## **Infectious Diseases and Microbial Agents**

#### Rationale Course Pathophysiology An infection is an organism's response to disease-causing microorganisms. It forms when pathogens enter and multiply in the body Unit V **Objectives** Process of Pathology Upon completion of this lesson, the student will be able to Identify and describe the main ways that infectious disease spreads Essential Identify the main human bodily defenses against infectious pathogens Question and explain how they work Can normal flora Describe the different microorganisms that cause infectious disease bacteria become • Identify the main classes of pathogenic organisms and the common pathogenic diseases associated with each pathogen organisms? Engage TEKS Introduce students to the history of infectious diseases as illustrated in an §130.208 (c) interactive timeline. Log on to http://www.diseasedetectives.org/timeline and 5A project onto screen for whole-group interactive activity. 6A, 6C, 6D Or Prior Student Ask students to consider the last time they had a cold or the flu, and how Learning they might have contracted the illness. What were the factors that made Basic them susceptible to getting sick? Why does it seem like a lot of people get understanding of the same cold at the same time, while others remain healthy? What other standard diseases are spread the same way as these common illnesses? precautions and lab safety **Key Points** An Introduction Ι. Estimated time A. We Are Not Alone! 3-5 hours 1. We are outnumbered 2. On the average human, there are about 100 trillion microscopic beings 3. As long as they stay in balance and where they belong, they do us no harm 4. Many of them provide important services for human survival 5. Most, however, are opportunists, who if given the opportunity of increasing growth or invading new territory, will cause infection B. Facts 1. Microorganisms cannot be seen without a microscope, with the exception of some intestinal parasites 2. Some of these organisms cause infection and illness

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- 3. Others are "good" organisms that help keep a balance in the environment and in the body
- II. Good vs. Bad Microbes
  - A. Microbes that cause disease (germs) are referred to as pathogens
  - B. Microbes that are beneficial or harmless are called *nonpathogens*
  - C. Only a small percentage of microbes are pathogenic. Most are beneficial or harmless
  - D. Some cause disease only if they accidentally invade the "wrong place" at the "right time." These organisms are referred to as *opportunistic pathogens*

87% – Beneficial Microbes

10% – Opportunists

03% – Pathogens

- III. Opportunistic infections
  - A. When is the "right time" for an opportunistic pathogenic invasion?
    - 1. When the host's resistance is low
    - 2. When otherwise harmless microbes gain entry to an organ system where they can multiply and do harm
  - B. Usually opportunistic pathogens live on and in the healthy human body (on skin, in mouth, in intestines)
    - 1. Since many of these microbes are potentially pathogenic, they can cause disease if they gain entrance to the bloodstream or internal organs, such as the bladder
    - 2. Other times microbes become pathogenic when they leave their normal environment in the body and move into other areas, i.e. the *E. coli* microbes which live in the colon and break down waste products. If these microbes move into the upper GI system, they cause infection
- IV. What are ideal growth conditions for microorganisms?
  - A. Most microorganisms that cause illness prefer warm temperatures (98.6° F)
  - B. Most organisms prefer a **dark area** to grow and reproduce (many are killed quickly by sunlight)
  - C. All need food to survive—some live on dead matter or tissues, and others use living matter (parasites)
  - D. All organisms need **moisture** Note: the human body is the ideal supplier of all requirements of microorganisms

- V. Main Classes of Pathogenic Microbes
  - A. Bacteria one-celled microorganisms
    - 1. Prokaryotic cells
    - 2. Pathogenic bacteria contain cell-damaging proteins that cause infection; these proteins come in two forms:
      - Endotoxins released when the bacterial cell wall decomposes (these endotoxins cause fever and aren't affected by antibiotics)
      - b. Exotoxins released during cell growth
    - 3. Bacteria are classified by shape and arrangement
      - a. Bacteria that are round or spherical are called *cocci* 
        - i. When they occur in pairs they are called *diplococci* (causing diseases such as gonorrhea, meningitis, and pneumonia)
        - ii. Cocci that occur in chains are called *streptococci* (causing strep throat and rheumatic fever)
        - iii. Cocci that occur in clusters are called *staphylococci* (causing pus-producing microbes that produce infections such as boils, wound infections, and toxic shock)
      - b. Bacteria that are rod-shaped are called *bacilli* 
        - i. Bacilli can occur in pairs or chains
        - ii. Many bacilli contain flagella (threadlike projections similar to tails) which allow them to move
        - iii. Some bacilli have the ability to form spores (thickwalled capsules) when conditions for growth are poor; in spore form, bacilli are extremely difficult to kill
        - iv. Diseases caused by bacilli include tuberculosis, tetanus, pertussis (whooping cough), botulism, diphtheria, and typhoid
      - Bacteria that are spiral- or corkscrew-shaped are called spirilla – diseases caused by spirilla include syphilis and cholera – chlamydia and rickettsia are specific types of bacteria
        - i. They are smaller than conventional bacterial but larger than viruses
        - ii. Chlamydia causes a variety of infections including conjunctivitis, chlamydial urethritis and cervicitis
        - iii. Rickettsia causes forms of typhus including Rocky Mountain spotted fever
        - iv. Spread through vectors such as mites, ticks, or lice
    - B. Protozoa and Helminths animal-like, single-celled organisms that may form colonies
      - 1. Most species are found in such aquatic habitats as oceans, lakes, rivers, and ponds

- 2. Protozoa obtain their food by ingesting bacteria, waste products of other organisms, algae, or other protozoa.
- 3. Most protozoan species are motile, either by flagella, cilia, or amoeboid motion
- 4. Some are pathogenic and cause diseases such as malaria, amoebic dysentery, trichomonas, African sleeping sickness, leishmaniasis, and toxoplasmosis
- 5. A helminth, commonly known as a parasitic "worm," usually of the intestines
  - a. Helminths are more complex than protozoa
  - b. Adult helminths are visible without a microscope.
  - c. Helminth infections are associated with unsanitary conditions, overcrowding, and warm climates.
- C. Fungi a diverse group of organisms that obtain food by absorbing nutrients from an external source
  - 1. Thousands of different types of fungi grow on and absorb food from substances such as soil, wood, decaying organic matter, living plants and other organisms.
  - A number of fungi cause diseases in humans and other vertebrates. In general, these fungal infections, or mycoses, develop slowly, recur more frequently than bacterial infections, and do not produce a lasting immunity in the body
  - 3. A mycosis is classified in one of two groups, depending on the part of the body that is infected:
    - a. A *dermatomycosis* is an infection of the skin, hair, or nails, such as ringworm or athlete's foot – these infections rarely progress to the internal organs. Most respond well to medication, although treatment may take several weeks
    - b. A systemic mycosis, which is an infection of the entire body, is typically more serious and can be fatal for individuals whose immune system has been weakened by diseases such as acquired immunodeficiency syndrome (AIDS) or cancer
  - 4. Fungal infections are typically spread by spores that enter the body through inhalation or through an opening in the skin
  - 5. Some infections are passed from animals to humans or between humans
  - A few drugs are effective in treating systemic infections, but because treatment may last for several months to years, to prevent relapse of the infection, these drugs often cause toxic side effects
  - 7. Some fungi are external parasites of humans, causing skin conditions such as ringworm, athlete's foot, and jock itch
  - 8. Other fungi invade internal tissues; examples include yeast that infect the genital tract and several fungi species that

cause a type of pneumonia

- D. Viruses microscopic genetic parasites that may contain genetic material such as DNA
  - 1. Viruses are not considered free-living, since they cannot reproduce outside of a living cell; they have evolved to transmit their genetic information from one cell to another for the purpose of replication
  - 2. Viral infections generally occur when normal inflammatory and immune responses fail
    - a. Develop in a host cell and hide there.
    - b. Viruses need these host cells in order to replicate
  - 3. Viruses often damage or kill the cells that they infect
  - 4. A few viruses stimulate cells to grow uncontrollably and produce cancers
  - 5. Although many infectious diseases, such as the common cold, are caused by viruses, there are no cures for these illnesses the difficulty in developing antiviral therapies stems from the large number of variant viruses that can cause the same disease, as well as the inability of drugs to disable a virus without harming healthy cells
  - 6. Diseases caused by viruses include mumps, measles, influenza, rabies, hepatitis, poliomyelitis, smallpox, AIDS, and certain types of cancer
- E. How Pathogens Are Spread The Chain of Infection. The analogous model used to understand the infection process is the chain of infection, a circle of links, each representing a component in the cycle. Each link *mus*t be present and in sequential order for an infection to occur
  - 1. First, there must be an **infectious agent** (pathogen) such as a bacterium, virus, fungus, or protozoan
  - 2. Second, the causative agent must find a **reservoir** where it can live (inside a human or animal, the environment, or objects contaminated with infectious material)
  - 3. Third, the pathogen must then have a **portal of exit** (a way to escape from the reservoir in which it has been growing). In the human body, pathogens can leave the body through urine, feces, saliva, blood, tears, mucous discharge, sexual secretions, and draining wounds
  - 4. Fourth, when the pathogen leaves the reservoir, it must have a **mode of transmission** to another reservoir or host where it can live. Transmission of pathogens occurs in different ways:
    - a. **Direct person-to-person** –direct contact with a bodily secretion containing the pathogen; contaminated hands are one of the most common sources of direct transmission; other direct contacts include kissing, sexual contact

- Indirect contact occurs when pathogens are transmitted from contaminated substances such a food, air, soil, insects, feces, clothing, instruments, and equipment.
  - i. Examples include touching contaminated objects and spreading pathogens to the hands, being bitten by an insect carrying a pathogen
- a. **Airborne** occurs when one breathes in droplets carrying airborne infections; coughing and sneezing project droplets into the air. Droplets cling to hair, cloths, and other objects
- 5. Fifth, there must be a **portal of entry** (a way to enter new reservoir or host). Pathogens may enter the body through breaks in the skin and breaks in the mucous membrane, and through the respiratory tract, digestive tract, genitourinary tract, and circulatory system
- 6. Sixth, the new host must be a **susceptible host**. This happens when large numbers of pathogens invade the body or when the body's defenses are weak
- VI. Breaking the chain of infection
  - A. Because many healthcare professionals come into direct contact with a number of patients, they must practice techniques to break the chain of infection
  - B. Two important practices are
    - 1. Medical asepsis keeping the environment as free from infectious organisms as possible aseptic techniques include
      - a. Hand-washing
      - b. Gowning and masking
      - c. Separating clean from contaminated materials
      - d. Providing patient information about appropriate hygienic practices
    - Universal precautions help control contamination from blood borne viruses such as HIV and hepatitis – protective measures include
      - a. Gloves
      - b. Gowns
      - c. Face masks and/or goggles
- VII. Emerging Infectious Diseases
  - A. Among diseases new to science are AIDS, Ebola Hemorrhagic Fever, Legionnaires' disease, and Lyme disease
    - 1. AIDS has been the most deadly of all the new diseases, but even it has not taken as high a toll as malaria, tuberculosis, and other diseases that have been around for centuries
    - 2. Some newly identified disease-causing agents for diseases

that have been recognized for a long time include human Tlymphotropic, which can cause some cases of non-Hodgkin's lymphoma, a type of cancer originating in the lymphatic system; and hairy-cell leukemia, a rare type of cancer of the blood

- B. Environmental changes may be responsible for some new diseases
  - 1. It has been speculated that the viruses for some of the lethal hemorrhagic fevers that have surfaced in Africa (e.g. Ebola and Marburg disease) have long existed in some feral animals
  - 2. As populations have trespassed into wilderness areas they have come into contact with infected animals, and the viruses have jumped from their customary animal hosts to new human hosts with deadly consequences
- C. Besides new diseases, pathogens change or mutate, giving rise to new, virulent strains
  - 1. Influenza viruses are among those that mutate frequently, which explains why flu shots are given annually and why epidemics of influenza sporadically arise
- D. Problems occur when mutations in infectious agents result in resistance to medicines that were previously effective treatments
  - 1. The bacteria that caused bronchitis, meningitis, tuberculosis, and pneumonia are among many that have developed strains that are now resistant to at least some antibiotics
  - 2. Physicians have fewer options for treating these resistant diseases and preventing their spread

### Activity

- I. Complete a case study over an infectious disease caused by an agent in each of the classes of pathogenic microbes. Have students look up the top ten infectious diseases from each class of pathogens. Then have them complete the Pathology Report provided.
- II. Complete the Pathogenic Organisms Lab Investigation
- III. Complete "The Case of Allison," a case study on infectious diseases found on <u>www.bioedonline.org</u>.

### Assessment

Successful completion of the Infectious Disease Quiz

### Materials

Materials for the *Pathogenic Organism Lab Investigation*: Prepared slides of pathogenic organisms

- Possible specimens for study
  - 1. Neisseria gonorrhea
  - 2. Staphylococcus aureus

- 3. Clostridium tetani
- 4. Escherichia coli
- 5. Entamoeba histolytica
- 6. Plasmodium vivax
- 7. Leishmania donovani
- 8. Taenia
- 9. Ascaris lumbricoides
- 10. Trichinella spiralis
- 11. Culex sp.
- Microscopes Gloves Laboratory coat or apron Goggles Biohazard containers Surface disinfectant Paper towels

\*Teacher's Note\*

Microscopes can be set up displaying unlabelled slides of all or some of the pathogenic organisms. Students rotate through the microscopes, categorizing the specimens in a laboratory practical examination.

See <u>http://sargentwelch.com/microslide-viewer/p/IG0039030/</u> to purchase Microslide viewer sets.

http://news.bbc.co.uk/1/hi/scotland/2009028.stm – New Superbug Found In Hospital; good but scary

Quiz Key

### Accommodations for Learning Differences

For reinforcement, the student will outline essential points over one of the following:

- A specific microbial infection
- Antibiotic resistant diseases
- Nosocomial diseases
- Treating systemic fungal infections

For enrichment, the student will research and report on emerging or reemerging diseases. Present using multimedia technology.

### **National and State Education Standards**

National Healthcare Foundation Standards and Accountability Criteria: Foundation Standard 1: Academic Foundation

1.2 Diseases and Disorders

1.21 Describe common diseases and disorders of each body

system (prevention, pathology, diagnosis, and treatment).1.22 Recognize emerging diseases and disorders.1.23 Investigate biomedical therapies as they relate to the prevention, pathology, and treatment of disease.

Foundation Standard 7: Safety Practices

7.1 Infection Control

7.11 Explain principles of infection control.

7.12 Describe methods of controlling the spread and growth of microorganisms.

### TEKS

§130.208 (c)(5)(A) identify pathogenic organisms using microbiological techniques;

§130.208(c)(6)(A) describe on the nature of diseases according to etiology, signs and symptoms, diagnosis, prognosis, and treatment options;
§130.208 (c)(6 (C) examine reemergence of diseases such as malaria

tuberculosis and polio;

§130.208 (c)(6)(D) describe drug-resistant diseases

Texas College and Career Readiness Standards SCIENCE

- A. (D) (3) Demonstrate appropriate use of a wide variety of apparatuses, equipment, techniques, and procedures for collecting quantitative and qualitative data.
- V (F) (1) Know that organisms possess various structures and processes (feedback loops) that maintain steady internal conditions.
- IV (A) (2) Explain how cells can be categorized into two major types: prokaryotic and eukaryotic, and describe what major features that distinguish one from the other.

(B) (5) Know how organisms respond to presence or absence of oxygen, including mechanisms of fermentation.

# Disease Report Template

Disease
Alternative Names
Definition
Deminion
Etiology
Signs & Symptoms
Signs & Symptoms
Diagnostic Tests
Treatment
Osmuliasticus
Complications
Prognosis
Bibliography

## **Disease Report Rubric**

Criteria	Possible Points	Points Awarded
Disease Correctly names the disease	3	
Alternate Names	2	
If applicable, includes any alternate names for the disease or disorder		
<b>Definition</b> Includes in-depth discussion of the history and general description of the disease with interesting facts	10	
Etiology Includes the cause or origin of the disease or disorder	15	
Signs & Symptoms Accurately describes common physical and medical symptoms	15	
<b>Diagnostic Tests</b> Identifies tests performed to aid in the diagnosis or detection of the disease or disorder	15	
<b>Treatment</b> Identifies the mode or course pursued for remedial ends for the disease or disorder	15	
<b>Complications</b> Identifies any diseases or injuries that may develop during treatment of the disease or disorder	10	
<b>Prognosis</b> Includes the prediction of the probable course, outcome, frequency, and life expectancy of the victim	10	
<b>Bibliography</b> Follows proper format and includes more than 3 sources.	5	
TOTAL	100	

### Pathogenic Organisms Laboratory Investigation

#### Purpose

In this laboratory, students will categorize selected pathogenic organisms by microscopic examination of prepared slides.

### Background

### **Materials**

Prepared slides of pathogenic organisms

Possible specimens for study:

- 1. Neisseria gonorrhea
- 2. Staphylococcus aureus
- 3. Clostridium tetani
- 4. Escherichia coli
- 5. Entamoeba histolytica
- 6. Plasmodium vivax
- 7. Leishmania donovani
- 8. Taenia
- 9. Ascaris lumbricoides
- 10. Trichinella spiralis
- 11. Culex sp.
- Microscopes Gloves Laboratory coat or apron Goggles Biohazard containers Surface disinfectant Paper towels

### Procedure

- 1. Wash hands and put on gloves and goggles
- 2. Assemble equipment and materials
- 3. Prepare the work area
- 4. Examine the prepared slides of pathogenic organisms, identifying key characteristics of the specimen
- 5. Draw and label observations
- 6. Clean work area with surface disinfectant. Remove goggles and gloves and wash hands

### Data

Draw and label observations



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### **Conclusion:**

1. Categorize the observed pathogenic organisms.

2. List disorders or diseases caused by the organism on each slide.

Name	eDate			Period			
	True/False Quiz: Infectious Diseases						
	1.	Most microbes are infectious. a. true	b. false				
	2.	Patients undergoing chemotherapy are at to their suppressed immune systems. a. true	higher risk for oppor b. false	tunistic infections due			
	3.	To date, malaria has killed more people the a. true	nan AIDS. b. false				
	4.	You cannot see any microorganisms with a. true	out a microscope. b. false				
	5.	Viruses must have a host cell in order to a a. true	replicate. b. false				
	6.	Both chlamydia and rickettsia are protozo a. true	a. b. false				
	7.	Among diseases new to science is Lyme a. true	disease. b. false				
	8.	Ideal growth conditions for microorganism dark, and dry. a. true	ns include an environ b. false	ment that is warm,			
	9.	The most common source of direct germ a. true	transmission is being b. false	bitten by an insect.			
	10.	Another name for fungal infection is myco a. true	osis. b. false				
	11.	Certain types of cancer have been linked a. true	to bacterial infections b. false	5.			
	12.	A helminth, is commonly known as a para a. true	asitic "worm". b. false				
	13.	New technology has provided researcher a. true	s with a cure for certa b. false	ain viruses.			

- \_\_\_\_\_ 14. Fungi are classified by shape and arrangement. a. true b. false
  - \_\_\_\_\_ 15. Medical asepsis includes hand washing. a. true b. false

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### Answers: True/False Quiz: Infectious Diseases

1. **b** 

- 2. **a**
- 3. **a**
- 4. **b**
- 5. **a**
- 6. **b**
- 7. **a**
- 8. **b**
- 9. **b**
- 10. **a**
- 11. **b**
- 12. **a**
- 13. **b**
- 14. **b**
- 15. **a**

### Laboratory Investigation Rubric

Student:\_\_\_\_\_ Date:\_\_\_\_\_

Scoring Criteria	4	3	2	1	N/A
	Excellent	Good	Needs Some Improvement	Needs Much Improvement	
Problem is					
appropriately					
identified.					
Problem is					
precise, clear,					
and relevant.					
Association					
between the					
problem and the					
predicted results					
is direct and					
relevant.					
All variables are					
clearly					
operationalized.					
Demonstrates					
comprehension of					
the use of					
scientific					
concepts and					
vocabularv.					
All significant					
data is measured.					
Data is recorded					
effectively and					
efficiently.					
Data table is well					
designed to the					
task					
requirements.					
All graphs are					
appropriate.					
All data					
accurately					
plotted.					

Graph visually			
compelling,			
highlights			
conclusions of the			
study.			
Conclusion			
relates directly to			
the hypothesis.			
Conclusion has			
relevancy in			
resolution of the			
original problem.			
Conclusion			
relates the study			
to general			
interest.			