Hamburg Area School District

Course Guide

Name:	Infectious Diseases
Grade(s):	10th - 12th
Length:	*Place an X next to the correct option*
	Full-Year (180 Sessions)
X	Semester (90 Sessions)
	Quarter (45 Sessions)
	Other (Specify):
Text:	*Microbiology: An Introduction*, 12th Ed. by: Tortora, Funke, & Case. Pearson *The Hot Zone* by Richard Preston
Approved on:	May 21, 2018

Course Description:

Prerequisite: 85% in Biology (PS or HONORS) and 85% in Chemistry (PS or HONORS) or taking Chemistry concurrently

The interests of pathogens are often at odds with those of humans. As a result, microbial diseases occur often, and emerging diseases are frequently in the news. The more we disturb the balance of nature and increase world-wide travel, the more often we increase the scope of disease outbreaks. In this rigorous, lab-based course, we will explore the fields of virology, microbiology, epidemiology, and immunology to gain an understanding of what makes us sick and how our body works tirelessly to keep us healthy. This course is intended to prepare students seeking to advance their education at a college or university, and as such will be formatted much like a traditional college-level course, thus good reading compression and critical thinking skills along with a strong work ethic will be key. In addition, a solid background in basic biological and chemical principles as well as safe laboratory procedures is highly recommended.

Infectious Diseases

Unit: *Epidemiology*
Unit Length: 16 classes

ESSENTIAL QUESTION	PERFORMANCE OBJECTIVES	LAB / ACTIVITY APPLICATIONS
What roles do microbes play in our everyday lives?	*List several ways in which microbes affect our lives *Describe the destructive and beneficial actions of microbes	
How are microorganisms named and classified for scientific study?	*Recognize the system of scientific nomenclature *Differentiate the major characteristics of each group of microorganisms	
What role did historical scientists play in developing our understanding of modern microbiology?	*Identify the contributions to microbiology made by Hooke, van Leeuwenhoek, Redi, Needham, Spallanzani, Virchow, Pasteur, Koch, Jenner, Ehrlich, Fleming, Lister, ect. *Compare spontaneous generation and biogenesis	*Create a podcast interview of an influential scientist to illustrate his/her influence on the field of microbiology
How does understanding the pathology of a disease dictate the way scientists study its transmission and the pathogen that causes it?	*Describe the objectives of the study of pathology *Differentiate normal microbiota and infectious diseases *State the importance of biofilms *Describe factors that contribute to the emergence of an infectious disease *List Koch's postulates and explain exceptions to them *Differentiate a communicable from a noncommunicable disease *Categorize diseases according to frequency of occurrence and severity *Identify four predisposing factors for disease *Identify and explain the proper sequence for the pattern of disease: period of decline, period of convalescence, period of illness, prodromal period, and incubation period *Explain the importance of healthcare-associated infections and compromised hosts *Contrast types of reservoirs of infection (human, animal, and nonliving)	*Read and analyze *The Hot Zone* by Richard Preston *Trace path of disease transmission using analysis of disease pathology and epidemiology to identify patient zero

How does understanding the pathology of a disease dictate the way scientist study its transmission and the pathogen that causes it? *(continued)*	*Explain methods of disease transmission *Explain the importance of herd immunity	
How does the data collected from epidemiological investigations influence the study of various diseases?	*Describe types of epidemiologic investigations *Identify the function of the CDC *Explain the relevance of morbidity, mortality, and notifiable infectious diseases to the study of epidemiology	*Utilize protein electrophoresis to identify major viral components in patient samples to determine patient diagnoses as means of demonstrating how data can be collected for epidemiological investigations and how those viral components influence disease pathways *Read and analyze *The Hot Zone* by Richard Preston
How do microbes invade their host, causing disease?	*Identify the major portals of entry and exit *Explain how capsules and cell wall components contribute to pathogenicity *Explain the importance of antigenic variation *Explain how microbes utilize the host cell's machinery to cause disease *Distinguish between the creation and effects of exotoxins versus endotoxins *List and describe cytopathic effects of viral infections	

Infectious Diseases

Unit: *Virology*
Unit Length: 16 classes

ESSENTIAL QUESTION	PERFORMANCE OBJECTIVES	LAB / ACTIVITY APPLICATIONS
What characteristics can be utilized to identify and classify viruses?	*Identify major characteristics utilized to classify different viral types including capsid shape, enveloped vs. non-enveloped, size, host range, presence of spikes, genetic material, etc.	*Research a viral infectious disease, construct a model of the virus along with a infographic about the viral disease, including the virus's specific infection pathway *Read and analyze *The Hot Zone* by Richard Preston
What is the connection between viral life cycles and their potential pathogenic effects?	*Identify the requirements needed for a virus to successfully replicate *Explain how the one-step growth curve illustrates the progress of a viral infection *Differentiate the major characteristics of the lytic vs. lysogenic cycle in bacteriophage replication *Contrast specialized vs. generalized transduction as a result of bacteriophage infection *Compare and contrast multiplication of bacteriophages to animal viruses *Compare and contrast the pathways for DNA (double and single stranded) vs. RNA (double and single stranded) viruses *Contrast latent vs. persistent viral infections	
How can a virus cause cancer?	*Explain the link between oncogenic viruses and cancer *Describe how cancer arises as a breakdown in cell cycle checkpoints due to mutations in proto-oncogenes and tumor suppressor genes causing cells to lose density-dependent inhibition and anchorage dependence *Describe how oncolytic viruses are being utilized to treat cancer	*Create a presentation on either a type of cancer that has known links to a viral infection and/or on a treatment that is utilizing viruses to treat cancer

How does a prion infection pathway differ from viral infections?	*Explain how prion infections differ from other types of infectious diseases	
What methods can scientists use to identify and study viruses for research and/or diagnostic purposes?	*Describe the different techniques utilized to culture and study different types of viruses in a laboratory setting *Describe how laboratory techniques can be utilized to identify a specific viral species including cytopathic effects, serological tests such as Western blotting, the use of nucleic acid techniques such as RFLPs and PCR	*Utilize gel electrophoresis to confirm “rapid” diagnosis testing that can be done in a doctor’s office *Read and analyze *The Hot Zone* by Richard Preston

Infectious Diseases

Unit: *Microbiology*
Unit Length: 40 classes

ESSENTIAL QUESTION	PERFORMANCE OBJECTIVES	LAB / ACTIVITY APPLICATIONS
How does the microscope enhance scientific study and understanding of microorganisms?	*Describe, numerically, the scale utilized to measure microorganisms *Diagram the path of light through a compound light microscope *Distinguish between total magnification and resolution in terms of view objects through a microscope *Compare and contrast different types of microscopy and their usefulness for viewing different types of objects depending on the scientific line of study (darkfield, brightfield, phase-contrast, fluorescence, transmission electron, scanning electron, various staining techniques, etc.)	*Practice/Learn necessary microscope skills including: ● Observing specimens through different objective powers, including under oil immersion ● How to measure objects under the microscope ● Demonstrating understanding of depth of field with layered specimens ● Creating wet mount slides (stained and unstained)
What are the structural differences between prokaryotic versus eukaryotic cells that are important in the way that they function?	*Compare and contrast prokaryotic vs. eukaryotic cells in terms of structure, genetic organization, and function	*Identification of Unknown Bacterial Species by performing the following lab experiments on known species as well as assigned unknown: ● Aseptic technique ● Obtaining pure cultures ● Gram stain and bacterial shape identification ● Motility determination ● Aerobic requirements
What methods are utilized for scientific classification of bacteria?	*Identify the basic characteristics utilized to classify bacteria (shape, size, cell wall structure, capsule, fimbriae, pili, motility, endospores, modes of nutrition etc.) *Explain the process of Gram staining, as well as its importance in classifying bacteria	

How does the understanding of basic biochemistry concepts allow scientists to further understand the growth and reproductive needs of microbes?	*Describe the structure of an atom and its relation to the physical properties of elements *Differentiate between ionic, covalent, and hydrogen bonding *Explain the properties of water that are essential to living systems (i.e. polarity & hydrogen bonding, cohesion, adhesion, capillary action, surface tension, universal solvent, pH & buffer systems, temperature regulation, etc.) *Distinguish between organic and inorganic compounds *Identify purpose of functional groups, as well as identify the major groups essential to biochemistry *Contrast dehydration synthesis vs. hydrolysis reactions in terms of monomers and polymers *Differentiate between the structures and functions of the major classes of macromolecules (carbohydrates, lipids, proteins, nucleic acids)	Unknown Identification *(continued)*: ● Effects of temperature and pH on culture growth ● Identification of culture characteristics on agar plates, agar slants, and in nutrient broth and nutrient gelatin ● Metabolism requirements (O/F, carbohydrate broths, citrate, mixed-fermentation, Voges-Proskauer, urea, oxidase, catalase, nitrate, tryptone, starch, casein, protein) *Test for antibiotic and antiseptic sensitivity in known species through the use of the disk-diffusion (Kirby-Bauer) method
How do microbes utilize materials in their environment for the purpose of generating and storing energy needed for life's major processes?	*Explain the difference between endergonic/exergonic and catabolic/anabolic reactions *Discuss the importance of enzymes as driving factors in metabolic pathways *Explain how enzyme activity can be regulated via cofactors/coenzymes, competitive vs. noncompetitive inhibitors, environmental factors, etc. *Compare and contrast the metabolic diversity among prokaryotic organisms (i.e. photoautotrophs, photoheterotrophs, chemoautotrophs, chemoheterotrophs) *Differentiate between substrate-level, oxidative, and photophosphorylation *Discuss the major steps of cellular respiration (glycolysis, Krebs cycle, oxidative phosphorylation, and chemiosmosis) *Contrast aerobic and anaerobic respiration *Compare pathways for carbohydrate, lipid, and protein catabolism	
How do metabolic requirements influence how microorganisms grow and reproduce naturally and in laboratory settings?	*Outline the major requirements for growth of various species (i.e. temperature, pH, salt concentration, chemical/nutrient requirements, oxygen requirements, etc.)	

How do metabolic requirements influence how microorganisms grow and reproduce naturally and in laboratory settings? *(continued)*	*Differentiate between the following: chemically defined media, complex media, reducing media, selective media, differential media, enrichment culture, etc.) *Explain the process of binary fission as it relates to different phases of culture growth *Differentiate different methods for determining cell counts in cultures (i.e. plate counts, filtration, most probable number, direct microscopic count, turbidity, metabolic activity, dry weight) along with the pros and cons of each method *Distinguish between the following terms utilized for microbial growth control: sterilization, disinfection, antisepsis, degerming, sanitization, biocide, and bacteriostasis *Compare and contrast how microbial control agents used in limiting bacteria's ability to reproduce function (i.e. alternation of membrane permeability, damage to proteins, damage to nucleic acids, etc)	
What role does genetic expression play in the ability of microbes to evolve over time?	*Explain the basic genomic organization including the presence of a single, circular chromosome located in the nucleoid region, as well as the potential presence of plasmids *Explain the flow of genetic information in a cell starting with DNA through expression of that information via protein production *Outline the steps of DNA replication, with particular emphasis on the role of enzymes to accomplish the process *Outline the steps of proteins synthesis (transcription and translation) *Discuss mechanisms utilized by cells to regulate gene expression (i.e. inducible and repressible operon systems, catabolite repression, epigenetic control, microRNAs, etc.) *Outline the potential outcomes of various types of mutations (i.e. substitution mutations include silent, nonsense, and missense; frameshift mutations) on protein expression *Discuss mechanisms that bacteria utilize to increase variation in their population given they are asexually reproducing (i.e. mutation rate, transformation, transduction, and conjugation) and how this relates to the evolution of bacterial species	*Perform bacterial transformation experiment by creating "glowing" bacterial colonies using pGLO plasmid

Infectious Diseases

Unit: *Immunology*
Unit Length: 20 classes

ESSENTIAL QUESTION	PERFORMANCE OBJECTIVES	LAB / ACTIVITY APPLICATIONS
How does the body's immune system functions to defend against invading pathogens?	*Define the major role of the immune system in living organisms *Discuss the role played by the circulatory and lymphatic systems in maintaining immunity *Outline the major organs/cells responsible for immunity *Distinguish between innate vs. adaptive immunity and active vs. passive immunity *Describe the role of skin and mucous membranes in innate immunity *Differentiate physical from chemical factors *Describe the role of normal microbiota in innate immunity *Outline the different types of blood cells in terms of structure and function as it relates to immunity *Outline the stages of phagocytosis *Describe the stages of inflammation and how they relate to innate immunity *Describe the cause and effects of fever *Discuss the importance of the complement system *Identify the role of interferons in the innate immune response	*Utilize ELISA test to determine if potentially infected patients test positive for the presence of antibodies for an given disease *Develop a public service announcement (audio or video) that outlines how vaccinations work, their importance in the prevention of disease/disease spread, and general safety *Read and analyze *The Hot Zone* by Richard Preston
How is the immune system able to "learn" from previous exposure to a pathogen to better protect the body?	*Differentiate humoral from cell-mediated immunity *Compare and contrast the development and roles played by the various cells of the adaptive immune response (B cells, Helper T cells, Cytotoxic T cells, Natural Killer Cells, etc.) *Explain antibody function, as well as describing their structure and chemical characteristics *Explain antigen-antibody specificity and its role in detecting and defending against various pathogens	

How is the immune system able to “learn” from previous exposure to a pathogen to better protect the body? *(continued)*	*Outline the structure and function for each of the five classes of antibodies *Differentiate the function and development of plasma cells from memory cells *Describe the process of clonal selection *Describe how a human can produce different antibodies and the vital role this plays in future immunity *Describe the role played by antigen-presenting cells in adaptive immunity *Distinguish a primary from a secondary immune response *Contrast the four types of adaptive immunity (i.e., natural acquired active, naturally acquired passive, artificially acquired active, artificially acquired passive)	
How have scientists applied the understanding of immunology to help prevent and/or diagnosis infectious diseases?	*Explain how and why vaccinations work *Differentiate between different types of vaccines (i.e., attenuated, inactivated, toxoid, subunit, conjugated, etc.) *Explain the value of vaccines and discuss acceptable risk for vaccines *Outline the various diagnostic tests utilized in immunology (i.e., precipitation reactions, agglutination tests, neutralization reactions, ELIZA, etc.) including the pros and cons of each	
How can dysfunction of the immune system cause its own diseases and/or cause complications in other medical treatment options?	*Describe the mechanism of anaphylaxis *Discuss the connection of ABO blood groups and blood transfusions with the antigen/antibody reactions *Describe how autoimmune diseases are a result of self-tolerance *Explain how self-tolerance presents challenges in organ transplant patients *Discuss the role the immune system plays in cancer surveillance in the body and its potential uses in treating cancer patients *Describe how diseases such as HIV/AIDS impact the functionality of the immune system in infected individuals	*Complete immunology case study where students are presented with a hypothetical patient’s medical history and utilize the knowledge learned throughout the course to present a potential diagnosis for the patient and to explain how the the diseases progresses