Rationale
An infection is an organism’s response to disease-causing microorganisms. It forms when pathogens enter and multiply in the body.

Objectives
Upon completion of this lesson, the student will be able to:
- Identify and describe the main ways that infectious disease spreads
- Identify the main human bodily defenses against infectious pathogens and explain how they work
- Describe the different microorganisms that cause infectious disease
- Identify the main classes of pathogenic organisms and the common diseases associated with each pathogen

Engage
Introduce students to the history of infectious diseases as illustrated in an interactive timeline. Log on to http://www.diseasedetectives.org/timeline and project onto screen for whole-group interactive activity.

Or

Ask students to consider the last time they had a cold or the flu, and how they might have contracted the illness. What were the factors that made them susceptible to getting sick? Why does it seem like a lot of people get the same cold at the same time, while others remain healthy? What other diseases are spread the same way as these common illnesses?

Key Points
I. An Introduction
   A. We Are Not Alone!
      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
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:
      a. 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 (thick-walled 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
      c. 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.
2. 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.
6. 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 must 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
b. **Indirect contact** – occurs when pathogens are transmitted from contaminated substances such as 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
      2. 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 T-lymphotropic, 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


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.


[http://news.bbc.co.uk/1/hi/scotland/2009028.stm](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

<table>
<thead>
<tr>
<th>Disease</th>
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<tbody>
<tr>
<td>Alternative Names</td>
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<tr>
<td>Definition</td>
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<td>Etiology</td>
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<td>Signs &amp; Symptoms</td>
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<td>Diagnostic Tests</td>
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<td>Treatment</td>
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<td>Complications</td>
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<td>Prognosis</td>
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<td>Bibliography</td>
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## Disease Report Rubric

<table>
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<th>Criteria</th>
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<td>Includes in-depth discussion of the history and general description of the disease with interesting facts</td>
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<td>Etiology</td>
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<td>Includes the cause or origin of the disease or disorder</td>
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<td>Signs &amp; Symptoms</td>
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<td>Accurately describes common physical and medical symptoms</td>
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<td>Diagnostic Tests</td>
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<td>Identifies tests performed to aid in the diagnosis or detection of the disease or disorder</td>
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<td>Treatment</td>
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<td>Identifies the mode or course pursued for remedial ends for the disease or disorder</td>
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<td>Complications</td>
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<tr>
<td>Identifies any diseases or injuries that may develop during treatment of the disease or disorder</td>
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<td>Prognosis</td>
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<tr>
<td>Includes the prediction of the probable course, outcome, frequency, and life expectancy of the victim</td>
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<td>Bibliography</td>
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<td>Follows proper format and includes more than 3 sources.</td>
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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 gonorrhoea
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

1. ____________________
2. ____________________
3. ____________________
4. ____________________
5. ____________________
6. ____________________
7. ____________________
8. ____________________
9. ____________________
Conclusion:
1. Categorize the observed pathogenic organisms.

2. List disorders or diseases caused by the organism on each slide.
True/False Quiz: Infectious Diseases

_____ 1. Most microbes are infectious.
   a. true      b. false

_____ 2. Patients undergoing chemotherapy are at higher risk for opportunistic infections due to their suppressed immune systems.
   a. true      b. false

_____ 3. To date, malaria has killed more people than AIDS.
   a. true      b. false

_____ 4. You cannot see any microorganisms without a microscope.
   a. true      b. false

_____ 5. Viruses must have a host cell in order to replicate.
   a. true      b. false

_____ 6. Both chlamydia and rickettsia are protozoa.
   a. true      b. false

_____ 7. Among diseases new to science is Lyme disease.
   a. true      b. false

_____ 8. Ideal growth conditions for microorganisms include an environment that is warm, dark, and dry.
   a. true      b. false

_____ 9. The most common source of direct germ transmission is being bitten by an insect.
   a. true      b. false

_____ 10. Another name for fungal infection is mycosis.
   a. true      b. false

_____ 11. Certain types of cancer have been linked to bacterial infections.
   a. true      b. false

_____ 12. A helminth, is commonly known as a parasitic “worm”.
   a. true      b. false

_____ 13. New technology has provided researchers with a cure for certain viruses.
   a. true      b. false
14. Fungi are classified by shape and arrangement.
   a. true       b. false

15. Medical asepsis includes hand washing.
   a. true       b. false
Answers: True/False Quiz: Infectious Diseases

1. b
2. a
3. a
4. b
5. a
6. b
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12. a
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14. b
15. a
# Laboratory Investigation Rubric

**Student:** __________________________  **Date:** ____________________________

<table>
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<th>Scoring Criteria</th>
<th>4 Excellent</th>
<th>3 Good</th>
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<th>1 Needs Much Improvement</th>
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<td>Problem is appropriately identified.</td>
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<td>Association between the problem and the predicted results is direct and relevant.</td>
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<td>All variables are clearly operationalized.</td>
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<td>All significant data is measured.</td>
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<td>All graphs are appropriate.</td>
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<td>Conclusion relates directly to the hypothesis.</td>
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<td>Conclusion has relevancy in resolution of the original problem.</td>
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<td>Conclusion relates the study to general interest.</td>
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