BIO-2500: MICROBIOLOGY

Cuyahoga Community College

Viewing: BIO-2500 : Microbiology

Board of Trustees:
10/26/2023

Academic Term:
Fall 2024

Subject Code
BIO - Biology

Course Number:
2500

Title:
Microbiology

Catalog Description:
The diversity of the microbial world is explored through subjects including microbial ecology, evolution, structure and function of microorganisms, metabolism, genetics, control of microorganisms, and host-microbe interactions.

Credit Hour(s):
4

Lecture Hour(s):
3

Lab Hour(s):
3

Other Hour(s):
0

Requisites

Prerequisite and Corequisite
BIO-1410 Anatomy and Physiology of Domestic Animals I; or BIO-2331 Anatomy and Physiology I; or BIO-1500 Principles of Biology I; or BIO-1050 Human Biology and BIO-105L Human Biology Laboratory and BIO-1100 Introduction to Biological Chemistry; or departmental approval: comparable knowledge or skills.

Outcomes

Course Outcome(s):
Microbial Evolution: Students will explain the process of microbial evolution, how it shapes the ecosystem, and leads to the development of new organisms.

Objective(s):

a. Explain the origin of the three major cellular domains.
b. Discuss the emergence of mitochondria and chloroplast applying the endosymbiotic theory.
c. Recognize the impact of microorganisms on our planet.
d. Apply the taxonomic hierarchy to the classification and nomenclature of microorganisms.
e. Identify the genetic mechanisms of evolution, such as mutations and horizontal gene transfer, that increase the genetic diversity of microorganisms.
f. Use concepts of microbial evolution to explain the development of drug resistance and the emergence of new infectious diseases.

Course Outcome(s):
Structure and Function of Microorganisms: Students will be able to compare and contrast the morphological and physiological characteristics of bacteria, archaea, eukaryotes, and infectious particles.

Objective(s):

a. Compare and contrast cellular structural differences between bacteria, archaea and eukaryotic cells.
b. Apply methods of simple staining and microscopy to identify bacterial shapes and arrangements.
c. Describe viral structures and categorize viruses based upon structural similarities.
d. Explain the role of viral components in viral multiplication.
e. Differentiate the structure of prions from other infectious agents and identify their role in disease.
f. Identify the components of the plasma membrane and explain its functions.
g. Apply methods of differential staining and microscopy to identify the differences in bacterial cell envelopes.
h. Apply methods of special staining and microscopy to identify the bacterial external structures.
i. Identify and describe the functions of intracellular structures of bacterial and eukaryotic cells.

Course Outcome(s):

Microbial Growth: Students will determine the nutrients and environmental factors that influence microbial growth in nature and in the laboratory.

Objective(s):

a. Identify the sources and types of nutrients necessary for microbial growth.
b. Classify nutrient media based on form, content, and function.
c. Perform microbial growth analysis utilizing different forms and types of nutrient media.
d. Describe the types of membrane transport mechanisms and how they apply to microbial nutrition and osmotolerance.
e. Illustrate the effect of environmental factors, such as temperature, pH, gas availability, radiation, osmotic pressure, and desiccation, on microbial growth.
f. Compare and contrast types of symbiotic and nonsymbiotic microbial relationships and their effects on microbial growth and their interactions with other organisms.
g. Define binary fission and its effects on population growth.
h. Identify the four stages of the population growth curve and explain its significance to food safety and disease progression.
i. Utilize laboratory methods to isolate, identify, and enumerate bacteria.

Course Outcome(s):

Metabolic Pathways: Students will explain the role of metabolic pathways in the production of energy and the identification of microorganisms.

Objective(s):

a. Describe the structure of enzymes and how it relates to their function.
b. List and describe the different types of enzymatic reactions.
c. Identify the molecular structure of ATP, its synthesis and its metabolic role.
d. Compare and contrast aerobic cellular respiration, anaerobic cellular respiration, fermentation, and photosynthesis.
e. Discuss modern applications of microbial metabolism in health and industry.
f. Identify non-carbohydrate sources of energy.
g. Perform laboratory assays to differentiate bacteria based on differences in metabolic pathways.

Course Outcome(s):

Genetics: Students will explain the mechanisms of molecular genetics as it relates to microbial reproduction, function, and biotechnology.

Essential Learning Outcome Mapping:

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

Objective(s):

a. Compare and contrast the genomes of bacteria, eukaryotes, and viruses.
b. Identify the structure of DNA and describe the process of DNA replication.
c. Describe the structures and functions of different types of RNA.
d. Discuss the process and regulation of gene expression.

e. Identify causes, types, and outcomes of mutations.
f. Compare and contrast the three types of horizontal gene transfer and its relevance to microbial evolution and the development of drug resistant strains of microorganisms.
g. Apply scientific methods of inquiry to predict the outcome of a bacterial transformation experiment and explain its significance in biotechnology.

Course Outcome(s):

Control of Microbial Growth and Infection: Students will be able to describe and evaluate methods of microbial control and antimicrobial therapies, and explain the impact of their misuse.

Objective(s):

a. Define factors that influence the effectiveness of antimicrobial agents.
b. Compare and contrast the antimicrobial outcomes of sterilization, disinfection, antisepsis, and decontamination/sanitization.
c. Describe the physical methods microbial growth control and their mechanisms of action.
d. Describe the mechanical methods of microbial growth control and their mechanisms of action.
e. Describe the chemical agents of microbial growth control and their mechanisms of action.
f. Evaluate experimentally the effectiveness of household disinfectants and antiseptics on microbial growth.
g. Describe the discovery of antimicrobial therapies, their purpose, and mechanisms of action.
h. Perform an antibiotic susceptibility test.
i. Explain the evolution, mechanisms, and impact of drug-resistant pathogens on human morbidity and mortality.
j. Identify and discuss novel approaches to the treatment of microbial diseases.

Course Outcome(s):

Human Microbiome and Progression of Infection: Students will examine microbe human interactions as it relates to the human microbiome and the progression of infection.

Essential Learning Outcome Mapping:

Critical/Creative Thinking: Analyze, evaluate, and synthesize information in order to consider problems/ideas and transform them in innovative or imaginative ways.

Objective(s):

a. Describe the types and anatomical locations of microorganisms and infectious agents that comprise the human microbiome.
b. Evaluate the findings of the human microbiome project and its impact on human health and disease.
c. List examples of virulence factors and cytopathic effects and explain their roles in disease progression.
d. Describe the process of infection, including sources and transmission routes.
e. List the factors that affect onset, severity, and progression of an infection into a disease.
f. Apply the concepts of disease progression to specific infections of different body systems.
g. Relate the concepts of epidemiology to emerging infectious diseases of the modern world.

Course Outcome(s):

Host Defenses: Students will be able to explain how the human body defends itself against pathogens.

Objective(s):

a. Compare and contrast the characteristics of the three lines of defense.
b. Describe the structures and functions of the immune and the lymphatic system.
c. List and describe the physical and chemical barriers of the human body and explain their roles in defense against infection.
d. Explain the mechanisms of the components that comprise the second line of defense of the immune system.
e. Identify the location and explain the processes involved in the development and maturation of lymphocytes.
f. Characterize antigens and describe the process of antigen presentation.
g. Describe T cell activation and differentiate between the functions of the different classes of T cells.
h. Describe B cell activation and differentiate between the functions of the different classes of B cells.
i. Identify the functions of the different classes of immunoglobulins.
j. Compare and contrast between the different types of acquired immunity.

k. Discuss the history of vaccine development, classes of vaccines, and the process of vaccination.
l. Distinguish between scientific and non#scientific evidence concerning vaccination and herd immunity.

Methods of Evaluation:

a. Examinations
b. Quizzes
c. Lab skills
d. Oral presentation
e. Concept mapping
f. Case studies
g. Discussion boards

Course Content Outline:

a. **Concepts:**
   i. History of microbiology
   ii. Characteristics of microorganisms
   iii. Microbial involvement in shaping the environment
   iv. Applications of microbiology
   v. Microbial and cellular evolution
   vi. Biological hierarchy and classification of microorganisms
   vii. Binomial nomenclature
   viii. Prokaryotic cell structure and function
   ix. Comparison of Gram positive and Gram negative cells
   x. Endospore formation and germination
   xi. Size, shape, and arrangement of bacteria
   xii. General structure and function of eukaryotic microorganisms (fungi, protozoa, and helminths)
   xiii. Structure and function of infectious particles (e.g. virus, prions)
   xiv. Biofilms and quorum sensing
   xv. Passive and active transport
   xvi. Binary fission**,** generation times, and the growth curve
   xvii. Physical factors that affect microbial growth (pH, temperature, gas, osmotic pressure requirements, and other miscellaneous environmental factors)
   xviii. Nutritional factors that affect microbial growth
   xix. Classification of growth media
   xx. Simple, differential, and special stains
   xxi. Enzyme structure and function
   xxii. ATP as an energy carrier
   xxiii. Types of enzymatic reactions (synthesis, hydrolysis, and reduction-oxidation reactions)
   xxiv. Microbial metabolism (aerobic respiration, anaerobic respiration, fermentation, photosynthesis, and biosynthesis)
   xxv. Structure and function of DNA and RNA
   xxvi. Semiconservative replication of DNA
   xxvii. Gene expression (transcription, translation, and the genetic code)
   xxviii. Mutagens and mutations
   xxix. Regulation of gene expression in prokaryotes
   xxx. Horizontal gene transfer (transformation, conjugation, and transduction)
   xxxi. Genetically modified organisms
   xxxii. Virus structure and function
   xxxiii. Virus classification
   xxxiv. Animal virus multiplication
   xxxv. Animal viruses (chronic, latent, and oncogenic)
   xxxvi. Bacteriophages (lytic and lysogenic cycles)

xxxvii. Cultivating and identifying viruses
xxxviii. Cytopathic effects
xxxix. Environmental and microbial factors that affect methods of microbial control
xl. Outcomes of antimicrobial agents (disinfection, antisepsis, sterilization, decontamination, and sanitization)
xli. Physical, chemical, and mechanical methods of microbial control
xlii. Modes of action of antimicrobial agents
xliii. Origins of antimicrobial drugs
xliv. Modes of action of antimicrobial drugs
xlv. Characteristics of the ideal antimicrobial drug
xlvi. Selection and proper use of antimicrobial drugs
xlvii. Selective toxicity of antimicrobial drugs
xlviii. Mechanisms of resistance to antimicrobial drugs
xlix. Normal flora (colonization and locations)
l. Symbiotic and non-symbiotic relationships
li. Modes of transmission (direct and indirect)
lii. Portals of entrance and exit
liii. Disease process of infection
liv. Types of infection (localized, systemic, focal, mixed, acute, chronic, latent, primary and secondary, nosocomial, and opportunistic infections)
lv. Signs and symptoms
lvi. Virulence factors
lvii. Reservoirs of infection
lviii. Koch's postulates
lix. Etiology and epidemiology
lx. Anatomical barriers
lxi. Pattern recognition receptors
lxii. Complement and interferon
lxiii. Inflammation and fever
lxiv. Cytokines
lxv. Phagocytosis
lxvi. Structures and function of the lymphatic system
lxvii. Types and functions of white blood cells
lxviii. Development, maturation, and activation of B and T lymphocytes
lxix. Recognition of self and non-self (cell surface proteins)
lxx. Characteristics of antigens
lxxi. Structure and function of antibodies
lxxii. Antigen presentation
lxxiii. Humoral and cell-mediated immune responses
lxxiv. Primary and secondary immune responses
lxxv. Passive and active immunity (artificial vs. natural)
lxxvi. Vaccine production and immunization
lxxvii. Immunological disorders (hypersensitivity reactions, immunodeficiencies, and autoimmune deficiencies)

b. **Skills:**
i. Review and demonstrate laboratory safety procedures
ii. Recognize different types of colonial morphology
iii. Demonstrate proper aseptic technique and inoculation procedures
iv. Perform and analyze simple, differential, and special stains
v. Use microscopy to evaluate stained and unstained microorganisms
vi. Isolate bacterial colonies using the quadrant streak method
vii. Differentiate and categorize bacteria based on the results of metabolic assays
viii. Measure volumes using serological pipettes to produce serial dilutions of a bacterial culture
ix. Collect data from a pour plate experiment and calculate the amount of bacteria in a sample

x. Predict, perform, and analyze the results of a bacterial transformation experiment
xi. Simulate transmission of a communicable disease, perform an enzyme-linked immunosorbent assay (ELISA), and analyze the results
xii. Measure the effectiveness of antimicrobial agents experimentally, collect data, and compare to standardized tables
xiii. Evaluate the characteristics of bacteria using enriched, selective, and differential media
xiv. Apply laboratory techniques in microbiology to independently identify an unknown bacterium

Resources

Cowan, M. Kelly, Heidi Smith. *Microbiology: A Systems Approach*. 6th ed. Boston: McGraw Hill, 2020.

Anderson, D., Salm S., Beins, M., and Nester, E. *Nester's Microbiology: A Human Perspective*. 10th ed. New York: McGraw Hill, 2021.

Leboffe, Michael J., and Burton E. Pierce. *Microbiology Laboratory Theory & Application*. 4th ed. Englewood, CO: Morton, 2015.

Tortora, Gerard J, Berdell R, Funke, and Christine L. Case. *Microbiology: An Introduction*. 13th ed. San Franscisco, CA: Pearson Benjamin Cummings, 2018.

Brunschwig E., Freer-Prokop M., Johnson E., Kapley R., and Tsarukyanova I. *Laboratory Manual of Microbiology*. 2nd ed. Cuyahoga Community College and bluedoor, LLC, 2017.

Ankur Sangoi. *"Thick Section" Gram Stain Yields Improved Detection of Organisms in Tissue Sections of Cystic Neutrophilic Granulomatous Mastitis*. 5. May 2020. https://academic.oup.com/ajcp/article/153/5/593/5674921

Cowan et al . *Microbiology: a systems approach*. 7th (2024 copyright).

Cowan et al . *Microbiology: a systems approach*. 3rd . 2023.

Resources Other

www.cdc.gov
www.who.org
www.hmpdacc.org

Instructional Services

OAN Number:

Ohio Transfer 36 TMNS

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