Common Course Outline for: BIOL 2208 Biology of Microorganisms

A. Course Description

1. Number of credits: 4
2. Lecture hours per week: 3
   Lab hours per week: 3
3. Prerequisites: BIOL 1502 (C or higher)
4. Co-requisites: None
5. MnTC Goal: 3

This course is designed for students majoring in biology. Students will explore major concepts in microbiology including taxonomy, structure and function, biochemistry, metabolism, pathogenesis, immunology, and ecology of microbes, emphasizing the diverse role of microbes in the biological world. Students will engage in techniques appropriate to the study of microorganisms and gain experience in experimental design, data analysis and interpretation, and the communication of results. This course meets a requirement for the Biology (Minnesota State Transfer Pathway) AS-P degree. It is strongly recommended that students have successfully completed (C or higher) BIOL 2205, before enrolling in this course. Lecture 3 hours per week. Lab 3 hours per week

B. Date last revised: August 2020

C. Outline of Major Content Areas

This course will focus on microbial diversity of structure, metabolism, growth/reproduction, genetics, and pathogenesis. Several groups of microorganisms will be considered, which may include Bacteria, Archaea, Protista, Fungi, and acellular microbes such as viruses and prions. This course was developed following the American Society for Microbiology "Recommended Curriculum Guidelines for Undergraduate Microbiology Education."

Lecture: Subtopics listed under each main topic may vary due to recent developments in the field and current events.

1. Prokaryotic cell structure
   a. Bacteria
      i. Gram (+) and Gram (-) bacterial cell walls
      ii. Acid fast bacterial cells
      iii. Other structures involved in pathogenesis, immunity, and antimicrobial therapy
   b. Archaea
2. Eukaryotic cell structure
   a. Protista
   b. Fungi

3. Viruses
    a. Structure
    b. Classification
    c. Viral replication in molecular detail
    d. Lytic and lysogenic cycles
    e. Infection and disease
4. Microbial reproduction
    a. Binary fission
    b. Sexual and asexual reproduction
    c. Bacterial growth curves
5. Control of growth
    a. Physical (temperature)
    b. Chemical (osmolarity, pH, salinity)
    c. Biological
    d. Mechanical
    e. Classification and application of bacterial growth mediums
6. Metabolic pathways
    a. Microbial diversity and niches
    b. Respiration: aerobic and anaerobic
    c. Fermentation
    d. Lithotrophy
    e. Phototrophy: oxygenic and anoxygenic
7. Evolution and phylogeny
    a. Cells, organelles and all major metabolic pathways evolved from early prokaryotic cells
    b. Genetic variation
    c. Mutation
    d. Horizontal gene transfer
8. Gene regulation
    a. External and internal factors
    b. Organization of bacterial operons, regulons, and genomes
    c. Regulation of gene expression in the lac, trp, and ara operons of *E. coli*
9. Mechanisms of pathogenicity
    a. Bacteria
    b. Protozoans
    c. Fungi
    d. Acellular microbes (viruses, viroids, prions)
10. Host responses to pathogens
    a. Mechanisms of innate immunity
    b. Mechanisms of acquired immunity
    c. Vaccination
    d. Human immune disorders

Laboratory: Students will actively participate in lab by applying the scientific process to studies related to:

1. Microscopy, use and application

a. Light
b. Electron

2. Staining
   a. Gram staining
   b. Other differential stains (e.g. Acid Fast, endospore, capsule)
3. Bacterial growth
   a. Bacterial growth curves
   b. Use of various media to grow a variety of bacteria
4. Isolation of bacteria
   a. Aseptic technique
   b. Streak plating for isolation
5. Application of molecular methods for microbial research
   a. PCR
   b. DNA isolation and sequencing
6. Phylogenetic analysis
   a. Application of bioinformatics databases and methods to bacterial DNA analysis
7. Techniques for the study of viruses
   a. Plaque assays
   b. Molecular techniques (e.g. Western blot, PCR)
8. Investigative project

D. Course Learning Outcomes

Upon successful completion of the course, the student will be able to:

1. Explain and apply fundamental concepts related to the taxonomy, structure, function, and ecology of microbes, including bacteria, viruses, fungi, and Protista. (2a, 2c, 3a)
2. Use critical thinking skills to understand, evaluate, and analyze processes related to microbes:
   a. Microbial pathogenesis
   b. The response of the mammalian immune system to microbial infection
   c. Microbial metabolic diversity
   d. Microbial biotechnology (2a, 2c, 2d, 3a)
3. Demonstrate the ability to use the microscope, identify microbes, and perform several staining techniques. (2b, 3b)
4. Utilize and understand the application of the isolation of microbes from the environment, food, and water. (2b, 3b)
5. Understand the action of antibiotics and disinfectants. (2c, 3a)
6. Formulate a hypothesis, and conduct and analyze an experiment with a model organism. (2a, 2b, 2c, 3b)
7. Organize, draft, edit, and revise formal scientific writing. (3c)
8. Read, interpret, incorporate, and cite information and ideas from primary literature into writing. (2c, 2d, 3c. 3d)
9. Explain and illustrate the role that microbiology and its applications play in medicine, agriculture, biotechnology, and social issues. (3a, 3d)
10. Identify, summarize, and critique key debates and arguments about current societal, ethical, and political issues that are relevant to microbiology. (2b, 2d, 3d)

E. Methods for Assessing Student Learning

A variety of evaluation and assessments methods will be used including, but not limited to, the following:

1. Examinations (multiple choice, true-false, fill-in-the-blank, matching, short answer and critical thinking questions)
2. Writing assignments
3. Quizzes
4. Demonstration of proficient laboratory skills, including microscopy, staining methods, pipetting, aseptic technique, DNA isolation, and gel electrophoresis.
5. Examinations over laboratory exercises including lab practical exams.
6. Attendance.
7. Laboratory reports, including formal scientific writing and data presentation
8. Small group project, report and presentation.
9. A final comprehensive exam

F. Special Information

The laboratory portion of the course is delivered in the Biology Learning Center (BLC). The BLC has its own set of operating policies and procedures. An instructor will include the most recent version of the Departmental and Biology Learning Center Policies in the course syllabus.

One or more labs require the use of Biosafety Level 2 standards.

Laboratory procedures require genetic modification of bacteria; there are no exceptions or alternate activities.