis of the eye muscles.

Oral glucose tolerance test (OGTT) A test in which a set amount of carbohydrates is consumed in a beverage with hourly monitoring of blood glucose levels for up to 2 hours for the diagnosis of diabetes, and occasionally involving a 6-hour monitoring for the diagnosis of hypoglycemia.

Oral hypoglycemic agents Medications in pill form used to control glucose levels in type 2 diabetes.

Organic foods Foods that originate from farms certified by the U.S. Department of Agriculture (USDA) that meet guidelines for use of pesticides and other chemicals.

Orofacial cleft Abnormal opening in or near the oral cavity.

Orthostatic hypertension Increased blood pressure that occurs with standing erect.

Osmolality The number of particles dissolved in a solution.

Osmotic effect Diffusion of fluids across permeable membranes that equalizes the concentration on both sides.

Osteoarthritis A noninflammatory degenerative joint disease; causes disintegration of the cartilage that covers the ends of bones.

Osteodystrophy A bone disease associated with renal disease, with elevated phosphorus and low or normal calcium levels found in the blood.

Osteomalacia Softening of the bones often associated with vitamin D deficiency; in children the condition is known as rickets.

Osteopenia Reduced bone mass.

Osteoporosis A condition characterized by a reduction in the quantity of bone.

Otitis media An ear infection; often a chronic condition in infancy and childhood.

Over-the-counter medications Medications that may be purchased without a prescription.

Overtraining syndrome Related to physical work-outs that exceed the body's ability to recuperate; associated with physical deterioration, including suppressed immunity, increased heart rate from the norm, and reduced physical productivity. Adequate rest is required for treatment.

Overweight An excess of 10% body weight over an ideal weight; body mass index (BMI) greater than 27 is accepted as overweight; some authorities state that overweight is BMI over 24.

Oxidation A chemical process in which oxygen removes electrons from atoms; involved in energy metabolism.

Oxytocin A hormone that causes uterine contraction and promotes the let-down reflex of breastfeeding; released during orgasm.

Palliative care Treatment to relieve or lessen pain or other uncomfortable symptoms but not to effect a cure.

Palmar grasp A hand grasp characterized by use of the palm.
Pancreas A gland behind the stomach that releases insulin, glucagon, and some enzymes of digestion for fats and proteins.
Pancreatitis Inflammation of the pancreas often associated with alcoholism and fat malabsorption.
Pancytopenia Abnormal reduction of blood elements.
Papilledema Fluid build-up of the optic disc; often found with increased intracranial pressure.
Paraprofessional "Near" professional; a person who is not a professional but is trained to do a type of professional work.
Parathyroid glands Small glands situated near the thyroid gland that are the major source of parathyroid hormone and that regulate serum calcium levels.
Parenteral nutrition Provision of a liquid nutrition formula directly into the blood system via the subclavian vein or other site.
Parkinson's disease A slowly progressive disease characterized by abnormal involuntary movements and alteration in muscle tone.
Pasteurization The heating of milk or other liquid to a temperature of 60° C (140° F) for 30 minutes, killing pathogenic bacteria and considerably delaying the development of other bacteria.
Pattern management A term used in diabetes management related to the identification of patterns of hyperglycemia and hypoglycemia.
Peak action A term used to describe the peak action of insulin by injection.
Pear shape A term used to describe carrying excess weight in the hips and thighs.
Pediatrician A physician specializing in childhood health and illness.
Pellagra A nutritional deficiency disease caused by long-term lack of niacin, resulting in a number of nervous, digestive, and skin symptoms.
Pepsin An enzyme found in gastric juice that breaks down protein into polypeptides.
Peptic ulcer A condition of the stomach in which the lining has been eroded.
Peptides Part of protein made up of amino acids.
Percutaneous endoscopic gastrostomy (PEG) tube A common form of long-term nutritional support.
Perimenopause The time near the onset of menopause up to a few years' duration.
Periodontal A term to describe the area around or near a tooth.
Periodontal disease Disease of the tissues supporting and surrounding the teeth.
Peripheral Parts of the body away from the interior.
Peripheral arterial disease Artery disease in the periphery of the body.
Peripheral nerves Nerves found in the arms, hands, legs, and feet.
Peripheral neuropathy A condition related to damage of peripheral nerves such as in the feet and hands.
Peripheral parenteral nutrition (PPN) Administration of nutrients through peripheral veins.
Peristalsis The wormlike movement by which the digestive tract propels its contents through waves of contraction.
Peritoneal dialysis A form of dialysis in which a dialysis solution is placed directly into the peritoneum surrounding the abdominal cavity and later removed.
Pernicious anemia A form of anemia caused by a lack of the intrinsic factor normally produced by the stomach mucosa, leading to a deficiency in vitamin B_{12}; left untreated can lead to irreversible neurologic damage and death.
Pescetarian diet A vegetarian diet that includes the eating of fish.
Phenylketonuria (PKU) A congenital disease resulting from a deficit in the metabolism of the amino acid phenylalanine.
Phlebitis Inflammation of a vein.

Phospholipids A lipid, or fat, that contains phosphorus; major lipids of cell membranes.

Physiologic anemia One form of anemia often found in pregnancy as a result of an increase in plasma volume without an increase in red blood cells; found with sports anemia.

Physiologic stress A condition of elevated counterregulatory "stress" hormones found with surgery and severe trauma.

Phytochemicals A term developed to describe substances in plant-based food that are neither vitamins nor minerals.

Pica An abnormal craving for nonfood substances.

PICC line A peripherally inserted central catheter. Used for delivery of nutritional support, antibiotics, or chemotherapy.

Pincer grasp A hand grasp characterized by use of the thumb and index finger.

Placenta The organ developed prenatally in the uterus that transfers maternal nutrients to the fetus. Also known as afterbirth.

Plant stanols Substances naturally found in plants that resemble cholesterol and compete for absorption in the intestinal tract, thereby lowering serum cholesterol levels.

Podiatrist A physician who specializes in problems of the feet.

Polycystic ovary syndrome (PCOS) A condition that is often found with insulin resistance and hyperinsulinemia; diagnosed based on levels of androgens, hirsutism, menstrual cycle dysfunction, and ovarian cysts.

Polydipsia A condition of excess thirst.

Polyneuropathy A disease involving many nerves.

Polyols Another term for sugar alcohols such as sorbitol; lower caloric value than sugar due to poor absorption and not associated with dental caries; excess intake related to diarrhea.

Polypeptide A protein compound containing two or more amino acids linked by peptide bonds.

Polyphagia A condition of excess appetite.

Polypharmacy The condition of use of multiple medications.

Polysaccharides The most complex form of carbohydrates; many units of sugar linked together.

Polyunsaturated fatty acids (PUFAs) Liquid oils that have less hydrogen than saturated fats.

Polyuria A condition of excessive excretion of urine.

Positive nitrogen balance The condition in which nitrogen intake surpasses nitrogen excretion.

Postpartum blues A period of depression, often brief, related to hormonal changes after pregnancy; often occurs 2 to 3 weeks after delivery.

Postpartum psychosis A condition of severe depression after pregnancy in which the woman loses touch with reality.

Postprandial After meals.

Postprandial dysmetabolic A term describing abnormal metabolism after meals, such as development of very high levels of triglycerides.

Pouching The retention of food in the side of the mouth; often found in conditions of dementia.

Poverty A financial situation in which the means to meet basic needs such as food and shelter are impaired.

Prader-Willi syndrome A condition beginning in infancy characterized by hypotonicity and failure to thrive, with hyperphagia beginning in later childhood with a degree of mental retardation; the hyperphagia is often severe enough that food has to be locked away or highly controlled to prevent extreme obesity.

Preconception The time before the conception of pregnancy.

Precursor Something that precedes, such as a substance that is formed into a more active one.

Prediabetes A newer term for borderline diabetes; diagnosed with fasting blood

glucose level of 100 to 125 mg/dL or blood glucose level after an oral glucose tolerance test of 140 to 199 mg/dL.

Preeclampsia A condition in late pregnancy related to increased blood pressure, edema, and proteinuria that can lead to eclampsia with convulsions and coma caused by cerebral edema; also called pregnancy-induced hypertension or toxemia.

Pregnancy-induced hypertension A condition of pregnancy characterized by elevated blood pressure, proteinuria, and edema; the cause is unknown, but the condition is associated with poor nutritional status; also called toxemia or preeclampsia.

Premenstrual dysphoric disorder (PMDD) A severe form of premenstrual syndrome affecting up to 10% of women.

Premenstrual syndrome (PMS) A condition that occurs after ovulation involving physical and psychologic changes that are relieved on the start of the monthly menstrual cycle.

Prenatal The time preceding birth; also referred to as perinatal.

Preterm milk Breast milk from a mother who has given birth to a premature baby.

Probiotics Forms of good bacteria required for a healthy gastrointestinal tract.

Products of conception The sources of weight gain in pregnancy, including the weight of the baby, the placenta, weight attributable to increased uterine and breast size, increased blood volume weight, and an expected amount of increased maternal body fat that is equal to a minimum of 15 to 20 lb.

Prostaglandins A group of chemically related fatty acids that stimulate contraction of the uterus and other smooth muscles and regulate blood pressure, body temperature, platelet aggregation, and inflammation.

Protease An enzyme that breaks down protein.

Protein-calorie malnutrition Also known as marasmus.

Protein Digestibility–Corrected Amino Acid Score (PDCAAS) A scoring method, commonly used with nutritional supplements, based on the content and availability of all essential amino acids with a score of 1.0 being the highest. The score is based on the recognition that the one essential amino acid most deficient in a given nutritional supplement, or food, limits the body's ability to produce proteins, regardless of stated total protein content.

Proteinuria A condition of protein in the urine.

Prothrombin A blood-clotting factor.

Prudent diet A diet that is very low in fat.

Pruritus An itchy, inflammatory skin disorder caused by allergy, parasites, or certain diseases such as diabetes mellitus and liver disease.

Psoriasis A noninfective skin disorder consisting of scaly, red patches as a result of a rapid production of skin cells; found primarily among Caucasians.

P:S ratio The amount of polyunsaturated to saturated fats found in the diet.

Psychomotor Pertaining to physical movements, such as with epilepsy.

Ptyalin An enzyme found in saliva, also known as amylase; helps digest carbohydrates.

Public health The field of health sciences concerned with the health of the community as a whole.

Purging Bulimic type of actions such as self-induced vomiting and laxative abuse.

Purines Compounds found in meat and meat extracts; sometimes avoided as a treatment for gout.

Radiation Electromagnetic waves (as in ultraviolet waves, x-rays, gamma rays, and so on).

Radiation therapy The treatment of cancer through the use of radiation to destroy cancer cells.

Radioallergosorbent (RAST) test Used to diagnose food allergies.

Raynaud's phenomenon A condition of vasoconstriction in the fingers and toes that cause discoloration because of impaired

circulation, typically induced by cold temperatures; may also be problematic with lactation.

Reactive hypoglycemia A form of low blood sugar level that may be a precursor to diabetes; characterized by excess but delayed insulin production in response to simple carbohydrate intake.

Reactive oxygen species (ROS) A term for free radicals.

Rebound scurvy A type of vitamin C deficiency disease caused by rapid withdrawal from chronic ingestion of megadoses of vitamin C.

Receptor sites The doors or entryways into body cells.

Recommended Dietary Allowances (RDAs) The recommended amount of nutrients to achieve health. The RDAs are felt to easily meet the nutritional needs of 95% of the population.

Refeeding syndrome Also called the nutrition recovery syndrome; occurs when nutritional support is undertaken too aggressively, resulting in decreased serum laboratory values as the cells increase their intake of minerals such as phosphorus.

Reference dietary intake (RDI) A term developed for use with food labels; average amounts of the updated RDAs.

Renal insufficiency A stage of diminishing renal function when the glomerular filtration rate is reduced to under 60 mL/min.

Renal osteodystrophy Disease of the bone related to inadequate kidney functioning.

Renal threshold The capacity for reabsorption by the kidneys.

Residue The undigested material found in food.

Restless leg syndrome A condition in which rest, usually sleep, causes the legs to have involuntary movement.

Retinoids A general term of forms of vitamin A.

Retinol-binding protein A form of protein that transports vitamin A.

Retinol equivalents (RE) A means of measuring the vitamin A content of food.

Retinopathy Disease of the eyes often found with uncontrolled diabetes; may include the growth of fragile blood vessels that can now be treated with laser surgery; a leading cause of blindness.

Rhabdomyolysis A condition of body cells rupturing and releasing their contents into the body; caused by use of statin cholesterol medications in certain individuals or overuse of muscles as in weight lifting; can cause acute renal failure.

Rickets A bone disease that begins in childhood, caused by a lack of vitamin D, that results in bowing of legs.

Roux-en-Y gastric bypass A form of bariatric surgery in which most of the duodenum is bypassed and reconnected to a surgically formed pouch in the upper stomach. The procedure reduces stomach size to about ¼ cup volume and decreases absorptive surface in the small intestine. Mineral deficiencies are common, along with deficiency of vitamin B_{12} and water-soluble vitamins.

Salivary gland The glands in the mouth that secrete saliva.

Salmonella A rod-shaped bacterium that can cause gastroenteritis; often associated with dairy products.

Sarcopenia A condition of muscle loss and/or strength.

Satiety The feeling of being satisfied or satiated; used to describe the point at which a person feels satisfied after eating a meal.

Saturated fat Solid fats; found in most animal fats in association with cholesterol, tropical oils and in hydrogenated fats.

Schizophrenia A large group of mental disorders characterized by mental deterioration, delusions, and withdrawal from the external world.

Scurvy A condition of severe vitamin C deficiency leading to breakdown of skin tissues with uncontrolled internal bleeding that can be fatal.

Second meal effect A newly recognized phenomenon in which one meal can

influence the blood glucose outcome of a second meal.

Self-monitoring of blood glucose (SMBG) The use of a personal blood glucose meter to monitor glucose levels.

Sepsis The presence in the blood or other tissues of harmful microorganisms or their toxins.

Serum creatinine Blood level of creatinine; a marker of renal functioning.

Short bowel syndrome A condition generally related to surgical removal of excess portions of the small intestine leading to malabsorption and diarrhea.

Shoulder dystocia A condition generally used to describe neonates whose shoulders are larger than the head, making normal delivery difficult or impossible; caused by uncontrolled maternal diabetes.

Sickle cell disease A serious hereditary disease that causes red blood cells to have a sickle shape and to be rigid; found mainly in persons of African ancestry, but also occurs in those with Mediterranean, Middle Eastern, and Asian Indian ancestry.

Sigmoid region A part of the intestinal tract.

Sleep apnea A condition of chronic periods of no breathing during sleep; related to obesity. Similar to the Pickwickian syndrome, as it is known in some countries.

Small-for-gestational age (SGA) Less than 10^{th} percentile height or weight based on gestational age.

Sodium The chief cation of extracellular body fluids.

Soluble fiber Forms of dietary fiber that dissolve in water and the digestive tract. Oat bran and legumes are high in soluble fiber.

Somogyi effect The condition in which blood glucose levels rise after hypoglycemia; related to the release of counterregulatory hormones that allow the breakdown of liver glycogen into blood glucose; named after Dr. Somogyi, who first gave credence to this phenomenon.

Spasticity Implying muscle spasms.

Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) A federal program that began in the 1970s with the initial chief goal of eradication of iron deficiency anemia. The program is aimed at lower-income women, infants, and children up to age 5 years and provides nutrition education, breastfeeding support, and food vouchers for foods that are high in iron, vitamin C, calcium, and protein.

Specific dynamic action The increase in metabolism related to the process of digesting food.

Spina bifida Also known as neural tube defect; a developmental birth defect in which the spinal cord is not completely enclosed.

Sports anemia Anemia of athletes unrelated to iron intake; see physiologic anemia.

Staphylococcus aureus A form of bacteria present on the skin and in the upper respiratory tract; often associated with a form of food poisoning when safe food-handling procedures are not followed.

Starch Digestible polysaccharides as found in grain products.

Steatorrhea Diarrhea characterized by excess fat in the stools.

Steroids An important group of body compounds that includes sex and adrenal hormones.

Sterols Lipidlike substances such as cholesterol found in animal fats.

Stomatitis Inflammation of the mucosa of the mouth.

Sugar The monosaccharide and disaccharide form of carbohydrate.

Sugar alcohols A form of sugar found in sugar substitutes that does not promote dental caries.

Supply and demand A term used to describe milk production, with increased milk supply occurring with increased nipple stimulation or demand of breastfeeding by the infant.

Syndrome of inappropriate antidiuretic hormone (SIADH) A syndrome in which the

antidiuretic hormone is not suppressed by the normal mechanism with fluid intake; associated with hyponatremia.

Systemic Implying involvement with interconnected systems of the body.

Systolic blood pressure The upper number in blood pressure readings; the amount of pressure required to stop blood flow with a blood pressure cuff; controlled, in part, by a low-sodium diet less than 2400 mg.

Tardive dyskinesia A late onset of impaired voluntary movements characterized by a chewing motion, darting movements of the tongue and involuntary movement of the extremities; associated with use of certain antipsychotic medications with symptoms potentially permanent.

Taurine A sulfur-containing amino acid; the end product of cysteine metabolism and a component of bile acids.

Tetany A condition with steady contraction of a muscle without distinct twitching caused by abnormal calcium metabolism.

Thalassemia A hereditary form of anemia.

Therapeutic Lifestyle Changes (TLC) Diet aimed at lowering serum cholesterol levels with the goals of 7% saturated fat, 30% total fat, less than 200 mg of cholesterol, less than 2400 mg of sodium, and kilocaloric intake aimed at achieving or maintaining a healthy weight; guidelines also advocate increased soluble fiber and up to 35% fat chiefly from monounsaturated fats for persons with the metabolic syndrome or the insulin resistance syndrome.

Thiazolidinediones A form of diabetes medication that increases insulin sensitivity.

Thrifty Food Plan A meal plan that can provide all necessary nutrients at the most minimal cost; the current basis for food stamp allotments.

Thrifty gene The theory related to the historical survival of groups of people or populations who withstood cycles of famine.

Thrombocytopenia A condition of decreased circulating platelets in the blood.

Thrombosis The formation of a thrombus or clot formed from platelets and other blood substances, which may partially or totally obstruct blood flow.

Thrush A bacterial infection often manifested with white blotches on the tongue and in the oral cavity.

Thyroxine A hormone produced by the thyroid gland that increases the rate of metabolism.

Tocopherol Vitamin E.

Tolerable Upper Intake Levels (ULs) A term developed to state the upper level of intake of vitamins and minerals that appears to pose no health threat.

Tongue thrust A condition usually related to having a small oral cavity that cannot fully contain the tongue.

Tongue tie A condition of restricted movement of the tongue due to excess attached to the floor of the oral cavity.

Total parenteral nutrition (TPN) Administration of nutrients through the superior vena cava.

Toxemia General condition sometimes resulting from absorption of bacterial products formed at an infection site. In late pregnancy toxemia is characterized by elevated blood pressure, edema, and proteinuria; also called preeclampsia or pregnancy-induced hypertension.

Transaminases Enzymes that allow transfer of amino acids.

Trans fatty acids The form of fat found in hydrogenated fats.

Transferrin A serum globulin or protein that binds and transports iron.

Transferrin saturation A laboratory value that helps determine if anemia is due to iron deficiency with transferrin serving as a protein to transport iron.

Transient ischemic attack (TIA) Ministroke.

Transtheoretical Model of Change An approach to help determine strategies to change health behavior based on an individual's readiness to make changes.

Triceps skinfold An anthropometric measure in which calipers measure the fat on the back

of the arm; such measuring requires training for accuracy.

Triglycerides The form of food fat found in the blood and body tissues and consisting of three fatty acids attached to a glycerol base.

Trypsin A digestive enzyme found in the small intestines that helps break down peptides into amino acids.

Tube feeding A form of delivery of nutrients through a tube that may be placed through the nose or abdominal opening into the stomach or small intestine.

Type 1 diabetes The form of diabetes in which the pancreas loses its insulin production ability because of autoimmune destruction by GAD antibodies.

Type 2 diabetes The common form of diabetes generally related to insulin resistance; the general term used to describe all nonautoimmune forms of diabetes.

Tyramine Substance related to tyrosine and found in ripe cheese; closely related structurally to epinephrine (a hormone), which has a similar, but weaker, effect.

Ulcerative colitis A chronic condition manifested by abdominal pain and rectal bleeding; long-standing ulcerative colitis is a high-risk factor for the development of colon cancer.

Umami A term used to describe a newly recognized fifth taste, adding to the tastes of salty, sweet, sour, and bitter with soy sauce having an umami flavor.

Underweight A body mass index less than 19.

Unsaturated fats The form of fat with low levels of hydrogen; liquid or soft forms of fat.

Uremia The final stage of renal disease associated with severe azotemia; includes symptoms of headache, muscular twitching, mental disturbances, nausea, and vomiting.

U.S. dietary guidelines Guidelines aimed at reducing the mortality and morbidity of several diseases such as cardiovascular disease, hypertension, cancer, and diabetes mellitus. The guidelines recommend increased amounts of complex carbohydrates and dietary fiber, with reduced amounts of fat, sugar, salt, and alcohol. Maintaining or achieving desirable weight and including a variety of foods are also recommended.

Vasoconstriction A condition whereby blood vessels constrict in size; a cause of hypertension.

Vegan A person who does not eat animal products. Protein is derived from plant sources such as legumes, nuts, and seeds.

Vegetarian A person who avoids eating meat for health or spiritual reasons. Some vegetarians avoid only red meat.

Very low birth weight Birth weight less than 3.3 lb.

Very-low-density lipoprotein (VLDL) Form of lipid comprising mostly fats with little protein; also known as chylomicrons and are ultimately metabolized to LDL cholesterol in the plasma.

Videofluoroscopy A test done to determine a person's ability to swallow.

Villi The hairlike projections inside the intestinal tract; involved in absorption of digested food matter.

Vitamin B complex The term used to describe all of the B vitamins.

Waist-to-hip ratio (WHR) A measure in which the waist size is divided by the hip size; large WHR is related to a variety of chronic illnesses as found in the insulin resistance syndrome

Water-soluble vitamins The B vitamins and vitamin C; vitamins that are easily lost in cooking water or destroyed from overcooking or exposure to air.

Weaning To discontinue breastfeeding and substitute other forms of feeding; may also relate to weaning off nutrition support or other life-support measures.

Wernicke's encephalopathy A degenerative brain disease associated with alcoholism, but due to thiamin deficiency; part of Wernicke-Korsakoff syndrome.

Wernicke-Korsakoff syndrome A disorder of the central nervous system related to depletion of vitamin B_1 or thiamin; includes memory impairment, gait disturbance, and altered eye movement.

Whey A form of milk protein.

Wilson's disease An autosomal recessive genetic disease involving a defect in metabolism of copper, causing high levels of blood copper and leading to liver and neurologic damage and degenerative changes of the brain.

Xerophthalmia Dryness and thickening of the membrane lining of the eyelid, eyeball, and cornea; results from vitamin A deficiency.

Xerostomia Dryness of the mouth caused by dysfunctional salivary glands; often induced with radiation treatment for cancer near the oral cavity; can result in severe dental decay because of the absence of the neutralizing effect of saliva.

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Dietary Reference Intakes (DRIs): Recommended Intakes for Individuals, Vitamins

Food and Nutrition Board, Institute of Medicine, National Academies

LIFE STAGE GROUP	VIT A (µG/D)[a]	VIT C (MG/D)	VIT D (µG/D)[b, c]	VIT E (MG/D)[d]	VIT K (µG/D)	THIAMIN (MG/D)	RIBOFLAVIN (MG/D)	NIACIN (MG/D)[e]	VIT B_6 (MG/D)	FOLATE (µG/D)[f]	VIT B_{12} (µG/D)	PANTOTHENIC ACID (MG/D)	BIOTIN (µG/D)	CHOLINE[g] (MG/D)
Infants														
0–6 mo	400*	40*	5*	4*	2.0*	0.2*	0.3*	2*	0.1*	65*	0.4*	1.7*	5*	125*
7–12 mo	500*	50*	5*	5*	2.5*	0.3*	0.4*	4*	0.3*	80*	0.5*	1.8*	6*	150*
Children														
1–3 y	**300**	**15**	5*	**6**	30*	**0.5**	**0.5**	**6**	**0.5**	**150**	**0.9**	2*	8*	200*
4–8 y	**400**	**25**	5*	**7**	55*	**0.6**	**0.6**	**8**	**0.6**	**200**	**1.2**	3*	12*	250*
Males														
9–13 y	**600**	**45**	5*	**11**	60*	**0.9**	**0.9**	**12**	**1.0**	**300**	**1.8**	4*	20*	375*
14–18 y	**900**	**75**	5*	**15**	75*	**1.2**	**1.3**	**16**	**1.3**	**400**	**2.4**	5*	25*	550*
19–30 y	**900**	**90**	5*	**15**	120*	**1.2**	**1.3**	**16**	**1.3**	**400**	**2.4**	5*	30*	550*
31–50 y	**900**	**90**	5*	**15**	120*	**1.2**	**1.3**	**16**	**1.3**	**400**	**2.4**	5*	30*	550*
51–70 y	**900**	**90**	10*	**15**	120*	**1.2**	**1.3**	**16**	**1.7**	**400**	**2.4**[i]	5*	30*	550*
> 70 y	**900**	**90**	15*	**15**	120*	**1.2**	**1.3**	**16**	**1.7**	**400**	**2.4**[i]	5*	30*	550*
Females														
9–13 y	**600**	**45**	5*	**11**	60*	**0.9**	**0.9**	**12**	**1.0**	**300**	**1.8**	4*	20*	375*
14–18 y	**700**	**65**	5*	**15**	75*	**1.0**	**1.0**	**14**	**1.2**	**400**[i]	**2.4**	5*	25*	400*
19–30 y	**700**	**75**	5*	**15**	90*	**1.1**	**1.1**	**14**	**1.3**	**400**[i]	**2.4**	5*	30*	425*
31–50 y	**700**	**75**	5*	**15**	90*	**1.1**	**1.1**	**14**	**1.3**	**400**[i]	**2.4**	5*	30*	425*
51–70 y	**700**	**75**	10*	**15**	90*	**1.1**	**1.1**	**14**	**1.5**	**400**	**2.4**[h]	5*	30*	425*
> 70 y	**700**	**75**	15*	**15**	90*	**1.1**	**1.1**	**14**	**1.5**	**400**	**2.4**[h]	5*	30*	425*
Pregnancy														
14–18 y	**750**	**80**	5*	**15**	75*	**1.4**	**1.4**	**18**	**1.9**	**600**[j]	**2.6**	6*	30*	450*
19–30 y	**770**	**85**	5*	**15**	90*	**1.4**	**1.4**	**18**	**1.9**	**600**[j]	**2.6**	6*	30*	450*
31–50 y	**770**	**85**	5*	**15**	90*	**1.4**	**1.4**	**18**	**1.9**	**600**[j]	**2.6**	6*	30*	450*
Lactation														
14–18 y	**1,200**	**115**	5*	**19**	75*	**1.4**	**1.6**	**17**	**2.0**	**500**	**2.8**	7*	35*	550*
19–30 y	**1,300**	**120**	5*	**19**	90*	**1.4**	**1.6**	**17**	**2.0**	**500**	**2.8**	7*	35*	550*
31–50 y	**1,300**	**120**	5*	**19**	90*	**1.4**	**1.6**	**17**	**2.0**	**500**	**2.8**	7*	35*	550*

NOTE: This table (taken from the DRI reports, see www.nap.edu) presents Recommended Dietary Allowances (RDAs) in **bold type** and Adequate Intakes (AIs) in ordinary type followed by an asterisk (*). RDAs and AIs may both be used as goals for individual intake. RDAs are set to meet the needs of almost all (97 to 98 percent) individuals in a group. For healthy breastfed infants, the AI is the mean intake. The AI for other life stage and gender groups is believed to cover needs of all individuals in the group, but lack of data or uncertainty in the data prevent being able to specify with confidence the percentage of individuals covered by this intake.

[a]As retinol activity equivalents (RAEs). 1 RAE = 1 µg retinol, 12 µg β-carotene, or 24 µg α-carotene, or 24 µg β-cryptoxanthin. The RAE for dietary provitamin A carotenoids is twofold greater than retinol equivalents (RE), whereas the RAE for preformed vitamin A is the same as RE.

[b]As cholecalciferol. 1 µg cholecalciferol = 40 IU vitamin D.

[c]In the absence of adequate exposure to sunlight.

[d]As α-tocopherol. α-Tocopherol includes *RRR*-α-tocopherol, the only form of α-tocopherol that occurs naturally in foods, and the *2R*-stereoisomeric forms of α-tocopherol (*RRR-*, *RSR-*, *RRS-*, and *RSS*-α-tocopherol) that occur in fortified foods and supplements. It does not include the *2S*-stereoisomeric forms of α-tocopherol (*SRR-*, *SSR-*, *SRS-*, and *SSS-* α-tocopherol), also found in fortified foods and supplements.

[e]As niacin equivalents (NE). 1 mg of niacin = 60 mg of tryptophan; 0–6 months = preformed niacin (not NE).

[f]As dietary folate equivalents (DFE). 1 DFE = 1µg food folate = 0.6 µg of folic acid from fortified food or as a supplement consumed with food = 0.5 µg of a supplement taken on an empty stomach.

[g]Although AIs have been set for choline, there are few data to assess whether a dietary supply of choline is needed at all stages of the life cycle, and it may be that the choline requirement can be met by endogenous synthesis at some of these stages.

[h]Because 10 to 30 percent of older people may malabsorb food-bound B_{12}, it is advisable for those older than 50 years to meet their RDA mainly by consuming foods fortified with B_{12} or a supplement containing B_{12}.

[i]In view of evidence linking folate intake with neural tube defects in the fetus, it is recommended that all women capable of becoming pregnant consume 400 µg from supplements or fortified foods in addition to intake of food folate from a varied diet.

[j]It is assumed that women will continue consuming 400 µg from supplements or fortified food until their pregnancy is confirmed and they enter prenatal care, which ordinarily occurs after the end of the periconceptional period—the critical time for formation of the neural tube.

Dietary Reference Intakes (DRIs): Recommended Intakes for Individuals, Elements

Food and Nutrition Board, Institute of Medicine, National Academies

LIFE STAGE GROUP	CALCIUM (MG/D)	CHROMIUM (µG/D)	COPPER (µG/D)	FLUORIDE (MG/D)	IODINE (µG/D)	IRON (MG/D)	MAGNESIUM (MG/D)	MANGANESE (MG/D)	MOLYBDENUM (µG/D)	PHOSPHORUS (MG/D)	SELENIUM (µG/D)	ZINC (MG/D)	POTASSIUM (G/D)	SODIUM (G/D)	CHLORIDE (G/D)
Infants															
0–6 mo	210*	0.2*	200*	0.01*	110*	0.27*	30*	0.003*	2*	100*	15*	2*	0.4*	0.12*	0.18*
7–12 mo	270*	5.5*	220*	0.5*	130*	**11**	75*	0.6*	3*	275*	20*	**3**	0.7*	0.37*	0.57*
Children															
1–3 y	500*	11*	**340**	0.7*	**90**	**7**	**80**	1.2*	**17**	**460**	**20**	**3**	3.0*	1.0*	1.5*
4–8 y	800*	15*	**440**	1*	**90**	**10**	**130**	1.5*	**22**	**500**	**30**	**5**	3.8*	1.2*	1.9*
Males															
9–13 y	1,300*	25*	**700**	2*	**120**	**8**	**240**	1.9*	**34**	**1,250**	**40**	**8**	4.5*	1.5*	2.3*
14–18 y	1,300*	35*	**890**	3*	**150**	**11**	**410**	2.2*	**43**	**1,250**	**55**	**11**	4.7*	1.5*	2.3*
19–30 y	1,000*	35*	**900**	4*	**150**	**8**	**400**	2.3*	**45**	**700**	**55**	**11**	4.7*	1.5*	2.3*
31–50 y	1,000*	35*	**900**	4*	**150**	**8**	**420**	2.3*	**45**	**700**	**55**	**11**	4.7*	1.5*	2.3*
51–70 y	1,200*	30*	**900**	4*	**150**	**8**	**420**	2.3*	**45**	**700**	**55**	**11**	4.7*	1.3*	2.0*
> 70 y	1,200*	30*	**900**	4*	**150**	**8**	**420**	2.3*	**45**	**700**	**55**	**11**	4.7*	1.2*	1.8*
Females															
9–13 y	1,300*	21*	**700**	2*	**120**	**8**	**240**	1.6*	**34**	**1,250**	**40**	**8**	4.5*	1.5*	2.3*
14–18 y	1,300*	24*	**890**	3*	**150**	**15**	**360**	1.6*	**43**	**1,250**	**55**	**9**	4.7*	1.5*	2.3*
19–30 y	1,000*	25*	**900**	3*	**150**	**18**	**310**	1.8*	**45**	**700**	**55**	**8**	4.7*	1.5*	2.3*
31–50 y	1,000*	25*	**900**	3*	**150**	**18**	**320**	1.8*	**45**	**700**	**55**	**8**	4.7*	1.5*	2.3*
51–70 y	1,200*	20*	**900**	3*	**150**	**8**	**320**	1.8*	**45**	**700**	**55**	**8**	4.7*	1.3*	2.0*
> 70 y	1,200*	20*	**900**	3*	**150**	**8**	**320**	1.8*	**45**	**700**	**55**	**8**	4.7*	1.2*	1.8*
Pregnancy															
14–18 y	1,300*	29*	**1,000**	3*	**220**	**27**	**400**	2.0*	**50**	**1,250**	**60**	**12**	4.7*	1.5*	2.3*
19–30 y	1,000*	30*	**1,000**	3*	**220**	**27**	**350**	2.0*	**50**	**700**	**60**	**11**	4.7*	1.5*	2.3*
31–50 y	1,000*	30*	**1,000**	3*	**220**	**27**	**360**	2.0*	**50**	**700**	**60**	**11**	4.7*	1.5*	2.3*
Lactation															
14–18 y	1,300*	44*	**1,300**	3*	**290**	**10**	**360**	2.6*	**50**	**1,250**	**70**	**13**	5.1*	1.5*	2.3*
19–30 y	1,000*	45*	**1,300**	3*	**290**	**9**	**310**	2.6*	**50**	**700**	**70**	**12**	5.1*	1.5*	2.3*
31–50 y	1,000*	45*	**1,300**	3*	**290**	**9**	**320**	2.6*	**50**	**700**	**70**	**12**	5.1*	1.5*	2.3*

NOTE: This table presents Recommended Dietary Allowances (RDAs) in **bold type** and Adequate Intakes (AIs) in ordinary type followed by an asterisk (*). RDAs and AIs may both be used as goals for individual intake. RDAs are set to meet the needs of almost all (97 to 98 percent) individuals in a group. For healthy breastfed infants, the AI is the mean intake. The AI for other life stage and gender groups is believed to cover needs of all individuals in the group, but lack of data or uncertainty in the data prevent being able to specify with confidence the percentage of individuals covered by this intake.

SOURCES: *Dietary Reference Intakes for Calcium, Phosphorus, Magnesium, Vitamin D, and Fluoride* (1997); *Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B_6, Folate, Vitamin B_{12}, Pantothenic Acid, Biotin, and Choline* (1998); *Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids* (2000); *Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc* (2001); and *Dietary References Intakes for Water, Potassium, Sodium Chloride, and Sulfate* (2004). These reports may be accessed via http://www.nap.edu.

Dietary Reference Intakes (DRIs): Tolerable Upper Intake Levels (UL[a]), Vitamins

Food and Nutrition Board, Institute of Medicine, National Academies

LIFE STAGE GROUP	VITAMIN A (µG/D)[b]	VITAMIN C (MG/D)	VITAMIN D (µG/D)	VITAMIN E (MG/D)[c, d]	VITAMIN K	THIAMIN	RIBOFLAVIN	NIACIN (MG/D)[d]	VITAMIN B_6 (MG/D)	FOLATE (µG/D)[d]	VITAMIN B_{12}	PANTOTHENIC ACID	BIOTIN	CHOLINE (G/D)	CAROTENOIDS[e]
Infants															
0–6 mo	600	ND[f]	25	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
7–12 mo	600	ND	25	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Children															
1–3 y	600	400	50	200	ND	ND	ND	10	30	300	ND	ND	ND	1.0	ND
4–8 y	900	650	50	300	ND	ND	ND	15	40	400	ND	ND	ND	1.0	ND
Males, Females															
9–13 y	1,700	1,200	50	600	ND	ND	ND	20	60	600	ND	ND	ND	2.0	ND
14–18 y	2,800	1,800	50	800	ND	ND	ND	30	80	800	ND	ND	ND	3.0	ND
19–70 y	3,000	2,000	50	1,000	ND	ND	ND	35	100	1,000	ND	ND	ND	3.5	ND
> 70 y	3,000	2,000	50	1,000	ND	ND	ND	35	100	1,000	ND	ND	ND	3.5	ND
Pregnancy															
14–18 y	2,800	1,800	50	800	ND	ND	ND	30	80	800	ND	ND	ND	3.0	ND
19–50 y	3,000	2,000	50	1,000	ND	ND	ND	35	100	1,000	ND	ND	ND	3.5	ND
Lactation															
14–18 y	2,800	1,800	50	800	ND	ND	ND	30	80	800	ND	ND	ND	3.0	ND
19–50 y	3,000	2,000	50	1,000	ND	ND	ND	35	100	1,000	ND	ND	ND	3.5	ND

[a]UL = The maximum level of daily nutrient intake that is likely to pose no risk of adverse effects. Unless otherwise specified, the UL represents total intake from food, water, and supplements. Due to lack of suitable data, ULs could not be established for vitamin K, thiamin, riboflavin, vitamin B_{12}, pantothenic acid, biotin, carotenoids. In the absence of ULs, extra caution may be warranted in consuming levels above recommended intakes.

[b]As preformed vitamin A only.

[c]As α-tocopherol; applies to any form of supplemental α-tocopherol.

[d]The ULs for vitamin E, niacin, and folate apply to synthetic forms obtained from supplements, fortified foods, or a combination of the two.

[e]β-Carotene supplements are advised only to serve as a provitamin A source for individuals at risk of vitamin A deficiency.

[f]ND = Not determinable due to lack of data of adverse effects in this age group and concern with regard to lack of ability to handle excess amounts. Source of intake should be from food only to prevent high levels of intake.

SOURCES: *Dietary Reference Intakes for Calcium, Phosphorus, Magnesium, Vitamin D, and Fluoride* (1997); *Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B_6, Folate, Vitamin B_{12}, Pantothenic Acid, Biotin, and Choline* (1998); *Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids* (2000). and *Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc* (2001). These reports may be accessed via http://www.nap.edu.

Dietary Reference Intakes (DRIs): Tolerable Upper Intake Levels (UL[a]), Elements

Food and Nutrition Board, Institute of Medicine, National Academies

LIFE STAGE GROUP	ARSENIC[b]	BORON (MG/D)	CALCIUM (G/D)	CHROMIUM	COPPER (µG/D)	FLUORIDE (MG/D)	IODINE (µG/D)	IRON (MG/D)	MAGNESIUM (MG/D)[c]	MANGANESE (MG/D)	MOLYBDENUM (µG/D)	NICKEL (MG/D)	PHOSPHORUS (G/D)	POTASSIUM	SELENIUM (µG/D)	SILICON[d]	SULFATE	VANADIUM (MG/D)[e]	ZINC (MG/D)	SODIUM (G/D)	CHLORIDE (G/D)
Infants																					
0–6 mo	ND[f]	ND	ND	ND	ND	0.7	ND	40	ND	ND	ND	ND	ND	ND	45	ND	ND	ND	4	ND	ND
7–12 mo	ND	ND	ND	ND	ND	0.9	ND	40	ND	ND	ND	ND	ND	ND	60	ND	ND	ND	5	ND	ND
Children																					
1–3 y	ND	3	2.5	ND	1,000	1.3	200	40	65	2	300	0.2	3	ND	90	ND	ND	ND	7	1.5	2.3
4–8 y	ND	6	2.5	ND	3,000	2.2	300	40	110	3	600	0.3	3	ND	150	ND	ND	ND	12	1.9	2.9
Males, Females																					
9–13 y	ND	11	2.5	ND	5,000	10	600	40	350	6	1,100	0.6	4	ND	280	ND	ND	ND	23	2.2	3.4
14–18 y	ND	17	2.5	ND	8,000	10	900	45	350	9	1,700	1.0	4	ND	400	ND	ND	ND	34	2.3	3.6
19–70 y	ND	20	2.5	ND	10,000	10	1,100	45	350	11	2,000	1.0	4	ND	400	ND	ND	1.8	40	2.3	3.6
> 70 y	ND	20	2.5	ND	10,000	10	1,100	45	350	11	2,000	1.0	3	ND	400	ND	ND	1.8	40	2.3	3.6
Pregnancy																					
14–18 y	ND	17	2.5	ND	8,000	10	900	45	350	9	1,700	1.0	3.5	ND	400	ND	ND	ND	34	2.3	3.6
19–50 y	ND	20	2.5	ND	10,000	10	1,100	45	350	11	2,000	1.0	3.5	ND	400	ND	ND	ND	40	2.3	3.6
Lactation																					
14–18 y	ND	17	2.5	ND	8,000	10	900	45	350	9	1,700	1.0	4	ND	400	ND	ND	ND	34	2.3	3.6
19–50 y	ND	20	2.5	ND	10,000	10	1,100	45	350	11	2,000	1.0	4	ND	400	ND	ND	ND	40	2.3	3.6

[a]UL = The maximum level of daily nutrient intake that is likely to pose no risk of adverse effects. Unless otherwise specified, the UL represents total intake from food, water, and supplements. Due to lack of suitable data, ULs could not be established for arsenic, chromium, silicon, potassium, and sulfate. In the absence of ULs, extra caution may be warranted in consuming levels above recommended intakes.

[b]Although the UL was not determined for arsenic, there is no justification for adding arsenic to food or supplements.

[c]The ULs for magnesium represent intake from a pharmacological agent only and do not include intake from food and water.

[d]Although silicon has not been shown to cause adverse effects in humans, there is no justification for adding silicon to supplements.

[e]Although vanadium in food has not been shown to cause adverse effects in humans, there is no justification for adding vanadium to food and vanadium supplements should be used with caution. The UL is based on adverse effects in laboratory animals and this data could be used to set a UL for adults but not children and adolescents.

[f]ND = Not determinable due to lack of data of adverse effects in this age group and concern with regard to lack of ability to handle excess amounts. Source of intake should be from food only to prevent high levels of intake.

SOURCES: *Dietary Reference Intakes for Calcium, Phosphorous, Magnesium, Vitamin D, and Fluoride* (1997); *Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B_6, Folate, Vitamin B_{12}, Pantothenic Acid, Biotin, and Choline* (1998); *Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids* (2000); *Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc* (2001); *and Dietary Reference Intakes for Water, Potassium, Sodium, Chloride, and Sulfate* (2004). These reports may be accessed via http://www.nap.edu.

Dietary Reference Intakes (DRIs): Recommended Intakes for Individuals, Macronutrients

Food and Nutrition Board, Institute of Medicine, National Academies

LIFE STAGE GROUP	TOTAL WATER[a] (L/D)	CARBOHYDRATE (G/D)	TOTAL FIBER (G/D)	FAT (G/D)	LINOLEIC ACID (G/D)	α-LINOLENIC ACID (G/D)	PROTEIN[b] (G/D)
Infants							
0–6 mo	0.7*	60*	ND	31*	4.4*	0.5*	9.1*
7–12 mo	0.8*	95*	ND	30*	4.6*	0.5*	**11.0[c]**
Children							
1–3 y	1.3*	**130**	19*	ND	7*	0.7*	**13**
4–8 y	1.7*	**130**	25*	ND	10*	0.9*	**19**
Males							
9–13 y	2.4*	**130**	31*	ND	12*	1.2*	**34**
14–18 y	3.3*	**130**	38*	ND	16*	1.6*	**52**
19–30 y	3.7*	**130**	38*	ND	17*	1.6*	**56**
31–50 y	3.7*	**130**	38*	ND	17*	1.6*	**56**
51–70 y	3.7*	**130**	30*	ND	14*	1.6*	**56**
> 70 y	3.7*	**130**	30*	ND	14*	1.6*	**56**
Females							
9–13 y	2.1*	**130**	26*	ND	10*	1.0*	**34**
14–18 y	2.3*	**130**	26*	ND	11*	1.1*	**46**
19–30 y	2.7*	**130**	25*	ND	12*	1.1*	**46**
31–50 y	2.7*	**130**	25*	ND	12*	1.1*	**46**
51–70 y	2.7*	**130**	21*	ND	11*	1.1*	**46**
> 70 y	2.7*	**130**	21*	ND	11*	1.1*	**46**
Pregnancy							
14–18 y	3.0*	**175**	28*	ND	13*	1.4*	**71**
19–30 y	3.0*	**175**	28*	ND	13*	1.4*	**71**
31–50 y	3.0*	**175**	28*	ND	13*	1.4*	**71**
Lactation							
14–18 y	3.8*	**210**	29*	ND	13*	1.3*	**71**
19–30 y	3.8*	**210**	29*	ND	13*	1.3*	**71**
31–50 y	3.8*	**210**	29*	ND	13*	1.3*	**71**

NOTE: This table presents Recommended Dietary Allowances (RDAs) in **bold type** and Adequate Intakes (AIs) in ordinary type followed by an asterisk (*). RDAs and AIs may both be used as goals for individual intake. RDAs are set to meet the needs of almost all (97 to 98 percent) individuals in a group. For healthy infants fed human milk, the AI is the mean intake. The AI for other life stage and gender groups is believed to cover the needs of all individuals in the group, but lack of data or uncertainty in the data prevent being able to specify with confidence the percentage of individuals covered by this intake.

[a] *Total* water includes all water contained in food, beverages, and drinking water.

[b] Based on 0.8 g/kg body weight for the reference body weight.

[c] Change from 13.5 in prepublication copy due to calculation error.

Dietary Reference Intakes (DRIs): Estimated Average Requirements for Groups

Food and Nutrition Board, Institute of Medicine, National Academies

LIFE STAGE GROUP	CHO (G/D)	PROTEIN (G/D)[a]	VIT A (µG/D)[b]	VIT C (MG/D)	VIT E (MG/D)[c]	THIAMIN (MG/D)	RIBOFLAVIN (MG/D)	NIACIN (MG/D)[d]	VIT B_6 (MG/D)	FOLATE (µG/D)[e]	VIT B_{12} (µG/D)	COPPER (µG/D)	IODINE (µG/D)	IRON (MG/D)	MAGNESIUM (MG/D)	MOLYBDENUM (µG/D)	PHOSPHORUS (MG/D)	SELENIUM (µG/D)	ZINC (MG/D)
Infants																			
7–12 mo		9*												6.9					2.5
Children																			
1–3 y	100	11	210	13	5	0.4	0.4	5	0.4	120	0.7	260	65	3.0	65	13	380	17	2.5
4–8 y	100	15	275	22	6	0.5	0.5	6	0.5	160	1.0	340	65	4.1	110	17	405	23	4.0
Males																			
9–13 y	100	27	445	39	9	0.7	0.8	9	0.8	250	1.5	540	73	5.9	200	26	1,055	35	7.0
14–18 y	100	44	630	63	12	1.0	1.1	12	1.1	330	2.0	685	95	7.7	340	33	1,055	45	8.5
19–30 y	100	46	625	75	12	1.0	1.1	12	1.1	320	2.0	700	95	6	330	34	580	45	9.4
31–50 y	100	46	625	75	12	1.0	1.1	12	1.1	320	2.0	700	95	6	350	34	580	45	9.4
51–70 y	100	46	625	75	12	1.0	1.1	12	1.4	320	2.0	700	95	6	350	34	580	45	9.4
> 70 y	100	46	625	75	12	1.0	1.1	12	1.4	320	2.0	700	95	6	350	34	580	45	9.4
Females																			
9–13 y	100	28	420	39	9	0.7	0.8	9	0.8	250	1.5	540	73	5.7	200	26	1,055	35	7.0
14–18 y	100	38	485	56	12	0.9	0.9	11	1.0	330	2.0	685	95	7.9	300	33	1,055	45	7.3
19–30 y	100	38	500	60	12	0.9	0.9	11	1.1	320	2.0	700	95	8.1	255	34	580	45	6.8
31–50 y	100	38	500	60	12	0.9	0.9	11	1.1	320	2.0	700	95	8.1	265	34	580	45	6.8
51–70 y	100	38	500	60	12	0.9	0.9	11	1.3	320	2.0	700	95	5	265	34	580	45	6.8
> 70 y	100	38	500	60	12	0.9	0.9	11	1.3	320	2.0	700	95	5	265	34	580	45	6.8
Pregnancy																			
14–18 y	135	50	530	66	12	1.2	1.2	14	1.6	520	2.2	785	160	23	335	40	1,055	49	10.5
19–30 y	135	50	530	70	12	1.2	1.2	14	1.6	520	2.2	800	160	22	290	40	580	49	9.5
31–50 y	135	50	530	70	12	1.2	1.2	14	1.6	520	2.2	800	160	22	300	40	580	49	9.5
Lactation																			
14–18 y	160	60	855	96	16	1.2	1.3	13	1.7	450	2.4	985	209	7	300	35	1,055	59	10.9
19–30 y	160	60	900	100	16	1.2	1.3	13	1.7	450	2.4	1,000	209	6.5	255	36	580	59	10.4
31–50 y	160	60	900	100	16	1.2	1.3	13	1.7	450	2.4	1,000	209	6.5	265	36	580	59	10.4

NOTE: This table presents Estimated Average Requirements (EARs), which serve two purposes: for assessing adequacy of population intakes, and as the basis for calculating Recommended Dietary Allowances (RDAs) for individuals for those nutrients. EARs have not been established for vitamin D, vitamin K, pantothenic acid, biotin, choline, calcium, chromium, fluoride, manganese, or other nutrients not yet evaluated via the DRI process.

[a]For individual at reference weight (Table 1-1). *indicates change from prepublication copy due to calculation error.

[b]As retinol activity equivalents (RAEs). 1 RAE = 1µg retinol, 12 µg β-carotene, 24 µg α-carotene, or 24 µg β-cryptoxanthin. The RAE for dietary provitamin A carotenoids is two-fold greater than retinol equivalents (RE), whereas the RAE for preformed vitamin A is the same as RE.

[c]As α-tocopherol. α-Tocopherol includes *RRR*-α-tocopherol, the only form of α-tocopherol that occurs naturally in foods, and the *2R*-stereoisomeric forms of α-tocopherol (*RRR-, RSR-, RRS-,* and *RRS*-α-tocopherol) that occur in fortified foods and supplements. It does not include the *2S*-stereoisomeric forms of α-tocopherol (*SRR-, SSR-, RRS-,* and *SSS*-α-tocopherol), also found in fortified foods and supplements.

[d]As niacin equivalents (NE). 1 mg of niacin = 60 mg of trytophan.

[e]As dietary folate equivalents (DFE). 1 DFE = 1 µg food folate = 0.6 µg of folic acid from fortified food or as a supplement consumed with food = 0.5 µg of a supplement taken on an empty stomach.

SOURCES: *Dietary Reference Intakes for Calcium, Phosphorus, Magnesium, Vitamin D, and Fluoride* (1997); *Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B_6, Folate, Vitamin B_{12}, Pantothenic Acid, Biotin, and Choline* (1998); *Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids* (2000); *Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc* (2001), and *Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids* (2002). These reports may be accessed via www.nap.edu.

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