Debre Berhan University

College of Natural and Computational Sciences

Department of Biology

Modular Curriculum for

Master of Science

In

Applied Microbiology

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1.Background, Mission and Goals

1.1.Background

The Department of Biology, Debre Berhan University, has been conducting undergraduate program in Biology since 2007. The department has now full-fledged the required academic qualification and professional composition of its staff members through the governmental teacher's development program and hence it is found a timely endeavor to launch MSc. Program in Applied Microbiology.

The establishment of the program is based on the general belief that all students who have secured first degree in life sciences and have aspirations to pursue a study in applied microbiology field, would get the opportunity to attain higher education in microbiological discipline. The Biology Department believes that all students attending this program could acquire the necessary knowledge, skills and attitude for teaching in secondary and tertiary levels and for conducting research that could help them contribute to the development of the country. This could fulfill the national demand for trained staff in expanding tertiary level education in Ethiopia and research on microbiological related disciplines at all aspects.

1.2.Mission and Goals

The mission of the Department of Biology, Debre Berhan University, is to contribute its part for country development through pursuit of education, learning and research in Biological sciences at the highest international level of excellence to the Ethiopian society. The launching of MSc. Program in Applied Microbiology stream would add a value to accomplish the mission of the department so as to be one of the best centers in microbiological and biotechnological related research.

2.Rationale

The number of universities in Ethiopia was nine until the middle of 1999 E.C. Now, the total number of Universities has reached thirty two. Launching of ten more new higher learning institutions in the country is also in progress. This entails the demand for new instructors. In light of this background, the Ministry of Education is training many university teachers at masters level. Moreover, new research institutes are being built in the areas of agriculture, industry, and health. The private sectors, local and international NGOs, are also in need of trained manpower. Generally, microbiologists are highly required to carry out activities in different sectors.

This is time to launch a postgraduate program in Applied Microbiology at DBU since demand for more teachers and researchers at a national scale is strongly increasing. The intended program also targets various stakeholders with high demand for well-trained microbiologists. This include, among other, the Ministry of Education, Ministry of Science and Technology, Agricultural Research Institute, Ministry of Agriculture, Environmental Protection Agency, and Ministry of industry.

The application of microbiology is so wide that it interacts with money fields related to life science. It ranges from soil formation (mineralization) to road and building constructions in which most doesn't recognize its importance. Microbiology is relevant in pharmaceutical, brewery, wine, food processing, leather processing, and abattoir industries. In addition, microbiology is highly needed in the field of waste treatment, bio-fertilizer production, and plant protection. In the era of climate change, great attention is given to renewable energy. Microbiology also contribute tremendous applications in the production of biofuels (bioethanol and biodiesel).

Since Applied Microbiology is greatly needed in different sectors, it potentially contributes to the successful implementation of Ethiopian growth and transformation plan II (GTP II). Therefore, it plays its own part to achieve Millennium Development Goal (MDG).

Therefore, microbiology contributes its part to meet Ethiopia's developmental needs, the application of resources for industry, solutions for environmental challenges and secure social welfare. Furthermore, several new universities have been established in Ethiopia. The national need for teaching and research staff in these new universities can partly be met by launching of new graduate programs. Therefore, this new MSc Program plays critical roles in supporting the teaching – learning effort of these new Universities besides different research activities. Clearly, MSc program in Applied Microbiology at Department of Biology, DBU will be critical in supporting these new universities by way of producing trained educators. Thus, the intended program is well-targeted at all aspects.

3.Program Title and Responsible Unit

3.1.Program Unit

Applied Microbiology

3.2.Responsible Unit

Biology Department, College of Natural and Computational Sciences, Debre Berhan University, is the responsible unit for running this program.

4.Training Objectives

General objective:

The general objective of the MSc Program is to produce quality trained manpower and conduct research in priority areas that give emphasis for Ethiopia's developmental needs in different areas such as bio-fertilizer production and soil fertility, solid and liquid waste treatment, medical mitigation programs, renewable energy production, biological plant protection, microbe based industrial products, as well as to satisfy the national demand in the areas of microbiological education and research.

Specific objectives

On the completion of the program, the specific objectives of the program are to

- produce graduates so as to satisfy the manpower needs of the country in applied microbiology and contribute to the environmental, industrial, medical, and agricultural sectors of the country;
- upgrade the qualification of lecturers and researchers in higher education and research institutions;
- train candidates who understand the current trends of microbiology;
- give training to students who demonstrate ability how to design, undertake, interpret, and present a specific microbiological project that solves specific challenges of the society ; and
- produce graduates that can play significant roles in society to promote scientific doctrine in the application of microorganisms in industry, agriculture, medicine, and environment.

5.Graduate Profile/Competencies

The graduate of Applied Microbiology will able to

- Teach Applied Microbiology at higher educational institutions;
- Contribute their expertise in agriculture, industry, health, food, and environmental management.
- Identify problems and seek solutions to scientific and developmental problems in his/her field of specialization;
- Design and implement research projects in his/her field of specialization;
- Provide advice and consultation to government, non-government and the private sector; and
- Serve as an agent of change in matters related to Applied Microbiology and influence people to build a more scientific society.
- Pursue the PhD programs to deeper and specialize in particular biological research

areas

6.Intended Learning Outcomes of the Program

This MSc Program gradually builds knowledge, understandings, and skills of basic principles on how to apply microorganisms for human and other organisms.

6.1.Knowledge and understanding

The MSc program will enable to analyze the application of microorganisms in industry, food, waste treatment, agriculture and health aspects at both national and global scales. The interactions of a microorganism with other microorganisms, plants, animals and other living thing will be efficiently understood and exploited the interactions for human welfare. The students will also gain knowledge in microbial diversity and ecology and the ways how to conserve it.

6.2.Skills and abilities

The MSc graduates will able to acquire skills on basic microbiological techniques and they will have skills on how to use and maintain basic microbiological tools.

7.Department Facilities

7.1.Staff Profile

Biology Department, DBU is staffed with qualified individuals in Applied Microbiology that could handle the task of the intended program. There are 2 PhD candidates and 3 lecturers in Applied Microbiology stream. Moreover, there are three support staffs who are managing laboratory.

Table 1 List of teaching staff members for the intended program

	Name	Rank	Qualification	Remark
1.	Asmamaw Tesfaw	Lecturer	Applied Microbiology	PhD candidate
2.	Jerman Mamo	Lecturer	Applied Microbiology	PhD candidate
3.	Bulti Kumera	Lecturer	Applied Microbiology	
4.	Negasi Akalu	Lecturer	Applied Microbiology	
5.	Melkam Desalegn	Lecturer	Applied Microbiology	
6.	Solomon Taddesse	Assistant Lecturer		

Furthermore, there are three support staff members, who are currently working at the biology laboratory of Debre Berhan University. They are listed below.

1. Ato Getasew Amsalu (Laboratory Technician)
2. Ato Demissew Gebeyehu (Laboratory Technician)
3. W/t Emebet Tadesse (Laboratory Attendant)

7.2.Non-Human Resources

7.2.1.Laboratories

Even if basic microbiological laboratories, media and chemicals are available for under graduate programs, it needs to establish applied microbiology research laboratories since the program is a new start.

7.2.2.Library

The DBU libraries have key references in various aspects of microbiology which surely helps the intended students to get enrolled in the Applied Microbiology stream.

7.2.3.Partners and Industrial Linkage near DBU

Department of Biology, DBU has a close linkage to Dashen and Habesha Breweries which enable microbiology students to visit and practice the real application of industrial

microbiology. Tannery and abattoirs are also located in Debre Berhan town. The Debre Berhan Agricultural Research Institute will help the Program by ensuring how to make microbial research in the field of agriculture.

The proximity of DBU to Addis Ababa enable to use different facilities in various institutions including Addis Ababa Universities which are found in Addis Ababa. Institute of Biodiversity, located in Addis Ababa, has a microbial culture collection center and different microbiological laboratory facilities to be utilized for the intended program.

8.Indicator of Quality and Standards

The Department of Biology, DBU, strives for educational excellence in all disciplines including Applied Microbiology through enriching its teaching-learning endeavors by incorporation of new scientific knowledge from researchers in area into the contents of its courses. The indicators of educational quality and standards of its MSc Program would include measuring:

- Proportion of number of applicants to its core teaching staff.
- Performance of students based on evaluation of their grades in specialized courses under the Applied Microbiology discipline.
- Performance of students in experimentation and analysis.
- Students ability in laboratory managements and cares taken while experimenting in laboratories.
- Performance of students in write-up of term papers, seminars and their thesis
- Their Cumulative GPA upon graduation

Mechanisms to Evaluate and Improve Quality and Standards

In order to ensure the highest international level of excellence in Applied Microbiology, the Department will get student support through teacher (teaching-learning) evaluation, teaching-learning resources, including recruiting highly trained academic and technical staff

in areas of deficiency, strengthening the infrastructure and facilities as well as the human needs required to improve students' achievements. In addition, feedback from stakeholders and periodic reviews of the curriculum and modules and feedback from academic staff of the Department would be tools to ensure quality.

9.Academic requirements

9.1.Course Requirement:

For the MSc program a minimum of 29 credit hours and Thesis Work (6 credit hours) are required for graduation. Students should carry out a research and defend their work on the time that will be scheduled by the Department.

9.2.Admission Requirement

Candidates should satisfy the following minimum requirements for admission to the MSc program in Applied Microbiology

- B.Sc or B.Ed degree in biology or other life sciences such as plant science, biochemistry, microbiology, biotechnology, animal sciences, veterinary sciences, general agriculture, forestry, aquatic sciences, zoological sciences, and health sciences from a recognized higher education institution CGPA of 2.0 and above or its equivalent ECTS. The students who are graduated with a grading system different from 4.0 system will be accepted after the approvable of Graduate Committee with the consent of Applied Microbiology professionals or Applied Microbiology stream coordinator.
- Other entrance requirements set by the University as indicated in the

University legislation.

- It needs to pass entrance examination given by the Program.

9.3.Overall Credit Value and Equivalent European Credit Transfer System (ECTS), Program Duration

The total Credit Hours for the MSc Program is 35 and the equivalent ECTS for this MSc Program of the Department is 99.

9.4.Duration of the Study

The MSc Program in biology takes two years in the regular program. For both summer and extension program students a minimum of three and maximum of four years is required to complete their study.

9.5.Assessment and Evaluation

9.5.1. For course Work

- Assignments
- Mid Semester Examination
- Final semester Examination
- Term papers and Seminars

9.5.2. For Practical Courses

- Laboratory Reports/ Field Reports
- Practical Examinations
- Written Examinations

9.5.3. For Theses/Seminars/Report

- Presentation, Quality of Paper Presented
- Way of Presentation
- Defending Material Presented

Thesis

Details to be assessed	**Weight**
1. Topic selection	5%
▪ Is it current	
▪ Is it applicable	
▪ Is it specific	
2. Write up	
▪ Abstract	5%
▪ Review Literature (Current, coherence, relevance)	10%
▪ Introduction	5%
▪ Material and Method (relevance to the topic and objective, inclusion, logical flow)	15%
▪ Result and discussion (Language quality, compression of the subject matter, statistical analysis, data presentation (pictures and tables) appropriateness of other research citation, logical sequence)	25%
▪ Conclusion, recommendation and future direction	5%
▪ References	5%
3. Oral presentation	
▪ Quality of slides	5%
▪ Clarity and coherent	5%
▪ Way of presentation	5%
▪ The way of defending to questions	5%
▪ Confidence and professional dressing	5%

9.6. Grading System

Pass criteria is based on the letter grading system relative to the performance of trainees. The letter grading and their equivalents are:

- A=4.00
- A^-=3.75
- B^+=3.5
- B=3.0
- B^-=2.75
- C^+=2.5
- C=2.0
- D=1
- F=0

A student should score an average CGPA of 3.00 for promotion. Students who score less than 2.50 in the first semester will be dismissed and apply to repeat courses or a probation status will be given to continue the lesson based on his/her performance. All other semester results following this should be above 3.00 grade points. If the student's result is between 2.50 and 3.00 it will be presented to the DGC for decision. The decision will be complete dismissal.

9.7.Graduation Requirements

Students will be eligible for graduation upon successful completion of all specified courses and a thesis work, which must be written and defended and concluded with a pass mark. Assigning students to thesis will be decided by the Department Graduate Council. Besides, No 'F' and 'D' should be scored in any of the courses taken and must be with a minimum

cumulative GPA of 3.0.

10.Degree Nomenclature

MSc Degree in Applied Microbiology

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11.Curriculum structure with Credit Hour Requirements

Table 2 total credit requirements

Course/Thesis	**Credit hours**
Common course	6
Major course	23
Thesis	6
Total	**35**

Common courses are going to be offered to all MSc streams in the Department. The seminar will be delivered by thesis supervisor or in the consent of thesis supervisor on the topics to be reviewed and presented if it will be delivered by anyone other than the supervisor.

12.Module and Course Coding

12.1.Module Coding

The module code begins with M and it is followed by three digits.

- M= Module
- First digit (6 or 7)= the year
- Second digit (3)= Applied Microbiology Stream
- Third= module numbering (what makes the module different)

12.2.Course Coding

The courses are coded by Biol followed with four digits

1. The first digit from left indicates the year (6 or 7)
2. The second digit from the left indicates the stream (Applied Microbiology, 3). If it is zero, the course will be delivered to all streams (common course)
3. The third digits from the left (1, 2, …..,9) indicates the specific course
4. The last digit from the left indicates the last digit of module code.

   For Example Biol 6312

   - 6= Year
   - 3= Applied Microbiology
   - 1= Microbial physiology and Biochemistry
   - 2= The last digit of the module code (2 in M632)

13.Course Lists According to Curriculum Structure

Table 3 Major course lists

Module Code	Course Name	Course Code	Course credit	Lec.	Lab.	Home study	ECTS	Delivery Mode
M632	1. Microbial Physiology and Biochemistry	Biol 6312	3	2	3	9	7	Semester
	2. Microbial genetics and molecular biology	Biol6322	2	1	3	6	5	Semester
M633	Biology of Pathogenic Microorganisms	Biol 6323	3	2	3	9	7	Semester
M634	1. Microbial Ecology and diversity	Biol 6334	3	2	3	9	7	Semester
	2. Environmental Microbiology	Biol 6344	3	2	3	9	7	Semester
M635	1. Industrial Microbiology	Biol 6355	2	1	3	6	5	Semester
	2. Food Microbiology	Biol 6365	3	2	3	9	7	Semester
M636	Basic techniques in Microbiology	Biol 6386	2	1	3	6	5	Semester
Total			**21**				**50**	

Table 4 Common course lists

Module Code	Course Name	Course Code	Course credit	Lec.	Lab.	Home study	ECTS	Delivery Mode
M601	1. Biological Data Analysis	Biol 6011	3	3		6	7	Semester
	2. Research Design and Scientific Writing	Biol 6021	2	2		6	5	Semester
M709	1. Bioseminar	Biol 7019	1			3	2	Semester
	2. M.Sc thesis	Biol 7029	6		40	20	30	Semester
Total			**12**				**44**	

Table 5 Elective course lists

Module Code	Course Name	Course Code	Course credit	Lec.	Lab.	Home study	ECTS	Delivery Mode
M634	Agricultural Microbiology	Biol 6354	2	1	3	6	5	Semester
M635	Fermentation Technology	Biol 6375	2	1	3	6	5	Semester
M633	Virology	Biol 6333	2	2		8	5	semester
M634	Bioremediation	Biol 6364	2	1	3	6	5	Semester
M635	Brewery and wine microbiology	Biol 6365	2	1	3	6	5	Semester
M634	Introduction to biofertilizers and Biocontrol	Biol 6364	2	1	3	6	5	Semester

14.Course Break Dawn

14.1.Course Break Dawn for Regular Applied Microbiology

Table 6 Course break dawn for regular Applied Microbiology

Year	Semester	Course Code	Name of the Course	Course Credit
Year 1	Semester I	Biol 6011	Biological Data Analysis	3
		Biol 6021	Research Design and Scientific Writing	2
		Biol 6334	Microbial Ecology and Diversity	3
		Biol 6344	Environmental Microbiology	3
		Biol 6323	Biology of Pathogenic Microorganisms	3
		Total credit in Semester I Year 1		**14**
	Semester II	Biol 6312	Microbial Physiology and Biochemistry	3
		Biol6322	Microbial Genetics and Molecular Biology	2
		Biol 6355	Industrial Microbiology	2
		Biol 6365	Food Microbiology	3
		Biol 6386	Basic Techniques in Microbiology	2
			Elective course	2
		Total credit in Semester II Year 1		**14**
Year 2	Semester I	Biol 7019	Bioseminar	1
		Biol 7029	MSc thesis	6
		Total credit in Semester I Year 2		**7**
	Semester II	Biol 7029	MSc thesis (continued)	6

14.2.Course Break Dawn for Summer Applied Microbiology

Table 7 Course break dawn for summer Applied Microbiology

Delivery Time/ Condition	Course Code	Name of the Course	Course Credit
Summer I	Biol 6011	Biological Data Analysis	3
	Biol 6334	Microbial Ecology and Diversity	3
	Biol 6344	Environmental Microbiology	3
Distance I	Biol 6021	Research Design and Scientific Writing	2
Summer II	Biol 6312	Microbial Physiology and Biochemistry	3
	Biol6322	Microbial Genetics and Molecular Biology	2
	Biol 6323	Biology of Pathogenic Microorganisms	3
Distance II	Biol 7019	Bioseminar	1
Summer III	Biol 6355	Industrial Microbiology	2
	Biol 6365	Food Microbiology	3
	Biol 6386	Basic Techniques in Microbiology	2
		Elective course	2
Distance III	Biol 7029	MSc thesis	6
Summer IV	Biol 7029	MSc thesis	6

14.3.Course break dawn for extension Applied Microbiology

Table 8 Course break dawn for Extension Applied Microbiology

Year	Semester	Course Code	Name of the Course	Course Credit
Year 1	Semester I	Biol 6011	Biological Data Analysis	3
		Biol 6334	Microbial Ecology and Diversity	3
	Semester II	Biol 6021	Research Design and Scientific Writing	2
		Biol 6344	Environmental Microbiology	3
	Summer I	Biol 6323	Biology of Pathogenic Microorganisms	3
		Biol 6386	Basic Techniques in Microbiology	2
Year 2	Semester I	Biol 6312	Microbial Physiology and Biochemistry	3
		Biol6322	Microbial Genetics and Molecular Biology	2
	Semester II	Biol 6355	Industrial Microbiology	2
		Biol 6365	Food Microbiology	3
	Summer II*		Elective course	2
		Biol 7019	Bioseminar	1
Year 3	Semester I	Biol 7029	MSc thesis	6
	Semester II	Biol 7029	MSc thesis	6

15.Course Description

15.1.Common courses to be delivered to all streams in Department of Biology.

1.Course title: Research Design and Scientific Writing

Module code: M601

Course code Biol 6021

Course Credits: 2 credits (5 ECTS)

Course description:

This course introduces students to research methods and designs specifically in science. It focuses on various research designs including experimental and quantitative/qualitative research methods. It gives highlights on several statistical tools and tests, what they measure, and how results are interpreted.

The module includes three parts: research methods, sampling design and science writing (including writing proposals).

Part I. Research methods: It starts with the definition of reflection, science and research. Proceeds to basic and applied research, logic in research (deductive and inductive). Defines experiment, i.e., answers questions, explores the nature of uncertainty as a whole and steps involved in research. Experimental designs: scientific research may be any of the following: case study (one or few occurrences studied and described), cross-section (the degree of relationships established), longitudinal (where variables are manipulated). Concepts discussed: observation, hypothesis, experimental unit, sampling unit, experimental error, discrimination, replication, generalization, controls, randomization, measurement, local control. Basic principles of experimental design are observation and experimentation. Common experimental designs: One-way classification design, Randomized (complete) block design, Factorial design or two-way classification design, Latin square design, Split-plot or nested design.

Part II. Sampling design: sampling is selection of individuals from population, census vs. sample. Steps in sampling (universe, sampling unit, frame, size, parameters, budget, procedure, biases (systemic, sampling error). Different sampling designs: based on representation (probability or simple random sampling and non-probability) and element selection technique (restricted or cluster/systematic/stratified/quota) and unrestricted/simple random sampling and haphazard sampling). Sample size

determination. Ethics in research.

Part III. Research proposal writing and scientific writing tips

Delivery of the course encourages cooperative learning and student self-teaching are encouraged. Following highlights of the subject matter by the instructor, students continue the learning effort by conducting small field or laboratory research work. Students may choose specific topics or they may get it from the instructor and this will be finally evaluated and scored from about 35% each. Students also work in groups, which constitutes some 25% of the task of the overall task.

Learning outcome

After taking this course, students will be able to:

- Display familiarity with research methods and approaches in science
- Demonstrate ability to apply basic research and ethical concepts
- Be able to identify appropriate research topics or select and define appropriate research problem and parameters, prepare a project proposal (to undertake a project including fund seeking) and organize and conduct research (advanced project)
- Attain basic skills in descriptive statistics and quantitative/qualitative data analysis
- Write a research report and thesis
- Attain skills to respond to feedbacks about the research
- Demonstrate competence in critical thinking by presenting and evaluating arguments in an academic fashion
- Exhibit competence in critiquing the research methods sections of research articles published

Course content

Part I. Research methods (15)

- Introductory remarks
- Experimental designs

Part II. Sampling design (6)

Choosing sampling designs based on:

- Representation
- Element selection technique

Part III. Research proposal writing and scientific writing tips (6)

- Proposals
- Science writing

Term papers/seminars (5)

- Students conduct small research, analyze data, interpret it and prepare term paper/seminar paper, present and discuss them in groups
- Topic identification is part of a learning experience and students are required to identify topics for seminars
- The instructor may propose a topic for them if that has justification

Teaching methods

Teaching method includes cooperative learning (interactive, collaborative and self-learning) methods; class-room lectures, seminars and group discussions. Field studies for practical application of statistical models learned in class.

Assessment criteria

Written exams, assignments, seminars

Inputs required:

- Standard classrooms

- Laptop and LCD projector
- Devices for biodiversity assessment in the field

Prerequisite: None

Roles of instructors and students

Instructor: delivers lectures, leads interactive learning, guides and supervises assignments

Students: attend all lectures, participates in cooperative learning seriously and work and present assignments (field studies) according to the given time table take all tests and exams.

2.Course Title: Bioseminar (Seminar in Applied Microbiology)

Module Code: M709

Course Code: Biol. 7019

Course credit: 1 credit (3 ECTS)

Course Description

Seminar on selected topics. Students review literature on a topic approved by a supervisor; prepare seminar paper on the topic and give oral presentation.

1. **Pre-Requisite Module Code**: Biol. 6021

2. **Module description:**

   This module contains the following contents: Title of the topic for seminar, abstract, introduction, materials and method, results, discussion, citation of references.

3. **Module objective**

The objectives of this module are to enable the students to:

- Identify part of key recent research questions in Applied Microbiology
- Learn to pinpoint key concepts for developing a scientific seminar paper
- develop a logical approach to review published scientific findings
- Develop a skill for independent thinking
- Develop analytical and synthetic ability
- Develop skills for publishing scientific results

4. Learning Outcomes

Have knowledge in:

- Developing seminar paper proposal
- Designing data collection/literature review protocols
- Writing an excellent summary of scientific findings in journals

Have skills in:

- Literature review and critical thinking
- Interpretation and summary of scientific findings
- Scientific writing and publishing

Have competencies in:

- Respective field of seminar work specific to their area of interests
- Presenting and defending their works for scientific audiences
- Doing further seminar papers on his/her area of specialization

5. Content Breakdown/Module Outline

This module will contain the following contents.

- Title of the topic of Seminar
- Abstract

- Introduction
- Materials and Method
- Results
- Discussion
- Citation of References

6. Teaching Strategy/Methods

- Guide the student to develop the proposal for their seminar work
- Discuss the data collection or literature review protocols and envisaged data analyses methods
- Guide the students to acquire key scientific journals relevant to their topic
- Discuss the key concepts
- Regular follow up and interactions

7. Assessment Criteria

Presentation of their reviews or findings for public audiences. An internal examiner will evaluate the findings. A pass or fail grade will be given.

8. The Respective Role of Instructors and Learners

- Guide the students in development of the contents of the seminar
- Introduce the students the skills of developing seminar papers
- Guide the students to develop independent and critical thinking
- The students are required to develop data collection/literature review protocols
- The students are required to review relevant literature or collect field data, analyse and write up the findings
- The students are required to present the finding of the study

9. Teaching Support and Inputs for Each Content

- Guide the students to acquire recent literature

- Guide the students to online educational resources
- The instructor will participate in follow up and evaluating the performance of the data collection, analysis and write up of the seminar
- The students will collect field data and/or review current literature

10. Module Requirements

- Each student should regularly interact with the instructors
- Each student will present the findings of the study for evaluation
- Each student will incorporate comments after presentation and submit the final seminar paper to the Department

11. Module Calendar

- Interactive teaching and learning: 20 days[1] (5 hours/day = 100 hours)
- Independent learning (self-learning) – literature search/ field work, data analyses and write-up: 85 days (8 hours/day = 680 hours)
- Collaborative learning: 10 day[13] (5 hours/day = 50hours)
- Presentation of seminar examination: one day (3-6 hours)

12. Reading Materials

Various published scientific journals relevant to each seminar topic

3.Course title: Biological Data Analysis

Module Code: M601

Course code : Biol. 6011

Course credit: 3 credits (7 ECTS)

Prerequisite: None

Course Description

This module starts with an introduction to biostatistics, its definition, role in research and types of data. Deals with data summarization (Frequency distribution, Charts and diagrams, Measures of central tendency, Measures of variation, Skewness and kurtosis). Probability and probability distributions including (Counting principles, Probability of events, Conditional probability, Discrete probability, distributions: Binomial, Poisson, Continuous probability distributions: Normal, t, Chi-square, F).

Sampling concepts and estimation (Sampling procedures, Sampling distribution of mean and proportions, Point and interval estimation, Sample size determination). One or two sample hypothesis testing (HT), Steps in HT, One sample problem, Two sample problem, Non-parametric methods, Application of Chi- square: Goodness of it, Test of independence (Test of association), Comparison of proportion, Odds ratio (based on availability of time). Statistical power. Regression and correlation analysis (Simple regression analysis, Multiple regression analysis, Correlation analysis, Logistic regression analysis (based on availability of time). Analysis of variance and covariance (What are ANOVA and ANCOVA?, Assumptions in ANOVA and ANCOVA, ANOVA: One-way, Two-way, ANCOVA). Multiple comparison of means and variances (Multivariate analysis). Nonparametric tests, Data transformation, Interpretation and report writing. Practicals on some popular statistical computer programs as available (SAS, JMP, excel)

Briefly it deals with basic statistical concepts such as mean, standard deviation, model, estimate, test, p- value, and confidence interval. One and two sample problems, paired data, correlation, analysis of variance and covariance, and linear regression. Non-parametric methods. The binomial distribution, logistic regression, and analysis of cross tabulated data. Simple survival analysis. Model diagnostics. Power and sample size calculations.

Learning outcome

After taking this course, students will be able to:

- Recognize and give examples of different types of data arising in the real world
- Interpret differences in data distributions via visual displays
- Calculate standard normal scores and resulting probabilities
- Calculate and interpret confidence intervals for population means and proportions
- Interpret and explain a p-value
- Perform a two-sample t-test and interpret the results; calculate a 95% confidence interval for the difference in population means
- Select an appropriate test for comparing two populations on a continuous measure, when the two sample t-test is not appropriate
- Understand and interpret results from Analysis of Variance (ANOVA), a technique used to compare means amongst more than two independent populations; ANCOVA, MANOVA, regression analysis, chi-square test, non-parametric tests, correlation analysis, etc.
- Choose an appropriate method for comparing proportions between two groups; construct a 95% confidence interval for the difference in population proportions
- Understand and interpret odds ratios when comparing two populations
- Determine what statistical model is appropriate for particular sets of data
- Be able to summarize and report statistical results

Course content

1. Introduction (2 hrs)
2. Research data summarization (2 hrs)
3. Probability and probability distributions (5 hrs)
4. Sampling concepts and estimation (6 hrs)
5. Hypothesis testing (3 hrs)

6. Chi-square (3 hrs)
7. Statistical power (2 hrs)
8. Regression and correlation analysis (6 hrs)
9. Analysis of variance and covariance (7 hrs)
10. Mean comparisons (3 hrs)
11. Non-parametric tests (4 hrs)
12. Projects **(6)**
    - Students conduct small research, analyze data, interpret it and prepare seminar paper, present and discuss them in groups
    - Topic identification is part of a learning experience and students are required to identify topics for seminars
    - The instructor may propose a topic for them if that has justification

Teaching methods

It includes cooperative learning (interactive, collaborative and self-learning) methods; class-room lectures, seminars and group discussions. Field studies for practical application of statistical models learned in class.

Assessment criteria

Written exams, assignments, seminars

Inputs required:

- Standard classrooms
- Laptop and LCD projector

Prerequisite

Research methods and reporting in science Biol. 3101

Roles of instructors and students

Instructor: delivers lectures, leads interactive learning, guides and supervises assignments

Students: attend all lectures, participates in cooperative learning seriously and work and present assignments (field studies) according to the given time table take all tests and exams.

REFERENCES

Heath, D. An Introduction to Experimental Design and Statistics for Biology, London, UCL Press, 1995. This book contains excellent conceptual explanations of the thinking behind many statistical tests and procedures.

Campbell, S. K. Flaws and Fallacies in Statistical Thinking, Prentice-Hall, 1974.

Fisher, R. A. The Design of Experiments. Hafner, 1971.

Gonick, L. and Smith, W. The Cartoon Guide to Statistics. Harper Perennial, 1993

Moses, L. E. Think and Explain with Statistics. Addison Wesley, 1986.

Sokal, R. R. and F. J. Rohlf. Introduction to Biostatistics, 2nd 3ed. Freeman, 1987.

Zar, J. Biostatistical Analysis. Prentice Hall, 1984.

4.Course Name: MSc Thesi

Module Code: M709

Course Code: Biol 7029

Credit Value of the Module:30 ECTS (6 credit hours)

Pre-Requisite Module Codes: All compulsory and required elective courses

Module description:

This module contains the following contents: Title of the topic for review, abstract, introduction, materials and method, results, discussion, citation of references.

Module objective

The objectives of this module are to enable the students to:

- Identify key recent research questions in plant biodiversity conservation, ecology and plant physiology
- Learn to pinpoint key concepts for developing the proposal and relevant literature
- develop a logical approach to review published scientific findings
- Develop a skill for independent thinking
- Develop analytical and synthetic ability
- Develop skills for publishing scientific results

2. Learning Outcomes

- ***Have knowledge in:***
  - Developing research proposal
  - Designing data collection protocols
  - Scientific data analyses
  - Writing scientific findings in journals

- ***Have skills in:***
  - Data analyses and critical thinking
  - Interpretation of scientific findings
  - Scientific writing and publishing

- ***Have competencies in:***
  - Respective field of thesis work specialization
  - Teach in higher education institutions and relevant Research Institutes
  - Do research in his/her area of specialization

- Advise MSc students

3. Content Breakdown/Module Outline

This module will contain the following contents.

- Title of the topic for review
- Abstract
- Introduction
- Materials and Method
- Results
- Discussion
- Citation of References

4. Teaching Strategy/Methods

- Guide the student to develop the proposal for the independent study project
- Discuss the data collection protocols and envisaged data analyses methods
- Field teaching on how to collect data and for further refining the data collection protocols and hypothesis
- Guide the students to acquire key scientific journals relevant to their topic
- Discuss the key concepts
- Regular follow up and interactions

5. Assessment Criteria

Presentation of the findings for public audience. Two internal examiners will be evaluate the findings. A pass or fail grade will be given.

6. The Respective Role of Instructors and Learners

- Guide the students in development of the contents of the proposal
- Introduce the students the skills of developing research proposal

- Guide the students to develop independent and critical thinking
- The students are required to develop data collection protocols
- The students are required to collect field data, analyse and write up the findings
- The students are required to present the finding of the study

7. Teaching Support and Inputs for Each Content

- Guide the students to acquire recent literature
- Guide the students to online educational resources
- The instructor will participate in the first field work to evaluate the performance of the data collection protocols and feasibility of the hypotheses for testing
- The students will collect field data

8. Module Requirements

- Each student should regularly interact with the instructors
- Each student will present the findings of the study for evaluation
- Each student will incorporate comments after presentation and submit the final review to the Department

9. Module Calendar

- Interactive teaching and learning: 20 days^{2} (5 hours/day = 100 hours)
- Independent learning (self-learning) – field work, data analyses and write-up: 85 days (8 hours/day = 680 hours)
- Collaborative learning: 10 day^{13} (5 hours/day = 50hours)
- Presentation of seminar examination: one day (3-6 hours)

10.Reading Materials

Various published scientific journals relevant to each seminar topic

15.2.Major Courses

1.Course Name: Microbial Physiology and Biochemistry

Module code: M634

Course Code: Biol 6312

Course Credits: 3 credits (7 ECTS)

Pre-requisite: None

Course Description

This course aims at understanding the physiology and biochemistry of prokaryotic and eukaryotic microorganisms. Main topics include growth physiology including: mechanisms of resistance to starvation, cell division and regulation of cell division, and growth measurement. Membrane bioenergetics with detailed discussion on: electron transport system, oxidative phosphorylation, and photophosphorylation. Central metabolic pathways, such as: glycolyis, pentose phosphate pathway, citric acid cycle, and fermentative pathways discussed in detail. Inorganic metabolism in relation to nitrogen metabolism, lithotrophy, sulfur metabolism hydrogen and iron metabolism will also be covered. The metabolism of C1 compounds, synthesis of cell walls and other macromolecules, and their regulation, transport of solutes across membranes, and response to external stimuli will be covered as well.

Learning Outcomes

After completing the course, students will able to

- become an expert on the structure and function of prokaryotic cells,
- Understand the physiological regulatory mechanisms involved in intra- and inter-cellular signaling and communication

- develop the concepts and skills required to understand and critically evaluate research articles that address the physiology and biochemistry of prokaryotes,
- apply the theories of bacterial cell physiology to solve current problems Applied Microbiology.

Course Contents

Section I: Physiology of prokaryotes

Introduction: Compare prokaryotic and Eukaryotic Cells

1. **Prokaryotic Cells:**
   - 1.1. The prokaryotic cell
   - 1.2. The Size, Shape, and Arrangement of Bacterial Cells
   - 1.3. Structures External to the Cell Wall
     - Glycocalyx, F1agella, Axial Filaments, Fimbriae and Pili
   - 1.4. Structures Internal to the Cell Wall
     - The Plasma (Cytoplasmic) Membrane, The Movement of Materials across Membranes, The Cytoplasm, The Nucleoid, Ribosomes, The inclusions, Endospores
   - 1.5. The Cell Wall
     - Composition and Characteristics, Cell Walls and The Gram Staining Mechanism, Damage to the Cell Wall
   - 1.6. The eukaryotic cell
     - Flagella and Cilia, The Cell Wall and Glycocalyx, The Plasma (Cytoplasmic) Membrane, The Cytoplasm, Ribosomes, The Organelles, The Nucleus, The Endoplasmic Reticulum
2. **Growth physiology**
   - 2.1. Bacterial Cell Division
   - 2.2. Cell Growth and Binary Fission
   - 2.3. Fts Proteins and Cell Division
   - 2.4. MreB and Determinants of Cell Morphology
   - 2.5. Peptidoglycan Synthesis and Cell Division

2.6. Population Growth

2.6.1. The Concept of Exponential Growth

2.6.2. The Mathematics of Exponential Growth

2.6.3. The Microbial Growth Cycle

2.6.4. Continuous Culture

3. Energy metabolism

3.1. Oxidative phosphorylation,

3.2. Photophosphorylation,

3.3. Electron transport system

4. Central metabolic pathways

4.1. Glycolysis,

4.2. Pentose phosphate

4.3. ED pathway,

4.4. Citric acid cycle,

4.5. regulation of metabolic pathways

4.6. respiration and fermentation

5. **Lipid metabolism** and its relation to central metabolic pathway

6. **Protein metabolism** and its relation to central metabolic pathway

7. Inorganic metabolism

8. **C1 Metabolism** - photosynthesis

9. **Metabolic Diversity among microbes**:

9.1. Photoauthotrophs

9.2. Photoheterotrophs

9.3. Chemoautotrophs

9.4. Chemoheterotrophs

10. **Biosynthesis of bacterial cell wall** and other macromolecules

11. Solute transport and its regulation

12. Response of bacteria to external stimuli

Section II: Physiology of Fungi

Fungal Physiology and metabolism

Teaching Method

- Lecture
- Discussion
- Students Presentation
- Lab activity

Assessment Criteria

- Mid Examination
- Term paper
- Assignment
- Final Exam

Inputs Required

- LCD projector
- Class room
- Equipped Lab room

References

1. David White, James T. Drummond, and Clay Fuqua (2012).***Physiology and biochemistry of prokaryotes***. Oxford University Press
2. Moat A.G., Foster J.W., and Spector M.P. (2002). ***Microbial Physiology***, Wiley-Liss Inc., New York
3. Lengler J. (1999). Physiology of prokaryotes, Georg Thieme Verlag, Germany.
4. Madigan, M.T, J.M. Martinko, and J. Parker (2006). ***Brock: Biology of Microorganisms***, 11th ed. Prentice-Hall, Inc. Englewood Cliffs, New Jersey.

2.Course Name: Microbial genetics and molecular biology

Module Code: M632

Course Code: Biol6322

Course Credit: 2 credit (5 ECTS)

Pre-requisite: None

Course Description

The course will give special focus to the history of the genetic material (Griffith, Avery and Hershey and Chase experiments). DNA replication and repair, Transcription and translation will be addressed Organization of Gene in Prokaryotes and Eukaryotes, the Operon concept, lac and trp operons, promoters and repressors. Regulation of gene expression-transcriptional control – promoters, terminators, attenuators and anti- terminators; Induction and repression; Translational control – ribosome binding, codon usage, antisense RNA; post-transcriptional gene silencing – RNAi. The course will cover gene transfer mechanisms, mutation and variation , transposable elements, gene mapping.

Learning Outcomes

At the end of the course students will able to enable the students to understand the basic and applied aspects of molecular biology and microbial genetics.

Course Contents

1. Introduction

1.1. identification of Genetic Material (Griffith, Avery and Hershy and Chase Experiments).

2. Nucleic Acid Structure and Function

2.1. Structure of nucleic acids

2.1.1. DNA

2.1.2. RNA

2.1.3. Hydrophobic interactions

2.1.4. Different forms of the double helix

2.1.5. Supercoiling

2.1.6. Denaturation and hybridization

2.2. Replication of DNA

2.2.1. Unwinding and rewinding

2.2.2. Fidelity of replication; proofreading

2.3. Chromosome replication and cell division

2.4. DNA repair mechanisms

2.4.1. Mismatch repair

2.4.2. Excision repair

2.4.3. Recombination (post-replication) repair

2.4.4. SOS repair

2.5. Gene expression

2.5.1. Transcription

2.5.2. Translation

2.5.3. Post-translational events

3. Mutation and Variation

3.1. Gene as a unit of mutation and Recombination.

3.2. Mutagenesis, Mutations and Mutants

3.2.1. Biochemical basis of Mutation, Spontaneous and induced mutations,

3.2.2. Isolation of mutants, mutagenesis, reversion, suppression, genetic analysis of mutants.

4. Gene Transfer Mechanisms

4.1. Transformation - competence cells, regulation, general process

4.2. Transduction - general and specialized;

4.3. conjugation - Hfr, Triparental mating, self transmissible and mobilizable plasmids, pili.

5. Biology of Plasmids - Extrachromosomal heredity

5.1. biology of bacterial plasmids,

5.2. properties of plasmids

5.3. structure of the plasmids, F1,ColE1, pSC101 and Ti plasmids,

5.4. replication, control, partitioning, incompatibility and gene transfer.

6. Transposable genetic elements and Gene Mapping

6.1. Introduction - Discovery, insertion sequences, complex and compound transposons - T10, T5, and retroposon.

6.2. Genetic mapping - Ecoli - Virus T4 phage.

7. Concept of gene and Gene regulation

7.1. Organization of gene in prokaryotes and Eukaryotes - Introduction, Operon concept, lac and Trp operons, promoters and repressors, regulation of gene expression

7.2. Transcriptional control - promoters, terminators, attenuators and anti terminators; Induction and repression; the lac operon - catabolite repression; Biosynthesis; trp operon - upstream activator sequences and enhancers, two component regulatory systems.

7.3. Translational control - ribosome binding, codon usage, antisense RNA; post-translational modification

Teaching Method

- Lecture
- Discussion
- Students Presentation
- Lab activity

Assessment Criteria

- Mid Examination
- Term paper
- Assignment
- Final Exam

Inputs Required

- LCD projector
- Class room
- Equipped Lab room

References

1) Maloy SR, Cronan Jr. JE, Freifelder D (1994). ***Microbial genetics***. Jones and Bartlett publishers.
2) Singer M, Berg P. (1991). ***Genes and Genomes***. University Science Books.
3) Antony JF, Griffiths, Gilbert WM, Lewontin RC and Miller JH (2002). ***Modern Genetic Analysis, Integrating Genes and Genomes***, 2nd edition, WH Freeman and Company, New York.
4) Malacinski GM and Freifelder D (1998) ***Essentials of Molecular Biology***, 3rd edition, John and Bartlett Publishers
5) Lewin B. (2000). ***Genes VII***. Oxford University press

3.Course Name: The Biology of Pathogenic Microorganisms

Module Code: M633

Course Code: Biol 6323

Course Credit: 3 credit (7 ECTS)

Prerequisite: None

Course Description

Review and contrast/comparison of common bacterial pathogens of human and their mechanisms of virulence, host invasion and iron acquisition strategies. Principles of host-parasite interactions;

infections caused by pathogenic bacteria; virulence factors, such as toxins and microbial structures; protein secretion pathogenesis and pathology of bacterial infections; non-specific factor in host resistance and susceptibility to infectious disease; and immunology of microbial infection. Cultural and physiological characteristics of pathogenic bacteria; cultivation of common and rare pathogens isolated from clinical material; conventional and rapid biochemical methods for detection/ identification of medically important bacteria tests for susceptibility of bacteria to antibiotics. A study of the roles of bacterial surface structures (LPS, capsules, flagella, fimbriae, outer membrane proteins) in the virulence of bacteria.

Learning outcomes

At the end of the course, students will able to

- Narrate the history of medical microbiology
- The normal flora and their significance in disease resistance
- Explain the biology of pathogenic microbes
- Know the method of diagnosis (biological perspective) for pathogens
- Describe the host parasite relationship
- Pathogenesis of common human pathogens.

Course content

1. **Historical perspective of the development of medical microbiology**
    - 1.1. The historical the development of microbiology
    - 1.2. Germ Theory of Disease
    - 1.3. Isolation of microorganisms in a pure culture
    - 1.4. The emergence of immunology Microbiology of Pathogenic microorganisms
2. **Biological features of pathogenic microorganisms**
3. **Host parasite relationship**
4. **Clinical, Epidemiological and laboratory diagnosis features: biological perspectives**

4.1. overview of the microbial diversity of pathogens

4.2. Diseases of the skin and eyes; respiratory system; nervous system, circulatory system; digestive system; urino-genital system

4.3. diagnosis; clinical features of pathogens; morphological, cultural, physiological, serological characters;

4.4. etioletic agents of human diseases; viruses, bacteria, fungi, protozoa, helminthes; arthropods (vectors).

Teaching Method

- Lecture
- Discussion
- Students Presentation
- Lab activity

Assessment Criteria

- Mid Examination
- Term paper
- Assignment
- Final Exam

Inputs Required

- LCD projector
- Class room
- Equipped Lab room

References

1. Murray ,P.R., Roesnthal, Kobayashi, G.S. and Pfaller ,M.A. (2002). ***Medical Microbiology***, Mosby.
2. Salle, A.J.(2002). ***Fundamentals Principle of bacteriology***, 7th edition. Tata Megraw-Hill

4.Course Name: Microbial Ecology

Module Code: M634

Course Code: Biol 6334

Course Credit: 3 credit (7 ECTS)

Prerequisite: None

Course Description

Microbes are organisms too small to be seen by the naked eye. Yet microbes define every ecosystem; indeed, Earth's upper atmosphere and subterranean depths contain microbes alone. Microbes produce and consume all our atmospheric nitrogen, and much of our oxygen and carbon dioxide. Therefore, main topics in microbial ecology includes origin of life, microbial diversity, microbe interaction with biotic and biotic factors, microbial community structure, microbes in extreme environments,

Learning Outcome

After taking this course, students will be able to point out :

- Role of microbial life in the evolution and ecology of the biosphere.
- Application of classical ecological concepts to microbial populations and communities.
- Underlying principles that drive microbial population structure.
- Abiotic and biotic interactions within microbial communities.
- Thermodynamic constraints on microbial processes.
- Microbial metabolism and biogeochemical cycling.

Course Contents

1. **Microbial diversity and Ecology**

    1.1. Origin of life

1.2. Microbial diversity

1.3. Microbial community : biofilms, colonization, succession, diversity, structure

1.4. Microbial Habitat, Ecological perspective: soil, fresh water, marine water

2. **Microbial interactions**: with the biotic environment: symbiosis, competition, parasitism, predation

2.1. Interactions within microbial communities: quorum sensing, syntrophy, antibiotics

2.2. Interactions with plants

2.2.1. Chemicals mediating microbe plant interaction

2.2.2. Rhizosphere and its agricultural importance

2.2.3. Mycorrhizal Association

2.2.4. Plant diseases

2.3. Interaction with animals

2.3.1. Normal flora

2.3.2. Diseases

3. Microbes in Extreme Environments: Physiological diversity

3.1. Thermophiles: Ecology, Mechanism of adaptation and Biological Importance

3.2. Acidophiles: Ecology, Mechanism of adaptation and Biological Importance

3.3. Alkalophiles: Ecology, Mechanism of adaptation and Biological Importance

3.4. Halophiles: Ecology, Mechanism of adaptation and Biological Importance

3.5. Microbes in deep part of water body

3.6. Microbes in deep part of soils

4. Biogeochemical cycles

4.1. Nitrogen cycles

4.2. Carbon Cycles: methane and global climate change

4.3. Sulfur cycle

4.4. Phosphorous cycle

4.5. Iron and manganese cycle

Teaching Method

- Lecture
- Discussion
- Field trips
- Students Presentation
- Lab activity

Assessment Criteria

- Mid Examination
- Lab and field trip reports
- Term paper
- Assignment
- Final Exam

Inputs Required

- LCD projector
- Class room
- Equipped Lab room

References

1. Larry L. Barton, and Diana E. Northup (2011) ***Microbial Ecology***, Wiley –Blackwell
2. Atlas RM & Bartha R (1998). ***Microbial ecology : fundamentals and applications***, Benjamin/Cummings, Menlo Park, Calif. ; Harlow) 4th ed.

3. Campbell RE (1983). ***Microbial ecology***, Blackwell Scientific Publications, Oxford ; Boston, 2nd ed
4. Alexander M (1977). ***Introduction to soil microbiology***, Wiley, New York ; London, 2nd ed.
5. Robert S. Burlage, Ronald Atlas, David Stahl, Gill Geesey, and Gary Sayler. (1998).***Techniques in Microbial Ecology***. Oxford University Press. NY.
6. Lesley A. Ogilvie and Penny R. Hirsch (2012). ***Microbial Ecological Theory: Current Perspectives***, Caister Academic Press.
7. J Vaun McArthur ***Microbial Ecology: An Evolutionary Approach***, Academic press.

5.Course Name: Environmental Microbiology

Module Code: M634

Course Code: Biol 6344

Course Credit: 3 credit (7 ECTS)

Prerequisite: None

Course Description

This course is designed in such a way that it will provide adequate understanding and equip the students with knowledge on the role micro-organisms in environmental problem solving specially in wastewater treatment and environmental pollution control. It provides an overview of micro-organisms and their metabolism; or Ecological and environmental considerations of soil micro-organisms, organic matter, enzymes. overview of biological wastewater treatment processes; composition of domestic and industrial wastewaters, the activated sludge processes; the microbiology of activated sludge; nutrient and pathogen removal by activated sludge process; microbiological aspects of drinking water treatment; role of micro-organisms in the biodegradation of metals and other toxic substances; biodegradation in aquatic environments and xenobiotics compounds; removal of toxic organic pollutants by biological processes, biodegradation of hazardous wastes (anaerobic, aerobic processes); bioremediation and bio-augmentation for

treating polluted environments (land, soil, aquifers). Microbial interaction with each other and the environment.

Learning outcomes

After the completion of the course, students will able to

- Describe the diversity of microbes in the environments
- Role of microbes in liquid and solid waste treatments
- Explain how microbes are important in soil fertility
- Exhibit the microbial roles in lignin, cellulose and hydrocarbon degradations

Course contents

1. **Microbes in the environments: terrestrial, aquatic and atmospheric**
2. **Microbiology of Soil**
    - 2.1. Soil as a habitat for organisms and their reactions.
    - 2.2. Soil development, classification components, texture, structure, bulk density, pore space,
    - 2.3. Interaction between soil components
    - 2.4. Cellulose degradation
    - 2.5. Lignin degradation
    - 2.6. Protein degradation
    - 2.7. Soil Pollution
        - 2.7.1. Sources
        - 2.7.2. Microbial remediation
    - 2.8. Hydrocarbons and their derivatives degradation
    - 2.9. Microbial degradation of pesticides, herbicides, plastics and other recalcitrants
3. **Microbiology of aquatic environments**
    - 3.1. Water as a habitat of organisms and their interaction
    - 3.2. Nutrients cycling in the aquatic environments and microbial roles
    - 3.3. Microbial quality for potable water

3.4. Sewage treatment

3.4.1. Primary treatment

3.4.2. Secondary treatment

3.4.3. Tertiary treatments

3.5. Industrial effluents treatments

4. Solid waste treatments and utilizations

4.1. Sources and Kinds of wastes

4.2. Sorting

4.3. Treatments

4.4. Voluble products from wastes using microbes

4.5. Composting

Teaching Method

- Lecture
- Discussion
- Students Presentation
- Lab activity

Assessment Criteria

- Mid Examination
- Term paper
- Assignment
- Final Exam

Inputs Required

- LCD projector
- Class room
- Equipped Lab room

References

1. A.H. Varnam & M.G. Evans (2000). ***Environmental Microbiology***, Manson Publishing Ltd.
2. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills,(2007). ***Manual of Environmental Microbiology***, ASM Press
3. W.D. Grant & P.E. Long (1981). ***Environmental Microbiology***, Kluwer Academic Publishers.
4. R. Mitchel (2009). ***Environmental Microbiology*** (2nd edition), Wiley-Blackwell.
5. P. Edmonds (1878). ***Microbiology: An environmental Perspective*** Macmillan, New York.
6. Raina Maier, Ian Pepper, & Charles Gerba (2008). ***Environmental Microbiology***, Academic Press.
7. Patrick K. Jjemba (2004). ***Environmental Microbiology: Principles And Applications*** , Science Publishing Inc
8. Robert L Tate, (2000). ***Soil Microbiology*** 2nd Edition. John Wiley & Sons
9. Gabriel Bitton, (1999). ***Waste Water Microbiology***. 2nd Edition. Wiley-Liss
10. Maier, R.M., Pepper,I.L. and Gerba, C.P. (2009). ***Environmental Microbiology***, 2nd Edition, Academic Press, San Diego, CA .

6.Course Name: Food Microbiology

Module Code: M635

Course Code: Biol 6365

Course Credit: 3 Credit (7 ECTS)

Prerequisite: None

Course Description

This course will cover the important aspects of food microbiology. It will start with general introduction and then will proceed into the details of the of food microbiology. The course introduces the diversity of microorganisms in various types of food and food components. It covers the microorganisms associated with food; effects of intrinsic and extrinsic factors on microbial growth in food; food spoilage and preservation of various food products; microbial food borne infection, microbial toxins and methods of prevention; methods for microbiological examination of foods; microbiological standards and quality control; the methods for the microbiological examination of foods; the mechanism of controlling the microbiological quality

of foods; processing, storage, distribution and consumption which contribute to the overall microbiological safety of the food and the Hazard Analysis Critical Control Point (HACCP) system will be covered in detail. Fermentation and fermented foods including the Ethiopian traditional fermented foods will be elaborated in detail. The role of microbes in fermented dairy products will be studied. Students will be provided with the practical isolation and identification of microorganisms from food items.

Learning outcomes

At the end of the course, the students will able to:

- Understand the various microbes involved in food.
- Discuss the diversity of microorganisms in foods
- Know the methods of isolation and identification of microbes from foods
- Identify the main causes of food spoilage
- Understand the main food borne infections
- Design methods of food preservation and food safety

Course contents

1. **Definition and scope of food microbiology**
2. **Diversity of microorganism in foods**
   - 2.1. Bacteria
   - 2.2. Fungi (mould and yeasts)
3. **Factors that affect microbial growth in foods** (intrinsic and extrinsic factors)
   - 3.1. Intrinsic factors
     - 3.1.1. pH
     - 3.1.2. Moisture content (water activity)
     - 3.1.3. Oxidation-reduction potential
     - 3.1.4. Antimicrobial components and barriers of food
     - 3.1.5. Nutrient composition
   - 3.2. Extrinsic factors

3.2.1. Temperature of storage

3.2.2. Relative humidity

3.2.3. Gaseous atmosphere

4. Important group of microorganisms in food fermentation and fermented foods

4.1. Definition of fermentation

4.2. Advantages of fermentation

4.3. Fermented foods and their health benefits

4.4. Lactic acid bacteria and dairy products

4.4.1. Antimicrobial activity of lactic acid bacteria

4.4.2. Health-promoting effects of lactic acid bacteria

4.5. Meat and meat products

4.6. Vegetables and cereal products

4.7. Ethiopian traditional fermented foods

4.8. Single cell protein (SCP) and Mycoproteins

5. Food borne diseases/infections

5.1. Definition of food-borne infections

5.2. Pre-disposing factors for food borne diseases

5.3. Staphylococcal gastroenteritis

5.4. Botulism (Clostridium)

5.5. Foodborne Listeriosis

5.6. Salmonella and Shigella gastroenteritis

5.7. Escherichia coli gastroenteritis

5.8. Gastroenteritis caused by other microorganisms

6. Microbial toxins in foods and their health impacts

6.1. Bacterial toxins

6.2. Fungal toxins (mycotoxins)

6.3. Algal toxins

7. Microbial food spoilage

7.1. Definition of spoilage

7.2. Main causes of food spoilage

7.3. Sources of microorganisms in food spoilage

7.4. Steps of food spoilage by microbes

7.5. Food spoilage by fungi (moulds and yeasts)

7.6. Food spoilage by bacteria

8. Foods protection/preservation methods

8.1. Removal of microorganisms from food

8.2. Low and temperature

8.3. Drying

8.4. Reduction of water activity

8.5. Chemicals

8.6. Salt (NaCl) and sugars

8.7. Radiation

8.8. Microbial Product–Based Inhibition

8.9. Modification of Atmosphere

9. Methods for the Microbiological Examination of Foods

9.1. Food safety and quality indicator organisms

9.2. Cultural Techniques

9.3. Enumeration Methods

9.3.1. Plate Counts

9.3.2. Most Probable Number Counts (MPN)

9.4. Microbiological criteria for food quality and safety

9.5. The Hazard Analysis and Critical Control Point (HACCP) Concept

Teaching Method

- Lecture
- Discussion
- Demonstration
- Students Presentation

- Lab activity

Assessment Criteria

- Mid Examination
- Term paper
- Assignment
- Final Exam

Inputs Required

- LCD projector
- Class room
- Normal and spoiled food samples
- Equipped Lab room

References

1. Doyle, M.P., Beuchat, L.R. and Montville, T.J. (2001). ***Food Microbiology: Fundamentals and principles,*** 2nd ed. ASM press.
2. Jay, J.M., Loessener, M.J., Golden, D.A, (2005). ***Modern Food Microbiology***. Springer science + business media Inc. 7th ed
3. Steinkraus, K. (1995). ***Handbook of Indigenous Fermented foods***. Marcel Decker, New York.

7.Course Name: Industrial Microbiology

Module Code: M635

Course Code: Biol 6355

Course credit: 2 Credit (5 ECTS)

Prerequisite: None

Course Description

Microorganisms of industrial importance; principles of screening, selection and strain improvement process; Topics include cultivation and maintenance of industrially important

micro-organisms; fermentation processes for production of primary metabolites, secondary metabolites, alcohol production, organic acid, pharmaceuticals, steroids and hormones and enzyme production, and other microbial products at laboratory scales; Principles and methods of microbial cell immobilization; properties of immobilized cells; factors and bioreactor systems affecting cell growth and efficiency; applications in food and enzyme industry;. Fermentation kinetics; factors affecting fermentation processes; medium and air sterilization; aeration and agitation; translation of laboratory data to pilot plant scales; instrumentations and their controlling systems; downstream processing such as solid-liquid separation, extraction, purification and product formulation will be given emphasis. Field studies included.

Learning outcomes

After completing the course, the students will able to

- highlight the importance of microorganisms in the production of useful human products
- dispel the age long fear that microorganisms can only cause sicknesses and diseases
- Explain how to source for microorganisms of industrial importance from the environment
- Describe the physical and chemical conditions that are involved in the production of useful industrial products of microbial origin
- Demonstrate cultural and genetic manipulation of these microorgasms in order to produce more of these useful products

Course content:

1. **Introduction**
    - 1.1. Introduction, history and scope of industrial microbiology
    - 1.2. Major types of microorganism used in fermentation
    - 1.3. Primary and secondary screening,
    - 1.4. Industrial strain improvement-strategies, selection and improvement of recombinant organisms.
2. **Industrial fermenters**

2.1. Design of a basic fermenter, bioreactor configuration, design features, individual parts, baffles, impellers, foam separators, sparger, culture vessel, cooling and heating devices, probes for online monitoring, computer control of fermentation process, measurement and control of process.

2.2. Reactors for specialized applications: Tube reactors, packed bed reactors, fluidized bed reactors, cyclone reactors, trickle flow reactors, their basic construction and types for distribution of gases.

3. Upstream processing

3.1. Media preparation and sterilization

3.2. Kinetics of thermal death of Micro-organisms

3.3. Batch, continuous and fed batch process

3.4. Aeration and agitation, foam and antifoam, microbial growth kinetics, measurement of growth, effect of pH, temp, and nutrient conc. on growth.

4. Downstream processing

4.1. Product recovery:

4.2. filtration of fermentation broths, ultra-centrifugation

4.3. recovery of biological products by distillation

4.4. superficial fluid extraction,

4.5. Electrokinetic's dialysis, flotation,

4.6. Chromatography

4.7. Product concentration

5. Industrial fermentation of desired products

5.1. Beverage industries

5.1.1. Brewery

5.1.2. Enology

5.1.3. Distilled alcohol

5.2. Industrial production of organic acids and solvents,

5.3. Amino acids and enzymes (amylase, proteases, cellulases) productions

5.4. Antibiotics, steroids and recombinant molecules (interferon, human proteins, vaccines) production

5.5. Single cell proteins.

6. **Petroleum microbiology** - microbiology and microbial leaching - role of microorganisms in the recovery of minerals (uranium, copper) from ores.

Teaching Method

- Lecture
- Discussion
- Field trip
- Students Presentation
- Lab activity

Assessment Criteria

- Mid Examination
- Field trip and lab reports
- Term paper
- Assignment
- Final Exam

Inputs Required

- LCD projector
- Class room
- Equipped Lab room

References

1. Crueger,W. and Crueger, A. (2005). ***Biotechnology: A Text Book of Industrial Microbiology***, 2nd ed., Panima Publishing Corporation
2. Demain, A.L. and Davies, J.E. (1999). ***Manual of Industrial Microbiology and Biotechnology.*** ASM Press.
3. Michael, J. W. (2001). ***Industrial microbiology: an introduction***. Blackwell science

4. Reed, G (2004).***Prescott& Dunn'sIndustrial Microbiology*** CBS Publishers
5. L.E.Cassida(1991). ***Industrial Microbiology*** Wiley Eastern
6. Patel,A.H(2000) ***Industrial Microbiology*** MacMillan
7. Bhosh,T.K., Fiechter,A and Blakebrough,N. ***Advances in Biochemical Engineering*** Springer

8.Course Name: Basic Techniques in Microbiology

Module Code: M636

Course Code: Biol6386

Course credit: 2 Credit (5 ECTS)

Prerequisite: None

Course Prescription

This course will provide updated knowledge for the selection of suitable research methods and instrumentation that are commonly employed in research work at the end of the course. Examination of living micro-organisms in natural environment, Microscopic examination of bacteria using different staining procedures, examination of endospores and capsules. General techniques of isolation and enumeration of bacteria. Isolation, enumeration and identification of bacteria, actinomycetes and fungi. Identification of bacterial enzymes. Identification of some important biochemical characters in selected microorganisms. Qualitative and quantitative analysis of soil microorganisms. Principles and application of staining, microscopy, centrifugation, chromatography, electrophoresis. Radiation techniques and Spectrophotometery

Course Outcomes

At the end of the course, students will able to

- demonstrate the basic techniques of handling, culturing, examination and identification of selected groups of microorganisms.

- build upon and develop the diverse range of laboratory skills and techniques required in the practical use and manipulation of microorganisms in the laboratory, industrial, and field situations
- practice the identification of bacteria and fungi
- Practice staining and manipulate different microscopes

Course content

1. **Cultivation and identification of microbes**
   - 1.1. Media preparation
   - 1.2. Isolation of microbes from food, water, beverages, and soil
   - 1.3. Identification of archea, bacteria, actinomycetes, and fungi
   - 1.4. Growth curve
   - 1.5. Growth Measurements
     - 1.5.1. Dry weight
     - 1.5.2. OD measurements
     - 1.5.3. Biochemical methods
2. **Microscopy:** light, phase contrast, fluorescent, electron, transmission electron and environmental scanning electron microscope
3. **Staining of bacteria**
   - 3.1. Simple staining.
   - 3.2. Gram staining.
   - 3.3. Negative staining.
   - 3.4. Capsule staining
   - 3.5. Endospore staining
   - 3.6. Acid – fast staining.
4. **Principles of Centrifugation** – Centrifugation techniques-preparative and analytical methods, density gradient centrifugation.
5. **Chromatography**
   - 5.1. Gel-filtration, ion-exchange and affinity chromatography,

5.2. Thin layer chromatography,

5.3. Gas chromatography,

5.4. High pressure liquid chromatography.

6. **Electrophoresis:** Principle of electrophoresis, General technique, Apparatus, Supporting media and Operational procedure, SDS-PAGE.

7. **Tracer techniques**

7.1. Principles and applications of tracer techniques in biology;

7.2. Measurement of alpha, beta and gamma radiations;

7.3. Radiation dosimetry, Radioactive isotopes and half life of isotopes;

7.4. Autoradiography, Cerenkov radiation, and Liquid Scintillation spectrometry.

8. **Radiation techniques and Spectrophotometery:** Determination of biopolymer structure (principles and applications): X-ray diffraction, fluorescence, UV, visible, CD/ORD, ESR, NMR and Mass spectroscopy, Colorimeter; types of spectrophotometer and their use in research; principle and application of radiation techniques in biology; Introduction of UV-VIS Spectroscopy, Flame photometry atomic absorption spectroscopy and plasma emission spectroscopy.

Method of teaching and learning:

- Demonstrative lecture
- laboratory exercises,
- group work
- presentations.
- Field visits

Assessment Criteria

- Mid Examination
- Term paper
- Assignment
- Final Exam

Inputs Required

- LCD projector
- Class room
- Equipped Lab room

References

1. Jean, D. (2003). ***Laboratory Investigation for Biology***. 2nd Ed., Benjamin Cumming.
2. Roberts K. (1987). ***Biology a functional approach: Student Manual***. 2nd Ed., Thomas Nelson & Sons Ltd.
3. Michael J. Leboffe and Burton E. Pierce (2012). ***Exercises for the Microbiology Laboratory,*** Fourth Edition, Morton Publishing Company
4. Pommerville J.C. (2005). ***Alcamo's Laboratory Fundamentals of Microbiology*** seventh edition, Jones and Bartlett Publishers Inc.

15.3.Elective Courses

1.Course Name: Agricultural Microbiology

Module Code: M634

Course Code: Biol 6354

Course credit: 2 credits (5 ECTS)

Prerequisite: Biol 6334

Course prescription

The course introduces the characteristics and historical development of agricultural microbiology; organism present in the soil with proportion and contribution; soil microbiology such as soil formation, plant microbes interaction, and composting; biogeochemical cycles with great emphasis to nitrogen cycles especially to nitrogen fixation; plant pathology; and agriculturally important microorganisms.

Learning Outcomes

After the completion of this course, students will able to

- Know of basic groups of microorganisms and their living activities in soil.
- Understand the basic characteristics of microbial biofilms
- Explain orientation in the interactions between prokaryotic and eukaryotic organisms especially among microorganisms and plants
- Describe the mechanism of composting
- List important microbes useful in agriculture in soil fertility and plant hormone production perspectives
- Demonstrate how microbes plant cause disease and their mitigation mechanisms.

Course Content

1. **Course characteristics and its historical development**
2. **Introduction to soil microorganisms** – bacteria, algae, fungi, actinomycetes, protozoans, nematodes and viruses - Role of microbes in soil fertility
3. **Soil Microbiology** - microbes in soil - Rhizosphere - Phyllosphere and mycorrhiza; Organic matter decomposition and composting - humus formation - biodegradation of pesticides and pollutants in soil
4. **Biogeochemical cycles** - carbon, nitrogen, phosphorus, sulphur cycles; Nitrogen fixation-plant growth promoting bacteria - Root nodule formation-nitrogen fixers - Nitrogenase, hydrogenase - Biochemistry of nitrogen fixation
5. **Plant pathology** (symptoms, disease cycle and control measures) Bacterial diseases - Blight of rice, citrus canker, wilt of potato; fungal diseases - Blast of rice, late blight of potato, rust and smust of wheat, smut of sugarcane, Wilt of cotton, Tikka leaf spot of ground nut
6. **Economically important agricultural microbes**
    - 6.1. Biofertilizer-*Rhizobium*, *Azospirillum*, *Azotobacter*, Cyanobacteria, Azolla - mass multiplication field applications and crop response.
    - 6.2. Biopesticide-Bacterial, Fungal and viral

6.3. Plant hormones preparation using microorganisms

6.4. Inoculants and carrier preparation

Teaching Method

- Lecture
- Discussion
- Field trip
- Students Presentation
- Lab activity

Assessment Criteria

- Mid Examination
- Field trip and lab reports
- Term paper
- Assignment
- Final Exam

Inputs Required

- LCD projector
- Class room
- Equipped Lab room

References

1. Paul E.A. (ed.) (2015) ***Soil microbiology, Ecology and Biochemistry***, 4th Edn., Elsevier Academic Press
2. Sylvia, D.M. Fuhrmann, J.J., Hartel, P.J. and Zuberer D.A. (2005) ***Principles and Applications of Soil Microbiology***, 2nd Edn. Pearson, Prentice Hall
3. Subba Rao (2001) ***Soil Microorganisms and plant growth***. Oxford and IBH Publishing Co.Pvt. Ltd

4. Agrios G.N. (2005) ***Plant Pathology***, 5th Edn.,Elsevier Academic Press,

2.Course Name: Fermentation Technology

Module Code: M635

Course Code: Biol 6375

Course credit: 2 credits (5 ECTS)

Prerequisite: Biol 6355

Course Description

This course includes: Fermenting media; how to improve and develop starter culture for different fermentation; Kinds of fermentation process during valuable product fermentation; Microbial product pathway intervention to produce require microbial products; valuable product fermentation such as organic acids, vaccines, therapeutic materials, enzymes, amino acids; brewery microbiology; wine microbiology, and fermentation technology to produce biofuels

Learning outcomes

After the completion of the course, students will able to

- Describe strain improvement and development for various fermentation
- Explain the mechanisms of industrial cultivation of microorganisms
- Understand the principles of microbiology
- Describe how valuable microbial products are produced by fermentation
- Explain the role of microbes in brewery, wine and biofuel production

Course contents

1. **Fermenting Media** Formulation. Carbon and nitrogen sources. Oxygen requirements. Anti-foams
2. **Starter culture improvement and development**
3. **Fermentation process** Batch, continuous and fed-batch cultures

4. Microbial Fermentations

4.1. Metabolic pathways and metabolic control mechanisms,

4.2. industrial production of citric acid, lactic acid, enzymes (alpha-amylase, lipase, xylase, pectinases, proteases), acetone- butanol, lysine and glutamic acid.

5. Microbial production of therapeutic compounds

5.1. Microbial production of therapeutic compounds (b lactam, aminoglycosides, Ansamycins (Rifamycin), peptide antibiotics Quinolinones)

5.2. biotransformation of steroids, vitamin B12 and riboflavin fermentation.

6. **Modern trends in microbial production:** Microbial production of

6.1. bioplastics (PHB, PHA),

6.2. bioinsectices (thuricide),

6.3. biopolymer (dextran, alginate, xanthan, pullulan),

6.4. Biofertilizers (nitrogen fixer Azotobacter,Phosphate solubilizing microorganisms),

6.5. Single Cell Protein and

6.6. production of biological weapons with reference to anthrax.

7. Brewery fermentation

7.1. Brewery fermentor types

7.2. Malting

7.3. Yeast biology

7.4. Yeast production

7.5. Flavor components imparted by yeasts

7.6. Other microbes affecting the brewery process

7.7. Control of microbes in brewery

8. Wine fermentation

8.1. Basic morphological, physiological and biochemical characteristics of milk, vinegar bacteria, yeasts and fungi occurring in the grapes, grape must and wine

8.2. The role of particular groups of micro-organisms (positives and negatives) in the various stages of the process of wine production.

8.3. The occurrence of mycotoxins in wines.

8.4. Wine spoilage and faults.

9. Biofuel fermentation

9.1. Biogas production

9.2. Bioethanol production

9.3. Biodiesel Production

9.4. Microbial Hydrogen gas

Teaching Method

- Lecture
- Discussion
- Field trip
- Students Presentation
- Lab activity

Assessment Criteria

- Mid Examination
- Field trip and lab reports
- Term paper
- Assignment
- Final Exam

Inputs Required

- LCD projector
- Class room
- Equipped Lab room

References

1. Hill A (2015). ***Brewery Microbiology***, Woodhead Publishing
2. Priest Fergus and Campbell Iain (1996) ***Brewing Microbiology***, Springer

3. Stanbury, P.F, Whitakar, A. and Hall, S.J.(1995) ***Principles of Fermentation Technology*** 2nd edition. Pergamon Press Oxford
4. Fugelsang, K. C. - Edwards, Ch. G. (2007). ***Wine microbiology. Practical applications and procedures***, 2nd ed., Springer

3.Course Name: Virology

Module Code: M633

Course Code: Biol 6333

Course credit: 2 credit (5 ECTS)

Prerequisite: None

Course Description

Biology of viruses and virus-host relationships. Replication strategies of virus genomes including prototypes of different animal, plant and (some) bacterial virus families; mechanism and control of viral gene expression; tumour virology; genetically engineered virus vaccines, cancer, unconventional viruses; interferon and other antiviral agents; viruses in biological control will be described.

Learning outcomes

After completing the course, the students will able to

- Describe the structure and function of viruses
- Distinguish diverse characteristics of viruses – host range, target tissues, replication strategy, transmission, etc.
- Explain the various techniques for detecting and treating viral diseases
- Develop an awareness of the impact of viruses on society.
- Describe the role of viruses in aiding our understanding of basic biological principles, biotechnology.

Course content

1. Classification and Morphology of Viruses

1.1 Cataloging the virus through virus classification schemes of ICTV / ICNV.

1.2 Morphology and ultra-structure of viruses.

1.3 Virus related agents, viroids and prions.

2. Cultivation and assay of viruses

2.1 Cultivation of viruses using embryonated eggs, experimental animals and cell cultures (Cell-lines, cell strains and transgenic systems).

2.2 Purification of viruses by adsorption, precipitation, enzymes, serological methods – haeme agglutination and ELISA.

2.3 Assay of viruses – Physical and Chemical methods (Electron Microscopy and Protein and Nucleic acids studies.)

2.4 Infectivity Assays (Plaque and end-point)

2.5 Genetic analysis of viruses by classical genetic methods.

3. Viral Multiplication

3.1 Mechanism of virus adsorption and entry into the host cell including genome replication and mRNA production by animal viruses

3.2 Mechanism of RNA synthesis

3.3 Mechanism of DNA synthesis

3.4 Transcription mechanism and post transcriptional processing, translation of viral proteins, assembly, exit and maturation of progeny virions

a. Multiplication of bacteriophages.

12. Pathogenesis of Viruses

4.1 Host and virus factors involved in pathogenesis, patterns of infection, pathogenesis of animal viruses Adenovirus, Herpes virus, Hepatitis virus, Picorna virus, Poxvirus and Orthomyxovirus, pathogenesis of plant [TMV] and insect viruses [NPV].

4.2 Host cell transformation by viruses and oncogenesis of DNA and RNA viruses.

5. Control of Viruses and Emerging Viruses

5.1 Control of viral infections through vaccines, interferons and chemotherapeutic agents.

5.2 Structure, genomic organization, pathogenesis and control of Human immunodeficiency virus.

5.3 Emerging viruses

6. **Viral vaccines**
   - 6.1. types of vaccines
   - 6.2. Conventional rDNA vaccines
   - 6.3. New generation vaccines
7. **Viral application in Biotechnology**
   - 7.1. Gene therapy
   - 7.2. Recombinant DNA technology
   - 7.3. Cancer treatment

Teaching Method

- Lecture
- Discussion
- Students Presentation

Assessment Criteria

- Mid Examination
- Term paper
- Assignment
- Final Exam

Inputs Required

- LCD projector
- Class room
- Equipped Lab room

References

1. Morag C and Tim bury M (1994). ***Medical Virology*** 10th Edition, Churchil Livingstone, London.
2. Dimmock N J and Primrose S. B. (1994). ***Introduction to Modern Virology*** 4th Edition, Blackwell Scientific Publications. Oxford.
3. Conrat H.F., Kimball P.C. and Levy J.A. (1994). ***Virology*** 3 rd Edition, Prentice Hall, Englewood Cliff, New Jersey.
4. Edward Wagner, Martinez J Hewlett, David Bloom, David Camerini (2008). ***Basic Virology*** 3rd edition, Blockwell Publishing USA.

4.Course Name: Bioremediation

Module Code: M634

Course Code: Biol 6364

Course credit: 2 (5ECTS)

Prerequisite: Biol 6344

Course prescription

This course will be divided into three parts. Part I deals with the soil and subsurface environment and covers the fate and transport of contaminants. Conservation of mass and transformation of chemicals are particularly stressed as unifying themes. Part II deals with aspects in microbial ecology, metabolism, and the biodegradation of selected contaminant compounds by plants and microorganisms. Part III covers bioremediation strategies ranging from in situ (microorganisms and plants), solid phase, slurry phase, and vapor-phase treatments. Emphasis also will be placed on natural attenuation. Generally, this course deals with introducing bioremediation, biofilm processing, bioremediation of soil, air, and water contaminates, biotreatment of metals, and margining technologies in bioremediation.

Learning Outcomes

By the end of the course, students will be able to

- Classify the main sources of contaminants and the environments where bioremediation is used
- Develop management plans for bioremediation projects
- Review the basic microbial systems and requirements for successful bioremediation
- Identify parameters for characterizing contamination sites
- Use test protocols for evaluating the treatability of contaminants
- Identify appropriate biological approaches for remediation of contaminants in soil and groundwater
- Increase their knowledge and understanding of phytoremedation and add realism to the study of constructed wetland through field trip

Course contents

1. What is bioremediation?

1.1. History of bioremediation

1.2. Sources of contamination

1.3. Bioremediation processes

1.4. Environments where bioremediation is used

2. Biofilm Processes

2.1. Trickling Filters and Biological Towers

2.2. Rotating Biological Contactors

2.3. Granular Media Filters

2.4. Fluidized-bed Reactors

2.5. Hybrid Biofllm Processes

3. Bioremediation for Soil Environment

3.1. Environment of Soil Microorganisms

3.2. Soil Organic Matter and Characteristics

3.3. Soil Microorganisms Association with Plants

3.4. Pesticides and Microorganisms

3.5. Petroleum Hydrocarbons and Microorganisms

3.6. Industrial solvents and Microorganisms

3.7. Biotechnologies for Ex-Situ Remediation of Soil

3.8. Biotechnologies for in-Situ Remediation of Soil

3.9. Phytoremediation Technology for Soil Decontamination

4. Bioremediation for Air Environment

4.1. Atmospheric Environment for Microorganisms

4.2. Microbial Degradation of Contaminants in Gas Phase

4.3. Biological Filtration Processes for Decontamination of Air Stream

4.3.1. Biofiltration

4.3.2. Biotrickling Filtration for air

4.3.3. Bioscrubbers

5. Bioremediation for Water Environment

5.1. Biochemical, Molecular, and Ecological Foundations of Bioremediation

5.2. Contaminants in Groundwater

5.3. Ex-situ Decontamination of Groundwater

5.3.1. Characterizing the Site and Contaminant Complexity

5.3.2. Selecting the Bioremediation Option

5.4. Process Optimization

5.5. In-situ Bioremediation of Groundwater

5.5.1. Factors Affecting Bioaugmentation

5.5.2. Delivery Systems for Oxygen, Nutrients, and Innoculation

5.6. Landfill Leachate Biotreatment Technologies

5.7. Industrial Wastewater Biotreatment Technologies

5.8. Biotreatment of Surface Waters

6. Biotreatment of Metals

6.1. Microbial Transformation of Metals

6.2. Biological Treatment Technologies for Metals Remediation

6.3. Bioleaching and Biobenificiation

6.4. Bioaccumulation

6.5. Oxidation/Reduction Processes

6.6. Biological Methylation

7. Emerging Environmental Biotechnologies

7.1. Phytoremediation

7.2. Sequestering Carbon Dioxide

7.3. Biomonitoring

7.4. Application of Microbial Enzymes

7.5. Biomembrane Reactors

Teaching Method

- Lecture
- Discussion
- Field trip
- Students Presentation
- Lab activity

Assessment Criteria

- Mid Examination
- Field trip and lab reports
- Term paper
- Assignment
- Final Exam

Inputs Required

- LCD projector
- Class room
- Equipped Lab room

References

1. John T. Cookson, Jr. (1995). ***Bioremediation Engineering: Design and Application***. McGraw-Hill, Inc. New York
2. A. Singh O. P. Ward (2004). ***Applied Bioremediation and Phytoremediation***, Springer, New York

5.Course Name: Brewery and Wine Microbiology

Module Code: M635

Course Code: Biol 6365

Course credit: 2 (5ECTS)

Prerequisite: Biol 6355

Course Description

This course will cover fundamental aspects of malting and fermentation chemistry. Some basic chemical principles will be presented followed by explanations of the underlying chemistry of steps in the brewing process and quality control monitoring. The student will obtain a knowledges about the microbiological processes that are a fundamental processes in the wine production. Student acquires the ability to identify the originators of all microbiological events, conditions of their growth and possibilities of their control. The course will focus mainly on the desired fermentation processes and microbial contaminants.

Learning outcomes

After completing this course, students will able to

- Narrate the history of beer and wine
- Explain the steps in malt and wort preparation
- Show how must is prepared
- Discuss the characteristics of good beer and wine yeast
- Describe the fermentation of beer and wine
- Exhibit the mechanism of beer and wine spoilage and their control mechanism

Part I Brewery Microbiology

1. **Beer types; their raw materials; sweet wort production.**
   - 1.1. Definition of beer and types of beer
   - 1.2. Barley and malt
   - 1.3. Adjuncts and colored Malts
   - 1.4. Grist composition and extract performance
2. **Wort**
   - 2.1. Sweet wort production.
     - 2.1.1. Grain handling and milling
     - 2.1.2. Mashing and conversion
     - 2.1.3. Wort separation
   - 2.2. Wort boiling.
   - 2.3. Wort clarification, cooling and oxygenation (aeration).
3. **Fermentation**
   - 3.1. The basic principles of yeast fermentation.
     - 3.1.1. Brewing yeasts
     - 3.1.2. Fermentation theory
   - 3.2. Fermentation practice.
     - 3.2.1. Fermentation vessel and their control
     - 3.2.2. Health and safety
   - 3.3. Yeast management.
     - 3.3.1. Yeast propagation, storage, and cropping
     - 3.3.2. Yeast selection, treatment and pitching
4. **Beer maturation and cold storage**
5. **Beer quality and process control.**
   - 5.1. Flavor.
   - 5.2. Dissolved oxygen.
   - 5.3. Microbiological contamination.
   - 5.4. Quality management.
   - 5.5. Plant cleaning – Detergents and sterilizing agents.

Part II wine making

6. History and classification of wine

7. Grape Fruit

7.1. diversity, harvest, and transport

7.2. fruit quality assessment

7.3. must processing

7.4. processing microbial deteriorated fruits

7.5. must storage

8. Grape and wine microorganisms

8.1. Yeasts

8.2. Lactic acid bacteria

8.3. Acetic acid bacteria

8.4. Molds and other microorganisms

9. Fermentation

9.1. Must supplementation

9.2. Alcoholic fermentation with starter culture

9.3. Natural fermentation

9.4. Fermentation problems

9.5. Malolactic fermentation

10. Post Fermentation

10.1. Aging and storage

10.2. Adjustment of volatile acidity

11. Microbial spoilages in wine process and their control

Teaching Method

- Lecture

- Discussion
- Field trip
- Students Presentation
- Lab activity

Assessment Criteria

- Mid Examination
- Field trip and lab reports
- Term paper
- Assignment
- Final Exam

Inputs Required

- LCD projector
- Class room
- Equipped Lab room

References

1. Fergus G. Priest and Iain Campbell (2003). ***Brewing Microbiology*****,** 3rd edition, Springer
2. Fugelsang, K. C. in Edwards, C. G. (2010). ***Wine Microbiology: Practical Applications and Procedures***, Springer
3. Jackson, Ronald S (2014). ***Wine Science: Principles and Applications****.* 4th Edition. London. Academic Press

6.Course Name: Introduction to Biofertilizers and Biocontrol

Module Code: M634

Course Code: Biol 6364

Course credit: 2 (5ECTS)

Prerequisite: Biol 6344

Course Description:

The ecological principles and applied practices of modern biological control of plant pathogens; including the history, scope, strengths and weaknesses, scientific basis of biological control, microbial control, biological control methods, population ecology as it relates to biological control; Biofertilizers preparation from bacteria and mycorrhizal; Mechanism of nitrogen fixation and phosphate solublization; Marketing and commercialization of biofertilizers and biocontrol.

Learning out comes

After the completing of this course, students will able to

- Understand theory and application of biological control principles and biofertilizers.
- Introduce students to the biological control agents used to control plant pathogens.
- Gain a deeper understanding for the history of biological control and biofertilizers
- Acquire a fundamental knowledge of the life history of natural enemies and their use in biological control
- Provide the student with an overview of the field of biological control and biofertilizers
- Study the interactions of these biological control agents with their target, host plant, and environment.
- Discuses the feasibility of utilization biofertilizers and biocontrol agents in a real and practical way.
- Explain the safe mechanism of how biocontrol and biofertilizers are prepared.

Outcomes: by the end of the course, students should be able to

- Explain the history, theory, practice and science of biological control.
- Evaluate scientific studies and concepts related to biological control.

- Asses the current and future roles of biological control within context of agricultural and natural ecosystem.
- Apply ecological principles of biological control and methods used in biological control of plant pathogens.
- Design and implement projects involving biological control agents and methods.
- Communicate their work effectively using the formats commonly employed in scientific oral presentations and writings.

1. Biofertilizers

1.1. Definition and types, importance of biofertlizers in agriculture

1.2. Symbiosis: Physiology, biochemistry and molecular genetics of symbiosis

1.3. Enzymes and their regulation: Nitrogenase, hydrogenase

2. Production, application and marketing

2.1 Production technology: Strain selection, sterilization, growth and fermentation, mass production of various Biofertilizers

2.2 Application technology: Standards and quality control, application for field and tree crops, nursery plants and seedlings

2.3 Extension, promotion and marketing: Extension strategies, diagnosis for the effectiveness of inoculation, improvement in distribution system

3. Bacterial biofertilizers

3.1 Introduction, scope.

3.2 A general account of bacterial biofertilizers organisms. *Azospirillum, Azotobacter, Frankia, Phosphobacteria* and *Rhizobium*.

3.3 Isolation - *Azotobacter* - Ashby's mannitol agar, *Azospirillum* -Semisolid medium. Rhizolium - Yeast Extract Mannitol Agar medium - Culture characteristics.

3.4 Mass production of *Azospirillum, Azotobacter* and *Phosphobacteria*.

3.5 Mechanism of nitrogen fixation (free-living and symbiotic) - Biochemistry and molecular basis of nitrogen fixation

3.6 Phosphate solubilization and mobilization.

4. **Mycorrhizal fungi as biofertilizers**

4.1 Introduction, scope.

4.2 A general account of Ecto, Endo and Arbuscular mycorrhizae (AM).

4.3 Methods of collection, wet sieving and decanting method and inoculum production.

4.4 Culture of mycorrhizae in Modified Melin - Norkrans (MMN) agar medium

4.5 Cultural characteristics of Ecto mycorrhizal fungi.

4.6 Techniques of Ectomycorrhizal inoculum, Endo mycorrohizae of orchids.

4.7 Isolation and method of inoculation of Arbuscular mycorrhizae (AM), Legume - AM interactions

5. **Biological control of plant pathogens**: Definitions, history, and importance of biological control

6. **Biological control of bacterial pathogens on aerial surfaces**

6.1. Bacterial pathogens of blossoms eg. *Erwinia amylovora;* russet-inducing bacteria

6.2. Bacterial pathogens of leaves eg *Pseudomonas syringae* and the INA concept; *Xanthomonas campestris*

7. **Biological control of fungal pathogens on aerial surfaces**

7.1. Ecology in the leave surface

7.2. Necrotrophic fungal pathogens eg. *Botrytis cinerea* - bacterial biocontrol agents and *Trichoderma; Sclerotinia sclerotiorum* - bacterial biocontrol agents and *Sporidesmium*

7.3. Biotrophic fungal pathogens eg. Rusts - bacterial biocontrol agents Powdery mildews - bacterial biocontrol agents and *Ampelomyces*

7.4. Virus and induced systemic resistance

8. Biological control of soil - borne pathogens and concepts of biotechnology

8.1. Bacterial pathogens eg. *Agrobacterium tumefaciens - A. radiobacter* K84 and K1026 and *Ralstonia* (=*Pseudomonas*) *solanacearum* - an example of plectropism and the transference of resistant gene

8.2. Fungal pathogens eg. *Fusarium* spp. - bacterial biocontrol agents and nonpathogenic fusaria *Rhizoctonia solani* - bacterial agents and nonpathogenic *Rhizoctonia Pythium* spp. - bacterial biocontrol agents and hyperparasitic *Pythium* spp.

9. Biological control of post-harvest pathogens

9.1. Bacterial pathogens eg. *Erwinia carotovora* soft-rots

9.2. Fungal pathogens eg. *Penicillium* spp. on citrus *Monilinia* on peaches; *Mucor* and *Rhizopus* on apple and pear

10. Mechanisms of biological control of plant pathogens

10.1. Competition for nutrients eg. competition between pathogenic and nonpathogenic fungi

10.2. Competition for iron and the role of siderophores

10.3. Competition for fungal germination stimulants

10.4. Antibiosis

10.5. Lytic enzymes

10.6. Induced systemic resistance

10.7. Cross protection

10.8. Hyperparasitism

10.9. Hypovirulence

Teaching Method

- Lecture
- Discussion
- Field trip
- Students Presentation
- Lab activity

Assessment Criteria

- Mid Examination
- Field trip and lab reports
- Term paper

- Assignment
- Final Exam

Inputs Required

- LCD projector
- Class room
- Equipped Lab room

References

Van den Bosch R., Messenger P. S. and Gutierrez A. P. (1982). An Introduction to Biological Control. Plenum, New York.

Roy G. Van Driesche, Thomas S. Bellows Jr. (1996). Biological Control, Kluwer Academic Publisher