Catch the Fever

INTEGRATED CURRICULUM UNIT ON COMMUNICABLE DISEASES

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National Consortium on Health Science
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Acknowledgments

Acknowledgments

Finally, we want to thank two individuals who provided tremendous support for this effort. Anne Stanton, Director of the Youth Program at the James Irvine Foundation and Gary Hoachlander, President of ConnectEd and MPR Associates, Inc. have promoted a new way of thinking about how to engage students in learning with the goals of improving academic outcomes and closing the achievement gap. They have encouraged us to create interdisciplinary curriculum material that delivers challenging, college- and career-preparatory academic and technical learning through authentic, career-focused applications. We hope that using this curriculum enlivens your classroom, excites your students to learn, and helps them achieve academic and career success.

Catch the Fever
CONTENTS

**National Healthcare Foundation Standards
that apply to this unit include:**

- Academic Foundations (Medical Terminology)
- Communications
- Health Maintenance Practices
- Information Technology Applications
- Teamwork
- Employability
- Safety Practices
- Ethics

Catch the Fever

UNIT OVERVIEW

Essential Question for This Unit

How has the development of society influenced the evolution of microorganisms?

Unit Summary

In this unit, students will explore the emergence and impact of communicable diseases on society. Students will investigate the role of microorganisms in causing disease. They will study the impact of a public health infrastructure, along with medical and pharmaceutical advances, on the evolution of microorganisms.

In Subunit 1, students learn about the emergence of disease in a population. In Health Science, students learn how microorganisms are transmitted, and how to avoid infection. They also examine their surroundings and possessions to discover that microorganisms can be found everywhere. In Biology, students learn about specific disease-causing pathogens, and how they can be treated. Students also explore how treatments can give rise to more dangerous forms of pathogens. Finally, students examine a mathematical model of disease in action and discuss how a more deadly pathogen does not equal the most successful pathogen.

Subunit 2 focuses on how society deals with the presence of communicable diseases. In Health Science, students participate in simulations in which they role-play the symptoms and diagnosis of common diseases while learning about and practicing common health-care procedures. Students also examine the importance of vaccination and explore the concept of vaccinating populations. In Algebra I, they make calculations needed to manage the production of medications, and to administer medications to adult and pediatric patients. Finally, students research how various countries address the subject of communicable disease.

Detailed accounts of an epidemic can be a fascinating and informational resource. Students begin Subunit 3 by reading excerpts of *The Hot Zone*, an account of the 1989 Ebola outbreak in Virginia. Students also learn about the events contributing to past epidemics around the world, as well as the public reaction. Students conclude the unit by engaging in an in-depth research project on a specific infectious disease of their choice.

Culminating Event

Society has recently experienced several communicable disease scares: Avian Flu, SARS, resistant tuberculosis, and the list goes on. It seems a rare year when a new disease doesn't emerge on the world stage. Working in teams, students can research the background and impact of a specific communicable disease on human society and prepare a presentation. Students can also prepare a plan for their school or community to respond to an epidemic, including researching, evaluating, and revising existing plans, if any.

Key Questions/Issues

- What causes people to get ill? How can illness be prevented, how is it spread, and what can be done to treat it? (Biology and Health Science)

- What makes a successful virus? Why don't viruses evolve to be as deadly as possible? (Algebra I)

- How do healthcare practices influence the natural selection of microorganisms? How have public health efforts dealt with constantly changing humans and microorganisms? (Biology and Health Science)

- Do children receive different amounts of medication than adults? How can you figure out what is the right dosage? (Algebra I)

- Given constraints (e.g., production time and cost), how are optimization decisions made regarding the production of yearly vaccines? (Algebra I or Algebra II)

- What are some of the cures, remedies, or alternative nontraditional healing practices found within Hispanic cultures? (Spanish I)

- If everyone else is vaccinated, why is it important for me to be vaccinated as well? (Health Science)

- What major pandemics have occurred in the past? What events or circumstances contributed to these outbreaks? What could have been done differently in response to these pandemics? (English Language Arts and World History)

Learning Scenario to Kick Off the Unit

Every year without fail, it seems like there is a cold or flu virus that goes around the school. When the weather starts getting colder, someone gets sick, and soon all the teachers and students are sniffling and sneezing. As often as not, you (or one of your siblings) will carry the virus home and your parents will get sick as well. It wouldn't be so bad, except that your dad hates being sick. At the first sign of sniffles, he is off to the doctor. The doctor diagnoses your dad with a cold, and tells him to go home, drink lots of fluids, and he'll be feeling better in 5 or 6 days. Your dad wants a prescription for medication. The doctor tells him antibiotics won't do any good for a cold and sends him home. Two days later, still under the weather, your dad goes back to the doctor, insisting on medication. He argues that maybe the antibiotics will help, and even if they don't, at least they won't do any harm. Exasperated with your dad's persistence, the doctor writes him a prescription and your dad leaves happy. Four days later, he's feeling better, and he says it's all due to the prescription. Is your dad correct? Should the doctor have written him the prescription? Why or why not?

Biomedical/Healthcare and Education Partner Roles

- A school librarian/media specialist can assist the Biology, Health Science, and/or English Language Arts instructors with teaching research skills, particularly in the use of print and other media resources.

- Invited speakers, such as public health specialists, epidemiologists, and/or microbiologists, can meet with students to discuss microorganism mutation and adaptation and the progression of disease-causing pathogens.

- Additional speakers to be invited to participate in the units and/or culminating event include:

  - Respiratory Therapist

  - Pulmonologist (physician who specializes in lung diseases)

  - Epidemiologist from a Health Department (local or state)

  - Pediatric Nurse Practitioner

  - Pediatrician

  - Medical Assistant

  - Pharmacist

  - Pharmacy Technician

SUBUNITS AND MAJOR TOPICS (ACROSS ACADEMIC AND TECHNICAL SUBJECT AREAS)		
Subunit 1 *Emergence of Disease*	**Subunit 2** *Dealing With Disease*	**Subunit 3** *Epidemic*
BIOLOGY · ALGEBRA I · HEALTH SCIENCE	HEALTH SCIENCE · ALGEBRA I OR II · SPANISH I · BIOLOGY	ENGLISH LANGUAGE ARTS · WORLD HISTORY
• Infectious disease transmission • Characteristics of viruses vs. bacteria and their role in infectious disease • Mutation, genetic variation, and natural selection • Co-evolution of organisms • Artificial selection of microorganisms resulting from advances in medical treatment • Direct and indirect relationships • Rational expressions	• Calculating percentages • Setting up and solving single-variable equations from word problems • Using linear programming to optimize a specific function within certain constraints • Clinical epidemiology: identifying symptoms of infectious disease • Vaccination and herd immunity • Habits and behaviors contributing to the spread of disease • Alternative medical practices in Spanish cultures	• Analysis of literature as a reflection of current societal issues • Use of multimedia strategies for research on specific pathogen transmission and effects in the human body and general population • Causes and impact of pandemics around the world • Persuasive essay composition presenting a clear, evidence-supported perspective • Composition and delivery of oral presentations for specific audiences

Emergence of Disease
SUBUNIT 1 OVERVIEW

Essential Question for This Unit
How has the development of society influenced the evolution of microorganisms?

Subunit Goals
In Subunit 1, students learn about the fundamentals of disease-causing microorganisms. In Health Science, they will be introduced to how communicable diseases are transmitted, and they will learn how to break the chain of infection. Students will also conduct an experiment that will lead them to recognize that microorganisms are found almost everywhere and will help them to learn how to take precautions against spreading them further. In Biology, students will learn how to describe the difference between viruses and bacteria, and to treat diseases from these two different types of pathogens. Students will also discuss how the overprescription of antibiotics may contribute toward selection of increasing dangerous bacterial strains. Students will also learn how a mathematical model can be used describe the virulence of a disease.

Subunit Key Questions
- What causes people to get ill? How can I protect myself from getting sick? (Health Science and Biology)

- Where are microorganisms found? Is washing your hands with water enough to make them clean? (Health Science)

- Why is it important to follow medication instructions exactly? Is there any disadvantage to taking medication for an infection you don't actually have? (Biology)

- Why haven't all viruses and bacteria evolved to be extremely deadly? What is a mathematical model for the survivability of different strains of infectious diseases? (Algebra I)

Lesson Summaries

Lesson	Subject	Description
1.1	Health Science	**Chain of Infection** Students are introduced to communicable diseases, specifically how they are transmitted, and to behavioral precautions people can take to protect themselves from infection.
1.2	Biology	**Viruses vs. Bacteria** Students compare and contrast the two major types of pathogens, how they cause disease, and how they are treated. Students research a specific pathogen, and then play and revise a card game simulation of disease transmission and treatment.
1.3	Health Science	**Fun With Fomites** Students culture samples from their school surroundings and their possessions to observe that microorganisms are present almost everywhere. Students also compare the effectiveness of water to disinfectants as a cleaning agent.
1.4	Biology	**Evolutionary Arms Race** Students investigate the effects of various antibacterial agents on bacterial cultures. They also discuss how the use of antibiotics can promote the evolution of increasingly dangerous strains of bacteria.
1.5	Algebra I	**Measure of Success** Students learn the concepts of *direct* and *indirect variation* when creating graphs that analyze the parasitic behavior of viruses and bacteria. Students mathematically model the change in a disease strain's virulence under environmental pressure.

Chain of Infection
LESSON 1.1

HEALTH SCIENCE

Time
55 minutes

Materials
- Sample Lecture: How Does Infection Occur?
- Notes: How Does Infection Occur? worksheet
- Sample Lecture: Chain of Infection
- Notes: Chain of Infection worksheet
- The Chain of Infection worksheet

Prior Student Learning
None

Essential Question for This Unit
How has the development of society influenced the evolution of micro-organisms?

Objectives
After completing this lesson, students should be able to

- Identify and describe the six major parts of the chain of infection.

- 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.

Lesson Activities
Lesson Springboard
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?

To answer these questions, it is necessary to understand how infection occurs in humans and what the chain of infection is from person to person.

Lesson Development
Direct Instruction
Tell students to prepare to take notes from a presentation on infection. The two worksheets—Notes: How Does Infection Occur? and Notes: Chain of Infection—are sample templates for students to use to take notes. Provide direct instruction on infection in whatever style best suits your class. The instruction should include the following content:

- Definitions of the terms *pathogen*, *susceptible*, *host*, and *disease*.

- Descriptions of the different types of pathogens—*fungi*, *bacteria*, *viruses*, *protozoans*, and *prions*. Depending on the level of science completed by the students in the class, it may be necessary to briefly describe the biological differences between bacteria and viruses, the pathogens that are the focus of this unit, and the differences and similarities between fungi, protozoans, and prions. These concepts are also covered in a Biology lesson in this unit.

- Common infectious diseases and different methods of treating infections—Remind students that antibiotics, as their name suggests, are effective only against bacterial infections and not against other types of infections.

Chain of Infection
LESSON 1.1

- Types of Infection and Disease

  - Endogenous—an infection or disease that originates within the body. Examples are metabolic disorders, birth defects, and tumors.

  - Exogenous—an infection or disease that originates outside the body. Examples are pathogenic organisms, radiation, chemicals, and physical and emotional trauma.

  - Nosocomia—an infection acquired by an individual in a health-care facility. These infections can be particularly dangerous. They are sometimes resistant to treatment because they have already survived exposure to treatment materials.

  - Opportunistic—an infection that occurs when the body's defenses are weak.

- Common Body Defenses Against Infection

  - Mucous membranes that line the respiratory, digestive, and reproductive tracts. These sticky membranes trap pathogens and prevent them from infecting the body.

  - Cilia that line the respiratory tract. These tiny hairlike structures catch and propel pathogens out of the body.

  - Coughing and sneezing also propel pathogens and other irritants out of the body.

  - Hydrochloric acid in the stomach destroys pathogens that are ingested.

  - Tears in the eyes contain antibiotic chemicals.

  - Fever is an immune response that kills pathogens via heat.

  - White blood cells produce antibodies that attach to pathogens and work with other cells to prevent them from doing harm.

Note that this might also be a good time to discuss factors that would weaken a body's defenses against infectious disease and behaviors, or other factors that could contribute to a stronger defense.

- The Chain of Infection. There are six main parts to the chain:

  - Causative Agent—a pathogen such as a bacterium or virus that can cause disease.

  - Reservoir—a place where a causative agent can live or stay dormant until it can enter and reproduce in a host. Common reservoirs are the human body, animals, and fomites, which are nonliving objects such as doorknobs, cups, utensils, and needles.

  - Portal of Exit—the way for a causative agent to escape from the reservoir. Portals of exit from humans are urine, feces, saliva, blood, tears, mucous discharge, and sexual secretions.

- Mode of Transmission—a way that a causative agent can be transmitted to a host.

  - Direct contact modes of transmission include sexual activity, saliva/kissing, and touching such as handshakes.

  - Indirect contact modes of transmission involve allowing pathogens into the body through contaminated food, air, soil, or equipment and insect and animal contact. Food and water, for example, are sometimes contaminated by the feces of infected animals or humans due to poor sanitation practices.

- Portal of Entry—a way for the causative agent to enter a new host. Some portals of entry into humans are breaks in the skin and in the respiratory, digestive, and genitourinary tracts.

- Susceptible Host—an individual who can contract the disease. Humans are susceptible to disease when large numbers of pathogens invade the body and/or bodily defenses are weak.

Small Group Work

When students have had all of their questions clarified, divide the class into small groups. Pass out the Notes: Chain of Infection worksheet and introduce the diseases *E. coli* and *influenza*. Have groups read the two descriptions of pathogens and fill out the worksheet for each one. Compare the results as a class.

Lesson Closure

Discuss the ways that students would prevent the spread of *E. coli* or the influenza virus, considering the information they have learned from the worksheet they just completed. What are different ways that the chain of infection can be broken, and which methods are most practical in these examples? Discuss the roles that different healthcare and public health professionals play in containing and preventing infectious disease, from clinical doctors to epidemiologists to policy makers.

Possible Prior Misconceptions

Students may believe that antibiotics are effective in treating any infectious disease. They may also think that there are antibiotics that can treat every type of bacterial infection.

Students may believe that all bacteria are harmful and that places that don't cause illness are sterile.

Students may not know that they can be a reservoir for a pathogen and transmit disease without actually presenting any symptoms themselves.

Student Assessment Artifacts

Completed student notes
Completed worksheets

Variations and Extensions

Invite a public health official or epidemiologist to be a guest speaker and share insights on the actual tracking and containment of disease. These individuals might also share information about their daily job responsibilities and the education and experience required for their jobs.

Ask students to research a particular infectious disease and report on its chain of infection. Alternatively, ask students to research a particular vector for disease, such as the mosquito, and report on what diseases it carries, where, to what hosts, and what efforts have been made to contain that vector's effect.

National and State Career Technical Education Standards

NATIONAL
NCHSTE National Healthcare Skill Standards

Foundation Standard 7: Safety Practices
Healthcare workers will understand the existing and potential hazards to clients, co-workers, and self. They will prevent injury or illness through safe work practices and follow health and safety policies and procedures.

7.1 Infection Control

CALIFORNIA
Health Science and Medical Technology Standards

6.0 Health and Safety
Students understand health and safety policies, procedures, regulations, and practices,including the use of equipment and handling of hazardous materials:

6.3 Understand the importance and use of standard precautions and infection control, as appropriate.

Name _____ Date_____ Period _____

Sample Lecture: How Does Infection Occur?

1. Microorganisms = small, living organisms not visible to the naked eye
2. Pathogens = microorganism that cause disease
3. Susceptible Host = an organism capable of contracting a specific disease
4. Disease results if the invading pathogen causes impairment in the host
5. Types of Pathogens
   a. There are different types of pathogens, including:
      i. Fungi
      ii. Bacteria
      iii. Viruses
      iv. Protozoans
      v. Prions
   b. Bacteria
      i. Single-celled organisms
      ii. Live in a variety of environments
      iii. Only 1% cause disease
      iv. Usually killed by antibiotics
      v. Examples of diseases caused by bacteria:
         1. Pneumonias
         2. Strep throat
         3. Tuberculosis
   c. Viruses
      i. Smallest of pathogens
      ii. Viruses can reproduce only by invading a host cell
      iii. NOT cured by antibiotics
      iv. Examples of diseases caused by viruses:
         1. Chicken pox
         2. Colds
         3. Flu (influenza)
         4. Small pox
         5. HIV
6. Types of Infection
   a. Endogenous = infection or disease originates within the body
      Examples:
      i. Metabolic disorders
      ii. Birth defects
      iii. Tumors
   b. Exogenous = infection or disease originates outside the body
      Examples:
      i. Pathogenic organisms
      ii. Radiation
      iii. Chemicals
      iv. Trauma
      v. Electric shock
      vi. Temperature extremes
   c. Nosocomial = infections acquired by an individual in a healthcare facility
      Usually present in the facility and transmitted by healthcare workers to the patient
   d. Opportunistic = infections that occur when the body's defenses are weak
7. Common Body Defenses
   a. Mucous membrane: lines the respiratory, digestive, and reproductive tracts
   b. Cilia: tiny hair-like structures that line the respiratory tract to propel pathogens out of the body
   c. Coughing and sneezing
   d. Hydrochloric acid: destroys pathogens in the stomach
   e. Tears in the eye: contain chemicals that kill bacteria
   f. Fever: kills pathogens via heat
   g. Immune response: body produces white blood cells and antibodies to fight pathogens

Name _____ Date_____ Period _____

Notes: How Does Infection Occur?

1. _____ = small, living organisms not visible to the naked eye

2. Pathogens = _____

3. Susceptible Host = _____

4. _____ results if the invading pathogen causes impairment in the host

5. Types of Pathogens

   a. There are different types of pathogens, including:

      i. Fungi

      ii. _____

      iii. _____

      iv. Protozoans

      v. Prions

   b. Bacteria

      i. Single-celled organisms

      ii. Live in a variety of environments

      iii. Only _____ cause disease

      iv. Usually killed by _____

      v. Examples of diseases caused by bacteria:

         1. Pneumonias

         2. _____

         3. Tuberculosis

   c. Viruses

      i. _____ of pathogens

      ii. Viruses can reproduce only by _____

      iii. NOT cured by antibiotics

      iv. Examples of diseases caused by viruses:

         1. _____

         2. Colds

         3. Flu (influenza)

         4. _____

         5. _____

Name _____ Date _____ Period _____

6.   Types of Infection

   a.   Endogenous = _____

   _____

   Examples:
   1.   Metabolic disorders

   2.   _____

   3.   _____

   b.   Exogenous = _____

   _____

   Examples:
   1.   _____

   2.   _____

   3.   Chemicals

   4.   Trauma

   5.   _____

   6.   Temperature extremes

   c.   Nosocomial = _____

   _____

   Usually present in the facility and transmitted by _____ to

   _____

   d.   Opportunistic = _____

   _____

7.   Common Body Defenses

   a.   Mucous membrane: lines the _____, _____, and

   _____tracts

   b.   Cilia: tiny _____ that line the respiratory tract to propel pathogens out of the body

   c.   _____and _____

   d.   Hydrochloric acid: destroys pathogens in the _____

   e.   Tears in the eye: contain _____that kill bacteria

   f.   Fever: kills pathogens via _____

   g.   Immune response: body produces _____ and _____ to fight pathogens

Name _____ Date _____ Period _____

Sample Lecture: Chain of Infection

Chain of infection = conditions that must exist for disease to occur and spread
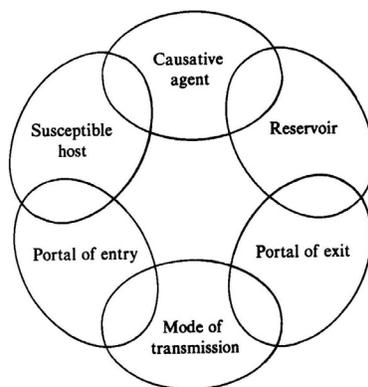
Six parts of the chain:

1. **Causative Agent** = a pathogen such as a bacterium or virus that can cause disease

2. **Reservoir** = the place where a causative agent can live
    Common reservoirs:
    a. Human body
    b. Animals
    c. Environment
    d. Fomites = nonliving objects such as doorknobs, cups, utensils, needles

3. **Portal of Exit** = the way for a causative agent to escape from the reservoir
    Pathogens can leave the body through …
    Urine, feces, saliva, blood, tears, mucous discharge, sexual secretions, and wounds

4. **Mode of Transmission** = the way that causative agent can be transmitted to a host
    a. Direct contact = person-to-person
        Examples include: sex, saliva/kissing, handshake/touching
    b. Indirect contact = contaminated substances
        Examples include: food, air, soil, insects, animals, feces, equipment

5. **Portal of Entry** = a way for the causative agent to enter a new host
    Different portals of entry include:
    a. Breaks in the skin
    b. Respiratory tract
    c. Digestive tract
    d. Genitourinary tract
    e. Circulatory system

6. **Susceptible Host** = an individual who can contract the disease
    Humans become susceptible if …
    a. Large numbers of pathogens invade the body
    b. Body defenses are weak

Name _____ Date _____ Period _____

Notes: Chain of Infection

Chain of infection = _____

_____
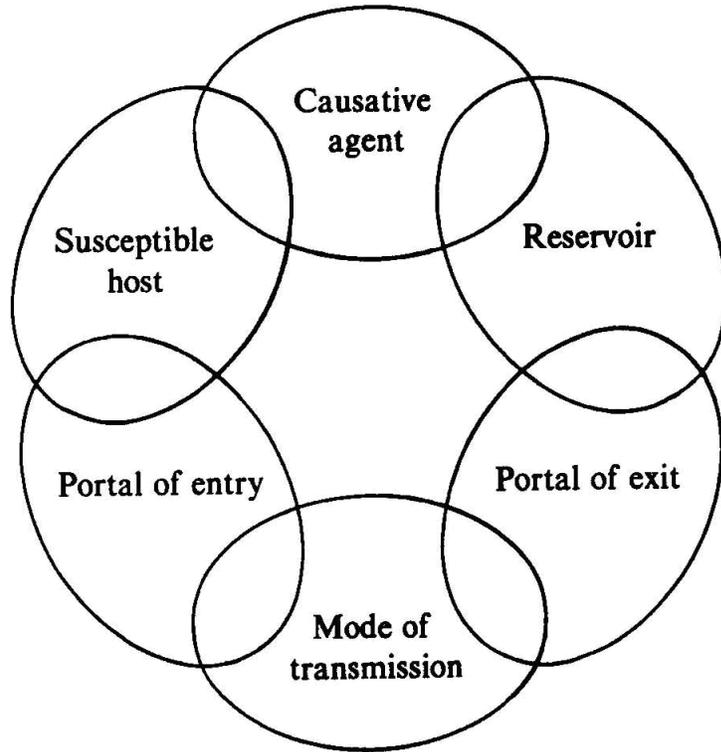
Six parts of the chain:

1. **Causative Agent** = _____

_____

2. **Reservoir** = _____

_____

Common reservoirs:

a. _____

b. _____

c. Environment

d. _____ = nonliving objects such as doorknobs, cups, utensils, needles

Name _____ Date _____ Period _____

3. **Portal of Exit** = _____

   _____

   Pathogens can leave the body through …

   Urine, _____, saliva, _____, tears, _____,

   sexual secretions, and _____

4. **Mode of Transmission** = _____

   _____

   a. Direct contact = _____

   Examples include: sex, saliva/kissing, handshake/touching

   b. Indirect contact = _____

   Examples include: food, air, soil, insects, animals, feces, equipment

5. **Portal of Entry** = _____

   _____

   Different portals of entry include:

   a. _____

   b. Respiratory tract

   c. _____

   d. Genitourinary tract

   e. _____

6. **Susceptible Host** = _____

   _____

   Humans become susceptible if …

   a. Large numbers of _____ invade the body

   b. Body defenses are _____

Name _____ Date _____ Period _____

The Chain of Infection
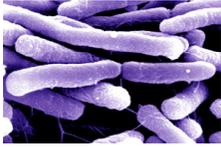
E. coli
(www.familydoctor.org)

E. coli is short for *Escherichia coli*—a germ that causes severe cramps and diarrhea. *E. coli* is a leading cause of bloody diarrhea. The symptoms are worse in children and older people, and especially in people who have another illness. *E. coli* infection is more common during the summer months and in northern states.

Healthy beef and dairy cattle may carry the *E. coli* germ in their intestines. The meat can get contaminated with the germ during the slaughtering process. When beef is ground up, the *E. coli* germs get mixed throughout the meat.

The most common way to get this infection is by eating undercooked hamburgers. You can be infected with the *E. coli* germ if you don't use a high enough temperature to cook your beef, or if you don't cook it long enough. When you eat undercooked beef, the germs enter your stomach and intestines.

1. causative agent = _____
2. reservoir = _____
3. portal of exit = _____
4. mode of transmission = _____
5. portal of entry = _____
6. susceptible host = _____
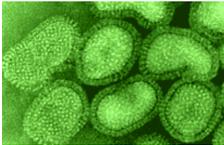
Influenza (flu)
(www.mayoclinic.com)

The flu is caused by three types (strains) of viruses—influenza A, B, and C. Anyone can get influenza, a viral infection that attacks your respiratory system, including your nose, throat, bronchial tubes, and lungs. You're especially at risk if you are an older adult, have diabetes, chronic heart or lung disease, or an impaired immune system.

You're exposed to the flu when someone who is infected with the influenza virus coughs or sneezes, or you touch something they've handled. That's why the flu spreads rapidly anywhere people congregate— schools, childcare centers, offices, nursing homes, buses, even luxury cruise ships.

1. causative agent = _____
2. reservoir = _____
3. portal of exit = _____
4. mode of transmission = _____
5. portal of entry = _____
6. susceptible host = _____

Viruses vs. Bacteria

BIOLOGY

Time
120 minutes

Materials
Equipment
• Pathogen Trading Card decks (minus the Pathogen Cards, to be created by students)
• Pennies (or other small items) to be used in game revisions

Resources
• Viruses vs. Bacteria worksheet and sample answers
• Pathogen Cards Assignment handout
• Catch the Fever Trading Card Game Rules handout
• Character Cards–Front (Healthy)
• Character Cards–Back (Sick)
• Vaccination Cards
• Antibiotics Cards

Prior Student Learning
Students should be familiar with basic cell structure.

Students should be familiar with the conditions required for something to be considered living. Students should also be familiar with common exceptions to generally accepted characteristics.

Essential Question for This Unit
How has the development of society influenced the evolution of micro-organisms?

Objectives
After completing this lesson, students should be able to

• Describe the physical structure of viruses.

• Describe the physical structure of bacteria.

• Explain the difference between viruses and bacteria as pathogens.

• Recognize the strengths and limitations of various defenses against disease, including vaccines and antibiotics.

Lesson Activities
Lesson Springboard
Start with a "mini-inquiry" on bacteria and viruses. Give each student a detailed picture of what a virus or bacteria looks like, but do not identify it. Give them 2 minutes to list as many details about the virus or bacteria from the picture as possible. Ask them to make a hypothesis about the picture, determining whether it is a bacteria or a virus. You might also pose the following questions: How do the students think their microorganism reproduces? What type of genetic material might the microorganism contain? How big do they think the microorganism is, perhaps in comparison with a familiar object? Provide students with a list of the names of bacteria and viruses and ask them to guess which one is in their picture.

Lesson Development
Class Discussion
Ask students what they think they know about viruses and bacteria. How are they similar and how are they different? Draw a Venn diagram for bacteria and viruses on the board and fill it in as the class responds. With each new characteristic, ask the class if everyone agrees. Accept inaccurate responses, but allow other students to challenge them. Emphasize that part of the lesson will involve learning about the accuracy of what they think they know. Save a copy of the Venn diagram to review at the end of the lesson.

Direct Instruction
Pass out the Viruses vs. Bacteria worksheet. Deliver an initial lecture to students describing bacteria and viruses and highlighting the differences between them. Tell students that some differences to note include the following:

Viruses vs. Bacteria

LESSON 1.2

Viruses	Bacteria
• Viruses are noncellular structures composed mainly of nucleic acids (genetic material; either DNA or RNA) contained within a protein coat known as a *capsid*.	• Bacteria are microscopic unicellular prokaryotic organisms characterized by the lack of a membrane-bound nucleus and membrane-bound organelles.
• Viruses are generally considered nonliving because they fail to meet several of the commonly accepted criteria of life.	• Most bacteria are one of three typical shapes—rod-shaped (bacillus); round (coccus— e.g., streptococcus); and spiral (spirillum).
• Viruses are usually grouped according to such properties as size, the type of nucleic acid they contain, the structure of the capsid and the number of protein subunits in it, host species, and immunological characteristics.	• Some bacteria (aerobic) can function metabolically only in the presence of free or atmospheric oxygen; others (anaerobic) cannot grow in the presence of free oxygen but obtain oxygen from compounds.

Also introduce common structures, shapes, and sizes, their means of reproduction, and their transmission as infectious agents. Have students take notes on the Viruses vs. Bacteria worksheet as you present this information.

Research Project
Have each student select a bacterial or viral pathogen to research. Students can choose one from the list below or select a different pathogen of interest to them. Students will be conducting research on an infectious disease in Lesson 3.4, so you may wish to coordinate your assignment of pathogens with the English Language Arts teacher.

Viruses	Bacteria
Measles	*Clostridium tetani* (tetanus)
Mumps	*Corynebacterium diphtheriae* (diphtheria)
Rubella	*Bordetella pertussis* (whooping cough)
Hepatitis B	*Rickettsia prowazekii* (typhus)
Polio	*Salmonella typhi* (typhoid fever)
Influenza	*Shigella* (dysentery)
Varicella-Zoster	*Mycobacterium tuberculosis* (tuberculosis)
Hepatitis A	*Neisseria meningitides* (meningococcal meningitis)
Ebola	*Bacillus anthracis* (anthax)
Smallpox	*Streptococcus pneumoniae* (pneumonia)
Yellow fever	*Streptococcus pyogenes* (strep throat, scarlet fever)
Dengue	*Helicobacter pylori* (stomach ulcers)
HIV	*Vibrio cholerae* (cholera)
Marburg	*Rickettsia rickettsii* (Rocky Mountain spotted fever)
Lassa	*Borrelia burgdorferi* (Lyme disease)
Rabies	

Pass out the Pathogen Cards Assignment handout. Students will make a playing card that contains information about their pathogen. Each card should contain the following information:

- Name of pathogen

- Picture of pathogen or transmission vector

- Brief description of pathogen (virus or bacteria, type, shape, and so on)

- Offenses

  - Attacks—transmission and description of infection target, if any

  - Outcome—name and brief description of the associated disease resulting from infection

  - Incubation—time from infection to presentation of symptoms (days, weeks, months, or years)

  - Duration—typical length of infection

  - Power—virulence and fatality rate

- Defenses

  - Vaccine—name and brief description of developed vaccine, if any

  - Behavioral—preventative behavior to avoid infection

  - Treatment—description of treatment if infected

Review Game
Resize the student cards and combine them with the vaccination and antibiotics cards. Photocopy enough sets to make a deck of cards for every two students. Each deck should have 8 vaccination cards, 30 pathogen cards, and 30 antibiotic cards. Each student also receives 5 character cards (front side indicates healthy status, back side indicates sick status). Have students pair up and pass out the card decks. Give students time to look though the deck and read the text on the cards. Explain the basic rules, as described below, and allow students to play the game for about 5 or 10 minutes.

1. The game is played in pairs.

2. Each player starts with 5 characters. The goal of the game is to keep all 5 characters healthy. The game ends when either player's characters are all "sick" or after a time set by the teacher (5 or 10 minutes). The winner is the player with the greatest number of healthy characters remaining.

3. Shuffle the deck and pass out 5 cards to each player. Place the remaining cards in a pile face down between the two players.

4. The first player may play as many cards out of her or his hand as possible.

5. Cards that may be played during a turn:
   a. Attacks—pathogen cards are attacks played against the opposing player's characters. When the opposing player's character has been attacked, place the pathogen card below the character card.

     i.   Characters can only have one pathogen at a time.

     ii. Bacteria can be played against any character.

     iii. Viruses without vaccines can be played against any character.

     iv. Viruses with vaccines cannot be played against a character with a vaccination card.

     v. There are select viruses (e.g., Rabies, Variella-Zoster) that can be treated with vaccine post-infection (if this is the case, it should say so on the pathogen card). If the opposing player has a vaccination card in his or her hand when attacked by one of these viruses, he or she can play the vaccination card at that time, and both the virus and vaccination cards are placed immediately into the discard pile.

  b. Defenses—there are two types of defenses that can be played on your turn:

     i.   Preemptive vaccines—vaccinations can be placed preemptively on a character to protect them from future virus attacks. A vaccination card will protect that character from any virus attack that has a vaccine. However, not all viruses have vaccines.

     ii. Antibiotics—antibiotics are played on characters that have previously been attacked with a bacterial infection. Each bacterial infection needs to be treated with antibiotics for three **consecutive** turns before the character is healed.

  c. Discard—you may discard any unwanted cards from your hand into the discard pile.

6. After all cards have been played, update the health status of all of your characters.

  a. Viral infections—flip over any characters that have a virus at the end of the turn. This character is now "sick" and out of the game. Return the virus card and any defense cards to the discard pile.

  b. Bacterial infections

     i.   No antibiotic played—if a character has a bacterial infection and no antibiotics card was played **this turn**, flip the card over and return any defense cards to the discard pile.

     ii. First or second antibiotic played—if a character has a bacterial infection and the first or second antibiotics card was played this turn, nothing happens.

     iii. Third antibiotic played—if a character has a bacterial infection and a third antibiotics card was played this turn, discard the pathogen card and all antibiotics cards to the discard pile (vaccination card remains, if any). The character is now healthy.

7. When the turn is over, both players draw up to 5 cards, as necessary.

8. The next player may now play cards.

After students are familiar with the game, have each group develop one rule modification that will represent another important variable in either bacterial or viral disease transmission. Some possible suggestions include the following:

• Have separate vaccination cards for each virus.

• Include incubation time listed on the cards as part of the game. Have each incubation time correspond to a set number of turns. Antibiotics are not used until the incubation time has elapsed.

• Include fatality rate and/or disease duration as part of the game. Have diseases last a set number of turns, and when this time is over, roll a die to see if the disease was fatal (based on fatality rate from pathogen card). Only fatalities are flipped; otherwise, characters recover.

Have students play the pathogen game again after making their rule revisions. Students may need to used some extra simple props (e.g., pennies) or alter the cards in some way to play the revised game. Give students the opportunity to share their revision suggestions with the rest of the class. You may want to incorporate several of the better revisions into a new class version of the game and then have all students play again.

Lesson Closure
Redraw the Venn diagram of bacteria and viruses from the beginning of the lesson. Review the facts that students suggested and move/correct any inaccurate items. Have students suggest additions for the Venn diagram as well.

Possible Prior Misconceptions
Some students may believe that vaccines are only used for viruses. However, several bacterial diseases also have vaccines.

Some students may believe that antibiotics are general treatments for all diseases, not just for bacterial infections.

Students may believe that all vaccines must be taken prior to infection to be effective. This is true of many vaccines, but not all.

Student Assessment Artifacts
Completed Viruses vs. Bacteria worksheet
Pathogen trading cards
Revisions to the pathogen game

Variations and Extensions

Invite an epidemiologist to speak to the class about disease transmission.

Have students build three-dimensional models of their pathogen. Students can deliver a presentation about their pathogen to the class, show their model, and pass out their trading cards to the other students.

Allow students to personalize the character cards in their card deck.

National and State Academic Standards

NATIONAL
NRC National Science Education Standards

Personal and Community Health
The severity of disease symptoms is dependent on many factors, such as human resistance and the virulence of the disease-producing organism. Many diseases can be prevented, controlled, or cured. Some diseases, such as cancer, result from specific body dysfunctions and cannot be transmitted.

CALIFORNIA
Science Content Standards

Biology/Life Science
10. Organisms have a variety of mechanisms to combat disease. As a basis for understanding the human immune response:

   d. *Students know* there are important differences between bacteria and viruses with respect to their requirements for growth and replication, the body's primary defenses against bacterial and viral infections, and effective treatments of these infections.

Name _____ Date_____ Period _____

Viruses vs. Bacteria

	Viruses	Bacteria
Are they alive? (Do they produce energy, eat food?)		
Genetic material		
Reproduction		
Survival in harsh conditions		
Example diagram		**A Typical Prokaryote Cell** Cytoplasms Ribosomes DNA Cell Membrane Cell Wall
Structure		
Size		
Treatment of diseases they cause (doctor's advice?)		
What can be done to prevent infections?		
Examples		
Useful? If so, how? Where?		
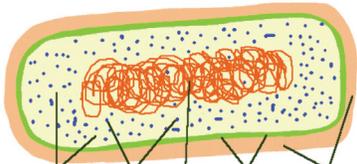
Name _____ Date_____ Period _____

Viruses vs. Bacteria (sample answers)

	Viruses	Bacteria
Are they alive? (Do they produce energy, eat food?)	No	Yes Some get nourishment from chemo-synthesis, some from sunlight
Genetic material	DNA or RNA, not both	DNA

Reproduction	Inside a host cell.
	Initiation phase:
	  • attachment
	  • penetration
	  • uncoating
	Replication phase:
	  • DNA synthesis
	  • RNA synthesis
	  • protein synthesis
	Release phase:
	  • assembly
	  • maturation
	  • exit from cell
		Asexual (binary fission) OR sexual (conjugation uses tube to exchange genetic material)

Treatment of diseases they cause (doctor's advice?)	Treat symptoms	Antibiotics
Structure	Nucleic acids enclosed by a capsid, or protein coat. Typically either icosahedral (20 sided) or helical	No organelles, have cell walls, some are motile
Draw example diagram	Icosahedral and helical	
Size	20–300 nanometers (1 billionth meter)	0.1–10.0 micrometers (1 millionth meter)
Survival in harsh conditions	Crystalline state; can exist for years unchanged until it invades a host	Endospores; some can only live in harsh conditions! (see usefulness)
What can be done to prevent infections?	Vaccines, wash hands, cover openings in skin	Wash hands or openings in skin, cook food thoroughly, boil infected water, clean home surfaces; expo-sure to small amounts may create immunity
Examples	Acquired immune deficiency syn-drome, common colds, smallpox, influenza, and warts	Streptococcus infections and diphtheria
Useful? If so, how? Where?	N/A	Intestines, wood-eaters, petroleum-eaters, plastic-eaters
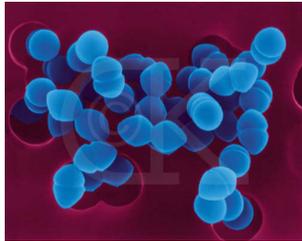
Name _____ Date_____ Period _____

Pathogen Cards Assignment

Research your assigned pathogen for the following information:

1. Type of pathogen
   a. Is it a virus or bacteria?
   b. Brief description of the pathogen

2. How is it transmitted?

3. Is there a part of the body it attacks particularly? If so, which part(s)?

4. What is incubation period? How long is the incubation period for your pathogen?

5. What diseases does it cause? What are the symptoms of infection?

6. What is the duration of illness?

7. What is virulence? How virulent is your pathogen? How deadly?

8. Is there a vaccine for your pathogen? If so, who discovered it, and when? Can the vaccine be taken even after infection?

9. What behaviors will help someone to avoid infection by your pathogen?

10. If you are infected, what is the treatment, if any?

After you have found all the information, make a trading card of your pathogen with the following information (see Yellow Fever sample card).

- Name of pathogen

- Picture of pathogen and/or the transmission vector

- Brief description of pathogen (virus or bacteria, type, shape, and so on) and an indication of its power (virulence and fatality rate)

- Offenses
  - **Attacks**—transmission and description of infection target, if any

  - **Outcome**—name and brief description of the associated disease resulting from infection

  - **Incubation**—time from infection to presentation of symptoms (days, weeks, months, or years)

  - **Duration**—typical length of infection

- Defenses
  - **Vaccine**—name and brief description of developed vaccine, if any; list whether the vaccine can be administered both before and after infection, or only before.

  - **Behavioral**—preventative behaviors to avoid infection

  - **Treatment**—description of treatment if infected

You can choose a different layout for your own pathogen card, but the card must include all the required information somewhere.

YELLOW FEVER VIRUS

Yellow fever virus is a single-stranded RNA virus endemic to tropical regions of Africa, South and Central America, and the Caribbean. **Power**: Without vaccination, yellow fever has a fatality rate that can exceed 50%.

OFFENSES	DEFENSES
Attacks Transmitted to humans through the infected saliva of certain types of mosquitoes, the yellow fever virus primarily attacks the liver.	**Vaccine** Yes, yellow fever vaccine, which was developed in 1937 by Max Theiler, provides 10 or more years of immunity. The vaccine provides 95% immunity just 1 week after vaccination.
Outcome Acute phase: fever, muscle, backache, headache, shivers, loss of appetite, and nausea and/or vomiting. Toxic phase (15% of infected): jaundice, abdominal pain, bleeding, leading to kidney failure.	**Behavioral** Get vaccinated. Use insect repellents and insecticide, wear protective clothing.
Incubation **Duration** 3–6 days 3–14 days	**Treatment** No cure. Treatment is symptomatic only: fluid replacement, correction of hypotension, and blood transfusions when necessary.

Name _____ Date _____ Period _____

Catch the Fever Trading Card Game Rules

OVERVIEW
The game is played in pairs. Each player starts with 5 characters. The goal of the game is to keep all 5 characters healthy. The game ends when either one player's characters are all sick, or after a time set by the teacher (5 or 10 minutes). The winner is the player with the greatest number of healthy characters remaining.

SETUP
Each player places 5 character cards in front of them, healthy side up. Shuffle the deck and deal out 5 cards to each player. Place the rest of the deck face down between the two players. Leave room for a discard pile next to the deck. Any cards that get discarded will go to this pile. When the deck runs out, create a new deck by shuffling the discard pile.

PLAYING THE GAME
Players alternate turns. Each player's turn has three parts:
1. Play Cards
2. Update Character Health
3. Draw Cards

KINDS OF CARDS
• **Character cards** (10) have a "healthy" side and a "sick" side. Healthy characters can get infections. Sick characters are out of the game.
• **Pathogen cards** (30) are attack cards played on other characters to infect them. Pathogen cards are either **viruses** or **bacteria**.
• **Antibiotic cards** (30) are defense cards played on characters with bacterial infections.
• **Vaccination cards** (8) are defense cards played on characters to prevent viral infections.

1. Play Cards
Play as many cards as you like. If you have any cards you don't like, you may discard them into the discard pile.

Pathogens are played on your opponent's characters. Place the card face up on the target character. Characters can only have one pathogen at a time.
- Bacteria and viruses can be played against any character; however, a vaccination card protects characters from viruses that have vaccines.
- There are certain viruses (e.g., Rabies, Variella-Zoster) that can be treated with vaccine post-infection (this will be stated on the pathogen card). If the opposing player has a vaccine card in his or her hand when attacked by one of these viruses, he or she can play the vaccine card at that time, and both the virus and vaccine cards are placed immediately into the discard pile.

Vaccination and **Antibiotic** cards are played on your own characters. Place the card face up on the character that this card is medicating.
- Preemptive vaccination—vaccinations can be placed preemptively on a character to protect them from future virus attacks. A vaccination card will protect that character from any virus attack that has a vaccine. However, not all viruses have vaccines.
- Antibiotics—antibiotics are played on characters that have previously been attacked with a bacterial infection. Each bacterial infection needs to be treated with antibiotics for three **consecutive** turns before the character is healed.

2. Update Character Health
For each of your characters, determine how their health changes.
- Viral infections—flip over any characters that have a virus at the end of the turn. This character is now "sick," and out of the game. Return the virus card and any defense cards to the discard pile.
- Bacterial infections
  - No antibiotic played—if a character has a bacterial infection with no antibiotics card that was played **this turn**, flip the card over and return any defense cards to the discard pile.
  - First or second antibiotic played—if a character has a bacterial infection and the first or second antibiotics card was played this turn, nothing happens.
  - Third antibiotic played—if a character has a bacterial infection and a third antibiotics card was played **this turn**, discard the pathogen card and all antibiotics cards to the discard pile (vaccination card remains, if any). The character is now healthy.

3. Draw Cards
When your turn is over, draw cards from the deck until you have 5 cards. If your opponent played any cards during your turn, she or he may also draw up to 5 cards before starting her or his turn.

GAME END
The game ends when one player has no healthy characters, or when your teacher says so. Whoever has the greatest number of healthy characters wins.

Name _____ Date _____ Period _____

Character Cards—Front (Healthy)

Name _____ Date_____ Period _____

Character Cards—Back (Sick)

Name _____ Date_____ Period _____

Vaccination Cards

VACCINATION	**VACCINATION**
VACCINATION	**VACCINATION**
VACCINATION	**VACCINATION**
VACCINATION	**VACCINATION**

Name _____ Date_____ Period _____

Antibiotics Cards

ANTIBIOTICS

ANTIBIOTICS

ANTIBIOTICS

ANTIBIOTICS

ANTIBIOTICS

ANTIBIOTICS

ANTIBIOTICS

ANTIBIOTICS

Fun With Fomites

LESSON 1.3

HEALTH SCIENCE

Time
100 minutes

Materials
Equipment
- 3 sterile Petri plates prepared with agar
- Cotton swabs
- Paper towels
- Cellophane tape
- Permanent marker or grease pencil
- Disinfectants (ethanol, bleach, commercial cleaning solution, and so on)

Resources
Fun With Fomites Lab worksheet (lesson adapted from http://www.microbeworld.org)

Prior Student Learning
Students should have a general understanding of fomites, the chain of infection, and the modes of transmission for infectious disease.

Essential Question for This Unit
How has the development of society influenced the evolution of micro-organisms?

Objectives
After completing this lesson, students should be able to

- Define a fomite as an inanimate object or substance capable of transmitting infectious organisms from one individual to another and identify examples.

- Describe the role of fomites in the chain of infection.

- Quantify the number of microorganisms that are present on various fomites.

- Compare the ability of various disinfectants to eliminate microorganisms present on various fomites.

Lesson Activities
Lesson Springboard
Review the links in the chain of infection from Lesson 1.1: causative agent, reservoir, portal of exit, mode of transmission, portal of entry, and susceptible host. Ask students to identify the two modes of transmission for infectious disease: direct and indirect transmission. Discuss examples of both modes of transmission. Ask students to describe the role of fomites in infectious transmission and to list examples.

Lesson Development
Lab Activity
Tell students they will be working in groups of three to test three different fomites of their choice for the presence of microorganisms. Hand out the Fun With Fomites Lab worksheet. Discuss the procedure with the students and make sure they understand it before continuing.

Distribute the lab materials and have students get started, following the instructions on the lab worksheet. Walk around the room and check that students are following the directions. Each group should have three Petri plates clearly labeled by the end of the period. When each group has streaked and labeled their Petri plates, collect them for incubation in a warm, dark location for 2 to 3 days.

Redistribute each group's Petri plates and ask the students to check them for microbial growth. Have students record the number of bacterial colo-

Classroom Management
Students should work in groups of three so that each student can pick a fomite for testing.

Support Strategy
Encourage students to be creative in selecting fomites for testing.

nies that have grown in the various sections of the Data Table on their lab worksheets. Have students answer the questions at the end of worksheet. Save the Petri plates with the heaviest bacterial growth for the Biology teacher to use in Lesson 1.4.

Lesson Closure
After all the groups are finished with the lesson, discuss which fomites had the most microbial growth. Were there any surprises? Ask students if cleaning the surface with water alone made any difference in the bacterial count. What about using a disinfectant? How do students think they can prevent the spread of disease via fomites?

Possible Prior Misconceptions
Students may believe that washing surfaces with water will eliminate bacterial growth.

Students may not realize that virtually *everything* is a fomite.

Beware of creating the misconception that all bacteria are harmful.

Student Assessment Artifacts
Completed Fun With Fomites Lab worksheet

Variations and Extensions
Begin the lesson by using Glo Germ to show students that microorganisms can easily spread. Place the Glo Germ powder on a countertop, a desk, and the door handle of the classroom. At the beginning of class, use a UV light to determine how many students became "infected" with the simulated microorganism in the just the first few minutes of class.

National and State Career Technical Education Standards

NATIONAL
NCHSTE National Healthcare Skill Standards

1.22 Analyze methods to control the spread of pathogenic microorganisms

7.11 Practice infection control procedures

7.12 Practice appropriate cleaning, disinfecting, and sterilizing processes

CALIFORNIA
Health Science and Medical Technology Standards

6.3 Understand the importance and use of standard precautions and infection control, as appropriate.

D2.1 Know how to evaluate potential causes and methods of transmitting infections and how to apply standard precautionary guidelines.

Name _____ Date_____ Period _____

Fun With Fomites Lab

Fomites? What are fomites? This is a term for any inanimate object that can carry disease-causing organisms. Your cutting board, kitchen sink, the change in your pocket and even that pen you keep putting in your mouth are all fomites. Very few things we encounter in our everyday activities are sterile, or microbe-free, including us. At birth, microbes immediately begin colonizing our bodies as they do most every object in the world. They float around until they come in contact with a surface that offers food and shelter. You are most likely to find microbes in and on dark, moist objects that frequently come into contact with food, dirt, or vegetation. Bathroom surfaces, hairbrushes, refrigerators, kitchen sinks, and cutting boards often have lots of microbes on them. But doorknobs and walls have fewer because they are nutrient-poor and dry.

Most of the microbes on our bodies and other surfaces are harmless, but some are pathogenic or disease-causing. For this reason, we want to control the number of microbes around us. The odds of becoming infected increase with the number of microbes on surrounding objects. But what can we do to affect the number of microbes on surfaces around us?

In this activity, you will test a chosen fomite for the presence of microbes and the effects of a disinfectant by growing colonies of bacteria in a medium on Petri plates. A medium has food, vitamins, and salts that help microbes grow. You usually don't see bacterial colonies like those that form on Petri plates on everyday surfaces. That's because there is rarely such a perfect concentration of nutrients on fomites in nature.

Note: This is an activity that you will start on one day and finish on a different day.

Materials
- 3 sterile Petri plates prepared with agar
- Cotton swabs
- Paper towels
- Cellophane tape
- Permanent marker or grease pencil
- Disinfectant

Procedure
1. If you have long hair, tie it back to keep it from dangling into the Petri plates as you're working. Wash your hands. Clean your work area by dabbing, not pouring, disinfectant solution onto a paper towel and swabbing your area. Set out your Petri plates, but DO NOT OPEN THE PLATES UNTIL YOU'RE TOLD TO DO SO.

2. Choose an object in the room (doorknob, countertop, computer keyboard, desk, coin, etc.). Take one unopened Petri plate and using your grease pencil or marker, divide the bottom of the plate into three equal sections as shown in the illustration. Write the object's name across the top and label the sections "1," "2," and "3." Write your name at the bottom.

3. Open the box of cotton swabs and select one being careful not to touch the tip. Swab your chosen object with all sides of the swab tip by turning and twisting the swab as you move it across the object's surface.
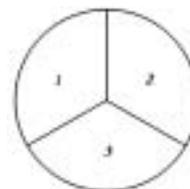
Name _____ Date _____ Period _____

4. Now open the lid of the plate and GENTLY make four streaks on the plate's sur-
    face as shown in the illustration in the section labeled "1." Use firm, but GENTLE,
    pressure and do not retrace your previous streaks. Your streaks should make only
    very slight impressions in the agar—don't gouge. Close the plate.

5. Clean half of the object you swabbed with a paper towel dampened with plain
    water—just wipe a couple of times; don't scrub. Using a new cotton swab, swab
    the cleaned area for microbes. Open the lid of the plate and GENTLY make a
    streak on the plate's surface in the section labeled "2." Close the plate.

6. Choose ONE of the disinfectants. Use your chosen disinfectant to clean the OTHER
    half of the object you swabbed. Using another new cotton swab, swab the disin-
    fected area for microbes. Open the lid of the plate and GENTLY make a streak on
    the plate's surface in the section labeled "3." Close the plate and seal it shut with
    two pieces of cellophane tape placed along the sides. Do not cover the top of the
    Petri plate with tape or you won't be able to see the inside of it well.

7. Throw away the used cotton swabs. Place your plates in an out-of-the-way spot
    and let them incubate at room temperature for at least 2 days. Clean your work
    area with disinfectant solution. Wash your hands.

8. After at least 2 days have passed, look at your Petri plate, but do not open it. Examine each of the
    labeled sections without opening the plate. Record your observations in the table below. Be sure to
    indicate whether microbes grew in each streak.
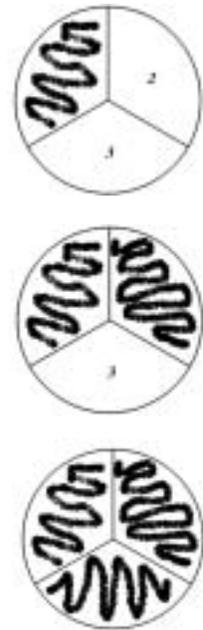
Data Table						
	Section 1 (fomite)		Section 2 (water)		Section 3 (disinfectant)	
	Growth?	Description	Growth?	Description	Growth?	Description
Plate 1 _____						
Plate 2 _____						
Plate 3 _____						

Name _____ Date _____ Period _____

Questions and Conclusions

1. Which plate (fomite) grew the most and largest colonies of bacteria? Why do you think that is?

2. Did the water reduce the amount of bacteria that was collected?

3. Did the disinfectant reduce the amount of bacteria that was collected?

4. What does this experiment tell us about how we can control microbial contamination?

Evolutionary Arms Race
LESSON 1.4

BIOLOGY

Time
150 minutes

Materials
Equipment
• Computer/LCD projector
• Microscopes
• Glass slides
• Cover slips
• Liquid cultures of bacteria
• Samples of "medicine"—antibiotic, hydrogen peroxide, isopropyl alcohol, hand sanitizer
• Colored pencils
• Post-it notes
• Butcher paper

Resources
• Evolutionary Arms Race Lab worksheet
• *The New York Times* op-ed and article: "Have Germs, Will Travel" by L. Masae Kawamura (http://www.nytimes.com/2007/06/02/opinion/02kawamura.html?ex=1188532800&en=99905948662c6346&ei=5070)
• *Rise of a Deadly TB Reveals a Global System in Crisis* by Lawrence K. Altman, M.D. (http://www.nytimes.com/2007/03/20/health/20docs.html?ex=1332043200&en=026a039266bc2f86&ei=5124&partner=permalink&exprod=permalink)

Prior Student Learning
Students should be familiar with the concept of genetic mutation and how mutations occur.

Students should be familiar with how bacteria reproduce (asexually).

Students should have a general understanding of natural selection.

Essential Question for This Unit
How has the development of society influenced the evolution of micro-organisms?

Objectives
After completing this lesson, students should be able to

• Define antibiotic resistance.

• Explain why drug resistant mutations quickly become prevalent in a bacterial population.

• Give examples of ways to prevent antibiotic resistance.

• Describe the potential public health crises that drug resistant strains of bacteria can cause.

• Operate a compound light microscope.

• Prepare wet mount slides for observation.

Lesson Activities
Teacher Preparation
One week before the lesson, prepare liquid cultures of bacteria with media containing five different "treatments": antibiotic, hand sanitizer, hydrogen peroxide, isopropyl alcohol, and water (control). Label each sample. You can culture the bacteria from Lesson 1.3.

Lesson Springboard
Remind students of the Pathogen Trading Card game they played in Lesson 1.2. Ask the class which cards were the most powerful? And which pathogens seemed the most frightening? In the game, viruses with serious outcomes and no vaccines, like Ebola, were powerful cards, because there was no way to prevent them and no way to cure them. Ask students to imagine there is someone outside the classroom with an untreatable, incurable fatal disease. Would they want to let someone like that into the room? In this lesson, students will learn how some pathogens can become untreatable, the social impact of the untreatable pathogens, and what can be done to avoid creating new, untreatable pathogens.

Lesson Development
Lab Activity
In this class session, students will conduct a laboratory investigation to determine if "medicine" has an effect on bacteria students found around the classroom during Lesson 1.3.

Hand out the lab instructions. Begin by explaining the scenario to students and help them construct a good working hypothesis before they start the investigation.

Ask students to team up in groups of three. Assign roles for each group member: recording, handling materials, cleaning up. Have each group prepare wet mounts of each sample and observe them under low, medium, and high power. Because bacteria were present in the water before the incubation, there should be at least some bacteria in every sample. It is important that students understand why they can see dead bacteria and why it was important to give the bacteria time to grow (or not) before they viewed the samples.

Have students count the number of bacteria they observe under low power in each sample and record that number on their Evolutionary Arms Race Lab worksheet. Then have students observe the bacteria at a higher power and draw (a minimum of) one bacterium in color. Draw a large data chart on board for recording the class data. Have the class compile their data by writing the number of bacteria that each group observed on separate Post-it notes and placing them on the class data chart.

After all groups have posted their data, review the results as a class. Begin by having students complete their own data tables on their lab worksheet. Have the class calculate the average number of bacteria that were observed in each condition.

As a class, discuss why the numbers of bacteria varied among the samples. What are the implications for each "medicine?" Is hand sanitizer an effective antibacterial agent? How about actual antibiotics? Would we have observed different results if a different antibiotic had been used? What would occur if the growth environments were altered? Would a less expensive hand sanitizer, containing less alcohol, be just as effective as an antibacterial agent?

After the discussion, have the students regroup and complete the lab graphs, as well as the analysis and conclusion questions at the end of the lab worksheet.

Class Discussion
Show students an agar Petri plate (or draw one on the board). Ask students what will happen if you place a single bacterium onto the agar? Students should respond that the bacterium grows and divides until there is a colony, and left long enough, the plate will have a lawn of bacteria.

If the original bacterium was killed by applying an antibiotic (e.g, ampicillin), what would happen if we applied the antibiotic to the entire lawn? Students should recognize that all the bacteria on the Petri plate should be identical, because they are essentially clones of the original bacterium. Therefore, if the original bacterium was susceptible to the antibiotic, all of the daughter bacteria would also be susceptible.

However, occasionally a cell division will result in a bacterium that is different. How could this happen? Discuss genetic mutations and review how mutations can occur during DNA replication in cell division. If a mutation occurs that makes one bacterium resistant to an antibiotic, ask students to imagine what would happen when the antibiotic is applied to the Petri plate. Students should recognize that all but the resistant bacteria will be killed, after which the single resistant bacterium could give rise to a new lawn of bacteria, and all of these bacteria would be resistant to the antibiotic. Why might a term like "arms race" be applied to this situation?

Reading and Reflective Writing

Discuss the implication for treating someone infected with these bacteria. Pass out the two news articles about Andrew Speaker (see Resources). Have students read the articles and write a one or two paragraph reaction to the events. Why did the incident garner so much news coverage? Why were government officials so concerned? Were officials too concerned, or not concerned enough?

Lesson Closure

Revisit the topic of mutated antibiotic resistant bacterium from the earlier discussion. Ask students to consider what would have occurred if no antibiotic had been applied to the original lawn of bacteria. Lead the discussion so that students recognize that after the application of the antibiotic, the "normal" bacteria were killed allowing the antibiotic resistant bacterium to multiply freely. Without the application of an antibiotic, the antibiotic resistant bacterium would not have been able to grow that much because it would be competing for space and nutrients with all the other bacteria. What implications does this have for the inappropriate prescription of antibiotics in medical treatment? Extend the discussion to include why it is important to complete an entire course of antibiotics when they are prescribed appropriately.

Possible Prior Misconceptions

Students may not understand that viruses cannot be killed like bacteria. Students may believe that viruses and bacteria are the same type of organism, and therefore antibiotics can treat viral infections.

Student Assessment Artifacts

Completed Evolutionary Arms Race Lab write-up
Reflective writing on the Andrew Speaker TB scare

Variations and Extensions

Extend the lab by including cultures of antibiotic-resistant *E. coli*. (Resistant bacterial strains can be purchased at biological supply companies, or you may be able to get a local university or biotech company to donate some cultures.) Have students place various strains on LB agar plates containing different types of antibiotics, and observe the differences in colony growth.

Evolutionary Arms Race

Extend the discussion to include other examples of "evolutionary arms races." Evolutionary biologists ask "why" a trait has come into being (i.e., the historical, or ultimate, causation) rather than "how" (i.e., the current functional sequence, or proximate mechanism). Discuss with students the difference between ultimate and proximate mechanisms in evolutionary biology. Pose some questions that ask why a certain trait exists in a modern population. For example:

- Why do cheetahs run fast?
  - Proximate: Muscle development, physiology, etc.
  - Ultimate: Cheetah ancestors who ran faster caught more gazelles, etc.
- Why do gazelles run fast?
  - Proximate: Muscle development, physiology, etc.
  - Ultimate: Gazelle ancestors who ran faster could escape from cheetahs, etc.

National and State Academic Standards

NATIONAL
NRC National Science Education Standards

Biological Evolution

- Species evolve over time. Evolution is the consequence of the interactions of (1) the potential for a species to increase its numbers, (2) the genetic variability of offspring due to mutation and recombination of genes, (3) a finite supply of the resources required for life, and (4) the ensuing selection by the environment of those offspring better able to survive and leave offspring.

Personal and Community Health

- The severity of disease symptoms is dependent on many factors, such as human resistance and the virulence of the disease-producing organism. Many diseases can be prevented, controlled, or cured. Some diseases, such as cancer, result from specific body dysfunctions and cannot be transmitted.

CALIFORNIA
Science Content Standards

Biology/Life Science

8. Evolution is the result of genetic changes that occur in constantly changing environments. As a basis for understanding this concept:
   a. *Students know* how natural selection determines the differential survival of groups of organisms.
   b. *Students know* a great diversity of species increases the chance that at least some organisms survive major changes in the environment.

Name _____ Date_____ Period _____

Evolutionary Arms Race Lab

Bacteria has been cultured in five different environments: antibiotic, hand sanitizer, hydrogen peroxide (H_2O_2), isopropyl alcohol, and water (H_2O). In this laboratory investigation, you will observe the effectiveness of modern "medicines" on the growth of bacteria found in the causeway. You will observe each sample and determine which environment is most and least conducive for bacterial reproduction.

Hypothesis
Write a hypothesis about the samples. Which do you think will have the most bacteria?
Which do you think will have the least amount of bacteria?

Materials
- Compound microscope
- Pipets
- 5 slides
- 5 cover slips
- Bacteria cultures in the 5 growth environments
- Colored pencils
- Post-it notes

Pre-Lab
1. What is natural selection?

2. How do bacteria reproduce?

3. What are some ways to reduce bacteria?

4. Calculate the total magnification for each lens of the microscope.

Eyepiece magnification	×	Objective magnification	=	Total magnification
_____	×	_____	=	_____
_____	×	_____	=	_____
_____	×	_____	=	_____

Name _____ Date _____ Period _____

Procedure

1. Create a wet mount for the antibiotic sample by taking two drops of the solution and placing it on the slide. Beginning at an angle, place the cover slip slowly on the liquid to prevent as many air bubbles from forming as possible.

2. Observe the sample under low power. Record the number of bacteria found in the sample in Data Table 1.

3. Observe the sample under medium and high power. Draw and color one of the bacteria found in the sample. Be sure to label your diagram with the appropriate magnification.

4. Record the number of bacteria you observed on a Post-it note and place it on the class data chart.

5. Once all the data have been posted, you can calculate the class average, record the results in Data Table 2, and graph the results.

6. Repeat steps 1–4 for the hand sanitizer, H_2O_2, isopropyl alcohol, and H_2O.

Observations

Data Table 1: Observations Under Low Power					
Environment	**Antibiotic**	**Hand Sanitizer**	**H_2O_2**	**Isopropanol**	**H_2O**
Number of bacteria observed	_____	_____	_____	_____	_____

Bacteria Diagrams (in color)

Antibiotic
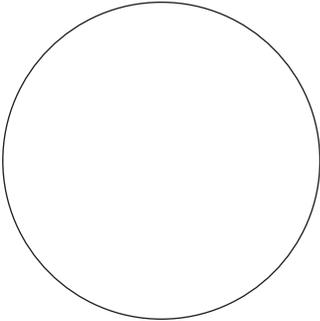
_____ X

Hand sanitizer
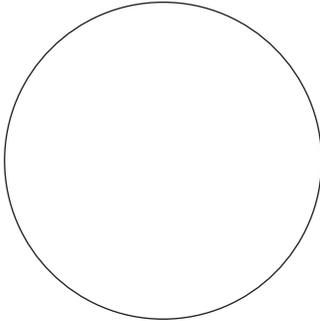
_____ X

H_2O_2
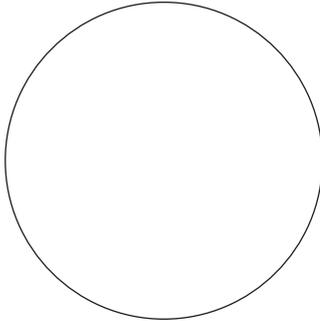
_____ X

Isopropanol
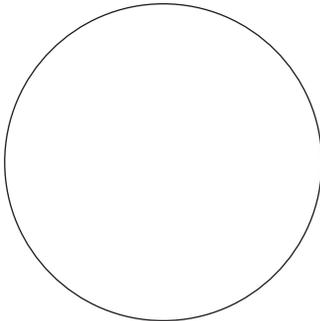
_____ X

H_2O

_____ X
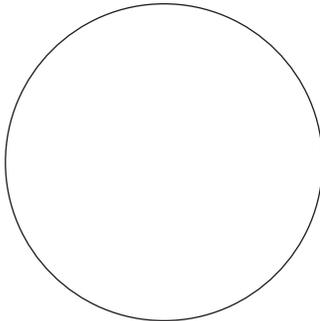
Name _____ Date_____ Period _____

Data Table 2: Class Data on Number of Bacteria Observed Under Low Power					
	Antibiotic	**Hand sanitizer**	**H_2O_2**	**Isopropanol**	**H_2O**
Group 1					
Group 2					
Group 3					
Group 4					
Group 5					
Group 6					
Group 7					
Group 8					
Group 9					
Group 10					
Class Average					

Results

Graph the class data on the number of bacteria grown in each condition.

Don't forget to include the title and to label the axes.

Name _____ Date _____ Period _____

Analysis and Conclusions

1. Was your hypothesis correct? Why or why not?

2. Which environment had the most bacteria? Why do you think this happened?

3. What can you tell about the natural selection of bacteria in the various environments?
    (*minimum four sentences*)

4. Can bacteria survive modern medicine? If so, what are the characteristics that help the bacteria survive?

5. Explain how bacteria fits into each step of natural selection:
    Overproduction:

    Genetic variation: (*explain differences you found in this lab*)

    Struggle to survive: (*what characteristics would the surviving bacteria have?*)

    Successful reproduction: (*what characteristics would the offspring have?*)

6. Do you think human intervention (use of medicine) interferes with the natural selection of bacteria?
    (*explain*)

Measure of Success
LESSON 1.5

ALGEBRA I

Time
55 minutes

Materials
Equipment
• Calculators
• Graph Paper

Resources
Measure of Parasitic Success worksheet

Prior Student Learning
Students should already be familiar with solving multiple-step equations with one variable.

Students should also know how to graph functions using an in-out table.

Essential Question for This Unit
How has the development of society influenced the evolution of micro-organisms?

Objectives
After completing this lesson, students should be able to

• Define direct and indirect variation.

• Perform algebraic operations on formulas to define a variable in terms of other variables.

• Characterize the graphs of direct and indirect relationships.

• Solve equations involving rational expressions.

• Use mathematics to model real-world situations.

Lesson Activities
Lesson Springboard
To get this lesson started, you might pose the following questions: What causes a virus or bacteria to become more virulent? What prevents a pathogen from evolving to become as deadly as possible? In terms of evolution, what traits are selected for in viruses, and what determines the success of a particular strain? Health science has been trying to characterize the evolutionary forces that affect the virulence and infec-tiousness of parasitic pathogens for decades. This lesson will look at the mathematical concepts underlying the formula that some scientists use to describe parasitic behavior.

Lesson Development
Class Discussion
Through discussion, have students come up with a measurable way to define the relative success of a viral strain. Then ask them to list the characteristics that contribute to the success of the strain when it is com-peting with other strains in the environment. Also, have them compile a list of characteristics that would be harmful to the success of a strain.

Define the terms *direct variation* and *indirect variation*. This might also be a good time to introduce the concept of *direct proportionality*. Ask students to think about which characteristics would have a direct rela-tionship to strain success, and which would have an indirect or inverse relationship. Have students volunteer to sketch for the class what they think a graph of one of the characteristics vs. strain success might look like. If all volunteers are sketching linear relationships, encourage them to think about why the graph might not be linear. For example, the ability of a virus to stay viable inside its host before the host becomes immune has a direct relationship with the success of the virus. However,

after a certain point, increasing the period of time a virus remains in a host will not contribute to its success, because the host will have died of other causes. The graph relating these two variables, then, might start out linear but will flatten out and eventually turn horizontal.

Choose some variables that have direct and indirect relationships to viral success and have all the students sketch graphs. Circulate around the room to check for understanding and ask students to explain the shapes of their graphs.

When the class is ready, pass out the worksheet and introduce the formula that scientists have used as the measure of parasitic success, called the *Basic Reproduction Ratio R*.

$$R = \frac{IN}{V + M + C} \text{ , where}$$

I = the transmission rate of the parasite (infectiousness)
N = size of susceptible population of hosts
V = rate of host mortality due to infection (virulence)
M = mortality rate of host without infection
C = clearance rate of pathogen by host (time it takes to become immune)

Note: All rates must be expressed using the same time scale.

Explain that R represents the expected number of infections caused by a single infected host, and thus scientists are defining success in this case as the ability of parasites to grow in number and survive in a population. Have students answer the first two questions on the worksheet. The numerator in the formula expresses the number of new infections per unit of time, and thus it makes sense that it has a direct relationship to R. The denominator is an expression of the average life expectancy of the infectious agent in the host. (The parasite will die if the host dies, which accounts for V and M, and it will also die if the host's immune system kills it, which accounts for C.) Therefore, it makes sense that these three variables have an indirect relationship to R.

If students ask why the three terms in the denominator are added, praise them for their astute question. Scientists are still debating the precise relationship of these variables to the success of parasitic organisms, because there is evidence to suggest that the variables are interdependent. That would lead to a far more complicated equation, however, which is why the class is using an older form of the equation.

Individual/Group Work
Students can work on the remainder of the worksheet individually or in groups. It may be helpful to suggest an appropriate scale and range of values for V for questions #4 and #5 on the worksheet.

Question #6 asks students to solve for V in terms of the other variables. This process is often intimidating to students, who may require extra guidance. Emphasize the usefulness of solving for different variables—it

allows mathematicians and scientists to see immediately what factors directly and indirectly vary with the variable, and in what way. If extra examples are needed, there are many formulas in science and math that often get manipulated into other forms such as

Distance = Rate × Time
Force = Mass × Acceleration
Circumference = π × Diameter = π × 2 (Radius)
Energy = Mass × (Speed of Light)^2
Pressure × Volume = number of moles × R × Temperature (R = ideal gas constant)

Lesson Closure
When students have completed the worksheet, have them compare their answers and correct any mistakes. Discuss the usefulness of modeling real-world phenomena with theoretical math equations, including this specific example of parasitic behavior. Have students come up with other current events that would benefit from creating a mathematical model or from a more accurate model. Discuss the connection between scientific investigation and the creation and modification of mathematical models.

Possible Prior Misconceptions
Students might assume that once an equation that models scientific results is published, it never gets modified. In fact, when the science on a topic is still emerging, equations are often altered as new and conflicting data are discovered. Students simply tend to be exposed to only well-established scientific knowledge that hasn't changed for decades or centuries.

Student Assessment Artifacts
Completed Measure of Parasitic Success worksheet

Variations and Extensions
Invite an epidemiologist or evolution scientist as a guest speaker to discuss modeling disease behavior mathematically.

Collaborate with the Science teacher to have students collect data and create a mathematical model of the phenomenon to make predictions about future behavior.

National and State Academic Standards

NATIONAL
NCTM Standards for School Mathematics

Algebra

- understand relations and functions and select, convert flexibly among, and use various representations for them
- interpret representations of functions of two variables
- understand the meaning of equivalent forms of expressions, equations, inequalities, and relations;
- write equivalent forms of equations, inequalities, and systems of equations and solve them with fluency—mentally or with paper and pencil in simple cases and using technology in all cases;
- use symbolic algebra to represent and explain mathematical relationships;
- judge the meaning, utility, and reasonableness of the results of symbol manipulations, including those carried out by technology.
- identify essential quantitative relationships in a situation and determine the class or classes of functions that might model the relationships;
- use symbolic expressions, including iterative and recursive forms, to represent relationships arising from various contexts;
- draw reasonable conclusions about a situation being modeled.
- approximate and interpret rates of change from graphical and numerical data.

CALIFORNIA
Mathematics Content Standards

Algebra I

4.0 Students simplify expressions before solving linear equations and inequalities in one variable, such as $3(2x-5) + 4(x-2) = 12$.

5.0 Students solve multistep problems, including word problems, involving linear equations and linear inequalities in one variable and provide justification for each step.

13.0 Students add, subtract, multiply, and divide rational expressions and functions. Students solve both computationally and conceptually challenging problems by using these techniques.

Name _____ Date _____ Period _____

Measure of Parasitic Success

Many scientists use the Basic Reproduction Ratio, *R*, as the measure of the success of a pathogen with parasitic behavior, such as the viruses and bacteria that cause infectious diseases.

$$R = \frac{IN}{V + M + C}, \text{ where}$$

I = the transmission rate of the parasite (infectiousness)

N = size of susceptible population of hosts

V = rate of host mortality due to infection (virulence)

M = mortality rate of host without infection

C = clearance rate of pathogen by host (time it takes to become immune)

All of the rates must be expressed in the same time scale (minutes, days, etc.)

1. What variables have a mathematically direct relationship with *R*? Why does this make sense in terms of parasitic success?

2. What variables have a mathematically indirect relationship with *R*? Why does this make sense in terms of parasitic success?

3. Suppose that there are several different strains of the same virus. They prefer the same types of host and have the same transmission rate, but their virulence differs. Scientists would like to know how a change in virulence would affect the strain's *R* value. Sketch the general shape of the graph that would show the relationship between *R* and *V*. Explain why your sketch makes sense with the formula for *R*.

For the remaining problems, use the following values:
    I = 0.2   *N* = 50,000   *M* = 0.005   *C* = 0.1

4. Graph the relationship between *R* and *V*, using the values above for the rest of the variables. Note any differences between your graph and your original sketch and explain why these differences may have occurred.

5. What would happen to the graph if

    a.   *I* increased to 0.5?
    b.   *N* decreased to 25,000?
    c.   *M* increased to 0.1?

6. Evolution selects for the most successful parasites, which in this case are those with the highest *R* values. It is unlikely that a new strain with a lower *R* value will survive in competition with existing strains. Changes to the environment, then, will put pressure for behaviorial changes that will at least keep the parasite's *R* value constant. Scientists are particularly interested in how a strain's virulence will adapt to changes in the environment.

    a.   Use algebra to solve for *V* in terms of the other variables. In other words, isolate *V* on one side of the equation.

Name _____ Date _____ Period _____

b. Assume that the host of a specific strain suddenly changes its noninfected mortality rate to 0.03. To keep its R value constant, the pathogen adapts into a new strain by changing its virulence. What will the new virulence be?

   i. Assume that a vaccine is developed against a certain virus, but it is not given to everyone who is vulnerable to the disease. This increases the value of C to 0.8. If the virus evolves into a strain that maintains its R value by changing only its virulence, what will the new virulence be? Why would this behavior make sense for the survival of the virus?

   ii. Does V have a direct or indirect relationship with M when all other variables remain constant? What relationship does V have with C? Explain your answers.

c. Write a paragraph explaining why it is useful for scientists to model organism behavior with mathematical equations.

Dealing With Disease
SUBUNIT 2 OVERVIEW

Essential Question for This Unit
How has the development of society influenced the evolution of microorganisms?

Subunit Goals
In Subunit 2, students focus on various topics related to preventing or reacting to the spread of communicable diseases. Regarding prevention, students learn how mass immunization serves as a public health measure. They will also use graphing and linear programming to resolve complicated situations such as decisions regarding yearly vaccine production.

Regarding treatment of communicable disease, students will learn and practice common health procedures such as taking a simple patient history, performing exam procedures (e.g., temperature and pulse reading), and matching symptoms for a diagnosis. Students will also learn how to determine and adjust medication dosages for children. Finally, students will also research how communicable diseases are treated in other parts of the world.

Subunit Key Questions
- How can you tell why someone is sick? How are diseases diagnosed? (Health Science)

- Children receive different amounts of medication than adults? How can you figure out the correct dosage? (Algebra I)

- If everyone else is vaccinated, why is it important for me to be vaccinated as well? (Health Science)

- How can constraints and priorities be organized to arrive at the best decision in complicated situations like yearly flu vaccine production? (Algebra I or II)

- What are the cures, remedies, or alternative non-traditional healing processes found within Hispanic cultures? (Spanish I)

Lesson Summaries

Lesson	Subject	Description
2.1	Health Science	**Clinical Epidemiology** Students practice common health diagnosis procedures on their classmates who simulate the symptoms of common communicable diseases.
2.2	Algebra I	**Calculating Medication Dosage** Students learn to use a West Nomogram to convert adult mediation dosages to dosages appropriate for children.
2.3	Biology	**Herd Immunity** Students learn about the concept of *herd immunity* by simulating the effect of varying levels of vaccination on the transmission of disease through a population. Students use a computer simulation to calculate a minimum safe vaccination percentage; they also observe the effects of virulence, rates of transmission, and other factors on the potential for epidemics.
2.4	Algebra I or II	**How Much of Each Vaccine?** Students graph inequalities to represent the feasible region of production for a pharmaceutical company producing this year's flu vaccine (Algebra I). Students then learn linear programming techniques to optimize time usage under production constraints (Algebra II).
2.5	Spanish I	**Alternative Medical Practices in Hispanic Culture** Students research the medical practices used to treat communicable diseases in Latin/Hispanic countries.

HEALTH SCIENCE

Time
55 minutes

Materials
Equipment
- Latex gloves
- Face masks
- Thermometers
- Sanitary covers for the thermometers
- Rubbing alcohol and cotton balls
- Tongue depressors
- Computer with Internet access

Resources
- Clinical Epidemiology Lab instructions handout
- Patient Record Form
- Symptoms and History Checklist
- Disease Description Key and Cards
- Disease Information worksheet

Prior Student Learning
Students should already be familiar with taking a person's pulse and temperature. They should know safety procedures related to patient contact.

Essential Question for This Unit
How has the development of society influenced the evolution of micro-organisms?

Objectives
After completing this lesson, students should be able to

- Record a simple patient history.

- Perform a patient exam, focusing on pulse, temperature, throat, balance, and respiration.

- Diagnose illness by matching observed symptoms with diseases using a checklist and suggest the appropriate course of treatment.

- Describe the symptoms and risk factors of various infectious diseases.

Lesson Activities
Lesson Springboard
Healthcare workers (HCWs) are on the front line of fighting the spread of infectious disease. One of the most important aspects of their job is accurately diagnosing a disease by collecting the right types of information from the patient. This involves taking a patient history and measuring bodily functions during an exam. This lab is a simulation of what HCWs do daily in clinics and hospitals across the globe in order to keep individuals and the public safe.

Lesson Development
Lab Activity
If necessary, define *epidemiology* as the study of the causes, distribution, and control of disease. Clinical epidemiology focuses specifically on patients and their treatment.

Assign each student a partner to work with for the rest of the lab. One partner will be the HCW, and the other will act as the patient. Hand each patient a Disease Description Card. It is the patient's role to present the symptoms and history on the card during his or her health examination.

Of course, students acting as patients cannot fake their pulse or temperature, so the Patient Record Form has space to record the actual results of the exam (for the student) and the data that pertains to the patient (from the Disease Description Card). The class needs to make sure to record both sets of information on the form.

Pass out the Clinical Epidemiology Lab instructions to each pair of students and allow time for the class to read through the entire activity. Review the correct safety procedures for contact with a patient. Distribute the remaining materials and allow the class to begin the lab.

After pairs of students finish their examinations, hand them the Symptoms and History Checklist, and allow them diagnose the disease the patient may have. A key is provided for the teacher. When they have the correct (preliminary) diagnosis, give the students the Disease Information worksheet and allow them to research their disease on the Internet or by using in-class reference materials to complete the questions.

Lesson Closure

Have students share information about their patient's disease with the class. If necessary, require the class to take notes on each disease. Discuss the difficulties that real HCWs would face in diagnosing some of these diseases accurately, the incidence rates of these diseases in the local area, and the diseases to which students feel they are most susceptible when considering their usual behaviors. Make sure to note that additional diagnostic tests are often required to arrive at a firm diagnosis.

Possible Prior Misconceptions

Students may not be aware of the large number of infectious diseases that medical professionals might encounter in their daily jobs.

Students may not have considered that a patient's history is as important as current symptoms when diagnosing a disease.

Students may assume that to make a diagnosis all of the related symptoms must be present.

Student Assessment Artifacts

Completed Patient Record Form
Completed Disease Information worksheet
Oral report on a specific disease

Variations and Extensions

Invite a clinical epidemiologist to speak about current innovations and topics of interest in the field, as well as daily job experiences.

National and State Career Technical Education Standards

NATIONAL
NCHSTE National Healthcare Skill Standards

1.21 Compare selected diseases/disorders including respective classification(s), causes, diagnoses, therapies, and care/rehabilitation to include biotechnological applications

1.24 Analyze body system changes in light of diseases, disorders, and wellness

2.13 Apply active listening skills using reflection, restatement, and clarification techniques

2.14 Demonstrate courtesy to others including self introduction

2.15 Interpret verbal and non-verbal behaviors to augment communication and within scope of practice

2.16 Demonstrate interviewing skills

2.21 Report relevant information in order of occurrence

2.22 Report subjective information

2.23 Report objective information

2.24 Analyze communications for appropriate response and provide feedback

2.25 Organize, write and compile technical information and summaries

2.26 Use medical terminology within a scope of practice in order to interpret, transcribe and communicate information, data and observations

4.14 Evaluate work assignments and initiate action with confidence commensurate with work assignment

4.15 Formulate solutions to problems using critical thinking skills (analyze, synthesize, evaluate) independently and in teams

4.16 Interact appropriately and respectfully with diverse ethnic, age, cultural, religious, and economic groups in various employment and social situations

7.11 Practice infection control procedures

7.12 Practice appropriate cleaning, disinfecting, and sterilizing processes

7.21 Manage a personal exposure incident in compliance with OSHA regulations

CALIFORNIA
Health Science and Medical Technology Standards

4.5 Know how to interpret technical materials and medical instrumentation used for healthcare practices and policies.

5.2 Use critical thinking skills to make informed decisions and solve problems.

5.3 Examine multiple options for completing work tasks by applying appropriate problem solving strategies and critical thinking skills to work-related issues.

6.2 Understand critical elements for health and safety practices related to storing, cleaning, and maintaining tools, equipment, and supplies.

6.3 Understand the importance and use of standard precautions and infection control, as appropriate.

Name _____ Date_____ Period _____

Clinical Epidemiology Lab

Objectives

1. To learn about symptoms and risk factors for various infectious diseases.
2. To record patient data based on exams and patient history.
3. To diagnose an illness based on clinical findings.
4. To record diagnostic testing and treatments for your diagnosed disease.

Materials

- Patient Record Form
- Disease Description Card
- Gloves and face masks
- Thermometer and sanitary covers
- Tongue depressors
- Rubbing alcohol and cotton balls

Directions

1. Choose a partner and decide who will be the "HCW" and "Patient."
2. Get a **Disease Description Card** from your instructor.
3. As a patient, follow the "role" of your disease carrier. As a HCW, record the data your patient gives you on the **Patient Record Form**.
4. Collect materials for the patient exam. Record the data under **Patient Exam and Observations**. Be sure to record two sets of data where indicated on the form (student and patient roles).
5. **Wearing your gloves and face mask**, complete the following:
   - Pulse Recording. Record your patient's *radial pulse* by taking their pulse on their wrist. Count the "beats" for 1 minute (or for 30 seconds and multiply by *2*).
   - Temperature Recording. Use the digital thermometer. **Be sure to use a sanitary cover, placing it on the end of the thermometer**. Record the temperature. **Wipe off the thermometer with rubbing alcohol** before giving it to the next group.
   - Throat Description. Using a tongue depressor, (gently) look inside your patient's mouth at the color of the throat. Record descriptions like pink, red, blotchy, white patches, etc.
   - Lymph nodes (neck). Swollen? Tender? Record findings.
   - Balance Test. Have students perform a balance test for 10 seconds.
   - Respiration. Count how many times the patient "breathes" in 1 minute.
6. Once you have recorded all of the exam and history data, get a **Symptoms and History Checklist** from your instructor. Examine the checklist and search for your patient's disease. Try to find the disease that matches all of the descriptions you recorded about symptoms and patient history (risk factors).
7. Turn in your patient's information with diagnosis. Keep the Symptoms and History Checklist in your notes. Return the Disease Description Cards to your instructor.

Name _____ Date_____ Period _____

Patient Record Form

Healthcare Worker (your name) _____

Patient (partner's name) _____

PART I–Patient Information

Disease (A–N) _____ Age _____

Complaints/Symptoms _____

_____

Questionnaire (history):

1. Have you eaten anything differently in the last 48 hours?   ____ no ____ yes ____ unknown

    if yes, what?_____

2. Have you traveled anywhere recently?   ____ no ____ yes ____ unknown

    where? _____

3. Do you own a pet?   ____ no ____ yes

    what kind?_____

4. Have you gone hiking or camping recently?   ____ no ____ yes ____ unknown

5. Are you up to date on your vaccinations?   ____ no ____ yes ____ unknown

6. Have you shared a soda or drinking glass with anyone recently?   ____ no ____ yes ____ unknown

7. Do you live in the countryside or near wildlife?   ____ no ____ yes ____ unknown

8. Do you have any recent cuts or bites on your skin?   ____ no ____ yes

9. Do you work in a healthcare setting?   ____ no ____ yes ____ unknown

10. Have you had any injuries or accidents recently?   ____ no ____ yes ____ unknown

    what type of injury? _____

11. Other important information? _____

PART II–Patient Exam and Observations

Pulse of student _____   Pulse of patient _____

Temperature of student _____   Temperature of patient _____

Description of throat (student) _____

Lymph nodes (student) _____

Balance of student ____ ____ Balance of patient ____ ____

                    Good Poor   Good Poor

Respiration of student _____ (optional)

PART III–Diagnosis and Treatment

1. Your diagnosis_____

2. Pathogen (infectious agent) _____

3. Diagnostic tests_____

4. Types of treatment or cures _____

    _____

5. Public health preventions _____

    _____

Name _____ Date _____ Period _____

Symptoms and History Checklist

Symptoms

DISEASE	headaches	fever	rash	skin irritation	nausea	vomiting	abdominal pain	muscle aches	chest tightness	fatigue	sore throat	joints hurt	uncoordination	mental confusion	anxiety	low blood count	diarrhea	cough	skin change or jaundice	thirst	dizzy
Lyme	X	X	X	X						X		X									
Pneumonia		X							X	X								X			
Influenza	X	X						X		X	X							X			
Malaria	X	X			X							X				X					X
Salmonella	X	X			X	X	X										X				
Giardia		X			X	X	X				X	X					X				
Tetanus				X				X								X					
Mononucleosis	X	X	X					X			X	X									
Rabies	X	X		X				X				X	X	X	X					X	
Hantavirus	X	X						X						X	X			X			
Hepatitis A					X		X			X									X		
Bovine spongiform	X								X	X			X	X	X						X
Meningitis	X	X	X			X		X		X				X	X						X
Pertussis	X	X							X									X	X	X	
Toxoplasmosis	X	X						X		X			X	X							X

History

DISEASE	hiking or camping	food—eggs & chicken	mouse exposure	mammal bite	insect bite	crowds or airborne	food—beef	contaminated fruit or water	soil infection, rusty objects	saliva transmission	high risk age group	brain infection	vaccination available	possible pet exposure	respiratory system affected	digestive system affected	stress adds to illness	travel	Health Care Worker
Lyme	X				X													X	
Pneumonia						X					X				X			X	
Influenza						X					X		X		X			X	
Malaria	X				X						X							X	
Salmonella		X						X			X								
Giardia	X							X	X										
Tetanus	X								X				X		X				
Mononucleosis						X				X	X				X		X		
Rabies	X		X	X								X	X	X					
Hantavirus	X		X																
Hepatitis A		X						X					X			X		X	X
Bovine spongiform							X					X						X	
Meningitis						X					X	X	X						
Pertussis						X					X		X		X				
Toxoplasmosis	X									X				X					X

Name _____ Date_____ Period _____

Disease Description Cards

Disease Description Card #1

You are seeking medical attention because your stomach hurts and you feel a lot of nausea. You've been very tired lately, and your skin is looking a little bit yellowish. Your temperature has been normal though. You were recently on vacation in Thailand, where you sampled a variety of foods sold on the street. You are unsure whether you are up-to-date on your vaccinations.

Disease Description Card #2

You are 72 years old and live in a crowded nursing home. You are seeking medical attention because you have a persistent fever (101 degrees) and a cough that hurts and makes your chest feel tight. The illness makes you very tired and worried. You are unsure whether or not your vaccinations are current.

Disease Description Card #3

You are urgently seeking medical attention because of extreme discomfort. You have a fever (102 degrees) and some new red-purple spots on your arms and back. In the last 24 hours your have vomited twice, and you have a bad headache. When the HCW asks you questions, you get confused and anxious, which is not normal for you. You have just started work at an elementary school and have not had a chance to get up-to-date on your vaccinations.

Disease Description Card #4

You have just come back from a visit to your uncle's farm in Ireland and are not feeling very well. Your throat is sore, your head aches, and you have dizzy spells. When the HCW asks you questions, you are confused and anxious, which is not normal for you. Also, you have become uncoordinated and your balance is poor. Your temperature is normal, and you are up-to-date on all of your vaccinations.

Name _____ Date_____ Period _____

Disease Description Card #5

You are seeking medical attention because your left leg muscles ache badly and your jaw is very stiff. You have a hard time chewing and swallowing. Your temperature and pulse are normal. You think the leg muscle ache has something to do with an injury you had a week ago while camping—you accidentally got stabbed in the leg by a large metal skewer when making S'mores over the campfire. You have had all your childhood vaccinations, but haven't had any shots for the last 10–15 years.

Disease Description Card #6

You are cancer patient who is currently undergoing chemotherapy, which weakens your immune system. You are seeking medical attention today because you have a fever (101.7 degrees), a bad headache, and your throat hurts. Your stomach hurts more than normal. When the HCW performs the balance test, you get somewhat dizzy, and overall you have been less coordinated and mentally aware than usual. When you come home from chemotherapy, you like to seek comfort from your two cats that spend a lot of time outside. You do not remember whether your vaccinations are current.

Disease Description Card #7

You have recently returned from a camping trip in the Appalachian Mountains, where you did a lot of hiking through the woods. You are seeking medical attention because you are having a hard time recovering from the trip. Your joints are sore, and you feel tired all the time as though you have the flu. You are running a fever (100.6 degrees) and have a headache. When the HCW checks your lymph nodes, they are swollen, and there is a red bump on your leg where you think an insect bit you. You are up-to-date on all of your vaccinations.

Disease Description Card #8

You are seeking medical attention because you have been suffering from nausea for several days, and last night you vomited. You've been having stomach cramps and diarrhea as well, and have generally been feeling run down and tired. You live near a lake that you like to swim in each morning, but have been too tired to do it for the past week. It often has a lot of kids and pets playing in it. You updated your vaccinations about 6 months ago.

Name _____ Date_____ Period _____

Disease Description Card #9

You are seeking medical attention because for the past 3 days you have been feeling very under the weather. You have a sore throat, cough, headache, and your muscles ache. Your body temperature is 101.4 degrees. You work in an office where a lot of employees have been calling in sick lately. The shortage in staff has made your job pretty stressful for the past couple of weeks. The last time you got your vaccinations up-to-date was 2 years ago.

Disease Description Card #10

You are seeking medical attention for a combination of symptoms you've never had before. Your hand and arm itches, and sometimes there is a shooting pain there. You have a fever (101.8), headache, and muscle soreness. When the HCW asks you questions, you show signs of some confusion and you complain that you can't think straight because you feel anxious a lot. Sometimes your throat is sore and you feel like you are thirsty more than usual. When asked if anything unusual has happened to the hand and arm that is irritated, the only thing you can think of is that you adopted a dog 6 months ago and he used to nip that hand a lot. You don't remember whether or not your vaccinations are current.

Disease Description Card #11

Last week you started to suffer from what you thought was the common chest cold, but this week the coughing has become a lot worse, especially at night. You start to cough very violently and then have to struggle to get enough air after the coughing bout is over. It makes your chest feel tight and gives you a headache. You still have a fever (101.2 degrees) and are usually thirsty. You are a recent immigrant from a country that doesn't require childhood vaccinations, and so you did not have many of them.

Disease Description Card #12

You think you have a bad case of the flu, but are seeking medical attention because it doesn't seem to be getting any better. For the past 2 days you've had a fever, and today your temperature is 102.3 degrees. Your muscles ache, you get chills, and have a headache. Sometimes you have a dry cough. The balance test reveals that you are somewhat less coordinated than you usually are, and the entire experience with the HCW makes you a lot more anxious than you normally would be. You are an engineer and have been spending your weekends for the past month helping your grandmother clean her attic, which had a mouse infestation. You are current on all of your vaccinations.

Name _____ Date_____ Period _____

Disease Description Card #13

You are seeking medical attention because last night you started having a fever, and today your temperature is 103.4 degrees. Your head and muscles ache, you feel very tired, and you get dizzy easily. Two weeks ago you returned from the rainforest in Brazil, where you spent a month conducting research on orchid species. You camped half of the time, and despite all your efforts, were bitten many times by mosquitoes and spiders. You were updated on all of your vaccines before you left on your research trip.

Disease Description Card #14

Last night your mother-in-law had you over for a chicken dinner and now you feel very sick. You vomited soon after you came home, and today you are suffering from stomach cramps and severe diarrhea. You have a temperature of 101.6 and a slight headache. You are a teacher and haven't traveled in the past 6 months. Your vaccinations are all up-to-date. You have two pets, a dog, and a parrot.

Disease Description Card #15

You are seeking medical attention because for the past week you have been extremely tired and do not seem able to feel completely rested. Whenever you try to work, you feel worse and have to lie down. Your throat is sore, and the HCW discovers that your lymph nodes are swollen. You have a temperature of 100.8 degrees, head and muscle aches, and are developing small, red, raised bumps on your chest and neck. You have very recently started to date a new person and often share food and drinks.

Disease Description Cards: Key

Card #	Disease
1	Hepatitis A
2	Pneumonia
3	Meningitis
4	Bovine spongiform
5	Tetanus
6	Toxoplasmosis
7	Lyme disease
8	Giardia
9	Influenza
10	Rabies
11	Pertussis
12	Hantavirus
13	Malaria
14	Salmonella
15	Mononucleosis

Name _____ Date _____ Period _____

Disease Information

Now that you have arrived at a preliminary diagnosis for your patient, there is additional information about the disease that you will want to have. Research your disease in order to answer the following questions:

What diagnostic testing is available for this disease?

What is the pathogen associated with this disease? How is the disease transmitted?

What are the major treatments for this disease?

How can individuals avoid contracting this disease?

Calculating Medication Dosage

LESSON 2.2

ALGEBRA I

Time
90 minutes

Materials
Equipment
• LCD or overhead projector
• Rulers

Resources
• West Nomogram handout
• Dosage Calculations worksheet
• Pediatric Dosage Calculations worksheet
• *Henke's Med-Math: Dosage Calculation, Preparation, and Administration* textbook (Grace Henke & Susan Buchholz, 2002)
• *Practical Problems in Mathematics for Health Occupations* textbook (Louise Simmers, 2005)

Prior Student Learning
Students should have a general understanding of formulas.

Essential Question for This Unit
How has the development of society influenced the evolution of micro-organisms?

Objectives
After completing this lesson, students should be able to

• Solve the multistep equation required to calculate medicinal dosages as prescribed by doctors.

• Use a West Nomogram to determine the estimated body surface area of a child given his or her height and weight.

• Set up and calculate equations based on word problems regarding pediatric medicinal dose, given the adult dosage information and the child's height and weight.

• Deliver a presentation explaining the calculations.

Lesson Activities
Lesson Springboard
Introduce the subject of medicinal dosage calculations and explain its importance. If possible, show the class a dosage calculation textbook that could be used in a college-level course. Explain that this lesson covers only a small part of the textbook and is designed as an introduction to calculating dosages.

Lesson Development
Introduce the basic dosage calculation formula:

$$\frac{D}{H} \times Q = X$$

X = Amount of medicine for administration
D = Desired dose
H = Dose on hand
Q = Quantity of the dose on hand

For example, the doctor orders 50 mg of Dilantin for an epilepsy patient. Dilantin is available in liquid form labeled as 125 mg/5ml. To calculate how much Dilantin to give to the patient:

$$\frac{50\ mg}{125\ mg} \times 5\ ml = \frac{250\ \cancel{mg} \cdot ml}{125\ \cancel{mg}} = 2\ ml$$

Remind students that they can use the units as a quick check to see if they have set up their equation correctly. If the units do not cancel appropriately (e.g., if their answer is in milligrams, instead of a drug vehicle unit like tablets or milliliters), then they have used the wrong variable somewhere in their equation.

Calculating Medication Dosage

LESSON 2.2

Sometimes, a unit conversion must first take place. For example, a doctor orders 1 gm of the antibiotic Keflex for a patient, and Keflex comes in capsules labeled 250 mg/capsule. First the desired dose and the dose on hand must have the same units so that they can be cancelled. In this case, 1 gm = 1000 mg; therefore, the calculation will be as follows:

$$\frac{1000 \; mg}{250 \; mg} \times 1 \; capsule = \frac{1000 \; mg \cdot capsule}{125 \; mg} = 4 \; capsules$$

After reviewing the examples with the class, ask students to fill out the Dosage Calculations worksheet in pairs. Circulate among the groups and assist those that are having difficulty.

When the class seems to have mastered this basic dosage calculation, explain the importance of accurately calculating pediatric dosages. Pass out the Pediatric Dosage Calculations worksheet and have a student read the introductory paragraph. Have another student read the first problem that provides the adult dosage and a child's weight. Pediatric doses of medication are generally based on weight or on body surface area (BSA). Pass out the West Nomogram handout and demonstrate how it is used to find a child's BSA.

The formula for calculating pediatric dosage is as follows:

Nomogram Instructions
To calculate a child's BSA, draw a straight line from the height (in the left-hand column) to the weight (in the right-hand column).

The point at which the line intersects the surface area (SA) column is the BSA (measured in square meters–m²). If the child is of roughly normal proportion, BSA can be calculated by weight alone using the enclosed column.

The graph to the right shows the BSA of a child who is 40 inches tall and weighs 36.5 pounds. Her BSA is 0.69 m².
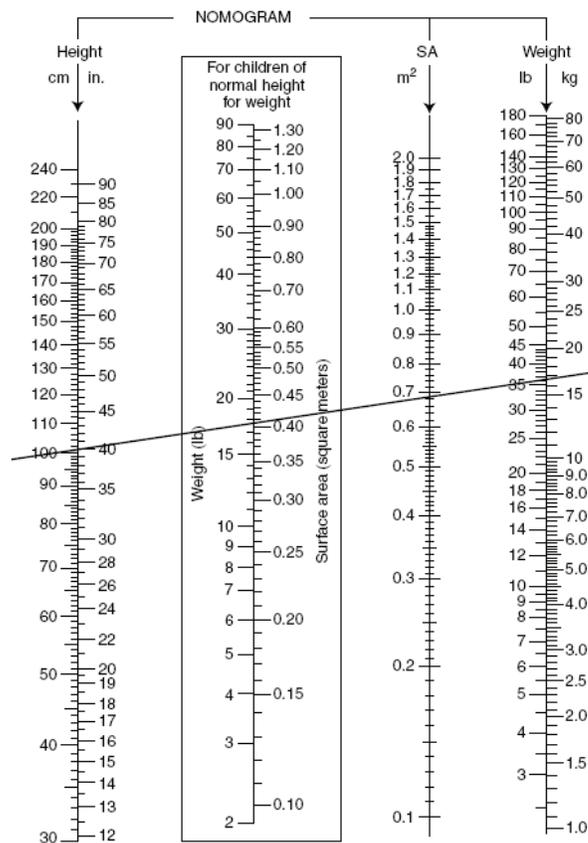
Calculating Medication Dosage

LESSON 2.2

$$\frac{BSA}{1.73} \times \text{adult dose} = \text{approx. child dose}$$

Give students the remainder of the period to complete both of the worksheets. As students work on their problems, check to make sure they understand them and assist any students who may need help. Have students who finish early help students who are struggling.

Lesson Closure
Review dosage calculations by asking several students to present their work to the rest of the class.

Possible Prior Misconceptions
Common misconceptions that students hold regarding this lesson's content should be provided here for teacher reference.

Student Assessment Artifacts
Completed Dosage and Pediatric Dosage Calculations worksheets

Variations and Extensions
To introduce the unit, invite a pharmacist or nurse to come in and speak about the importance of dosage calculations in performing their jobs.

Have students make up their own dosage calculation problems using family members and medications that are familiar. Use these questions for a quiz, review game, or review worksheet.

National and State Academic Standards

NATIONAL
NCTM Standards for School Mathematics

Algebra
Represent and analyze mathematical situations and structures using algebraic symbols
Write equivalent forms of equations, inequalities, and systems of equations and solve them with fluency—mentally or with paper and pencil in simple cases and using technology in all cases.

CALIFORNIA
Mathematics Content Standards

Algebra I
5.0 Students solve multistep problems, including word problems, involving linear equations and linear inequalities in one variable and provide justification for each step.

13.0 Students add, subtract, multiply, and divide rational expressions and functions. Students solve both computationally and conceptually challenging problems by using these techniques.

Name _____ Date_____ Period _____

West Nomogram

A West Nomogram is used to help adjust medication calculations for children. Because children are smaller than adults, they are usually given smaller amounts of medication. The adjustment of the medication dosage is based on the child's size, a combination of height and weight (which can be measured directly), or body surface area (BSA).

To calculate a child's BSA, draw a straight line from the height (in the left-hand column) to the weight (in the right-hand column). The point at which the line intersects the surface area (SA) column is the BSA (measured in square meters–m^2). If the child is of roughly normal proportion, BSA can be calculated by weight alone using the enclosed column.

The West Nomogram below shows the BSA of a child who is 40 inches tall and weighs 36.5 pounds. Her BSA is 0.69 m^2.
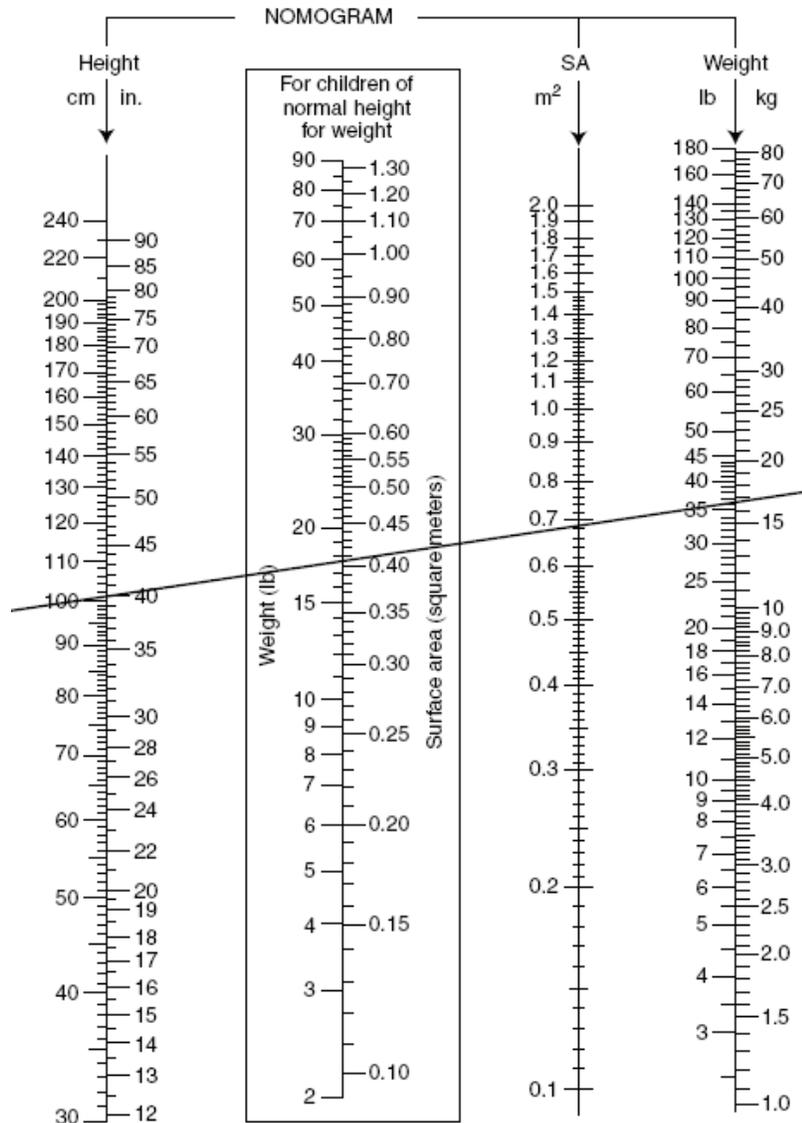
Name _____ Date_____ Period _____

Dosage Calculations

Pharmacists have to make lots of calculations every day. They must be very accurate when they calculate how much medication to give every patient they see. A small mistake could mean the difference between helping a patient and harming one. Pretend that you are a pharmacist. For each prescription below, calculate how much medication should be given to each patient. Show your work.

1. A doctor orders 600 milligrams (mg) of Potassium Chloride for a patient taking diuretics. Tablets available contain 300 mg per tablet. How many tablets should be given?

2. A physician orders 250 mg of Sulfasalazine for a patient with rheumatoid arthritis. Tablets available contain 500 mg per tablet. How many tablets should be given?

3. A physician orders 15 mg of Prednisone for a patient with an inflammatory joint disease. Tablets available contain 10 mg per tablet. How many tablets should be given?

4. A physician orders 10 mg of Nembutal elixir to treat a patient with insomnia. It is available as 20 mg in 5ml. How many ml should be given?

5. A physician orders 20 mg of Phenobarbitol elixir for a patient with seizures caused by meningitis. It is available as 30 mg per 7.5 ml. How many ml should be given?

Name _____ Date_____ Period _____

Pediatric Dosage Calculations

For adults, the physician uses the dosage recommended by the pharmaceutical company that makes the medication. Correct medication dosages for infants and children are based on weight, height, body surface area, and age. It is extremely important to calculate the dosage accurately. A minor error in calculating a dosage for an infant or child can be extremely serious, causing an overdose or even death. Pretend that you are a pediatrician who has to prescribe medication for the following patients. Show all your work.

1. An infant who weighs 10 kilograms (kg) is very sick with a respiratory infection. The correct medication is Vantin. The average adult dose is 500 mg every 12 hours. How much medication should you prescribe for this infant?

2. Acetaminophen has a safe dosage range of 10 to 15 mg/kg, every 4 hours. Your patient is a 1-year-old infant who weighs 12 kg. What is the maximum dose this child could receive?

3. The average adult dose for Wellcovorin is 20 mg. A 15-year-old boy with colon cancer is 5 feet 6 inches tall, but weighs only 115 pounds. How much Wellcovorin should you prescribe?

4. Minoxidil is used to help children with hypertension or high blood pressure. A 9-year-old child with hypertension weighs 15 kg. The drug manufacturer recommends a dose of 0.2 mg/kg/day. How much Minoxidil should you prescribe?

Name _____ Date_____ Period _____

Additional Problems

Sample: Ordered: Potassium Chloride 20 mEq added to the IV

Available: 40 mEq per 10cc

How much Potassium Chloride will you add?

D = 20 mEq   H = 40 mEq   Q = 10 cc

$$\frac{20 \text{ mEq} \times 10 \text{ cc}}{40 \text{ mEq}} = X$$

1.5 × 10 = X = 5 cc

1.   Ordered: Trilafon 24 mg po bid
     Available: Trilafon concentrate labeled 16 mg/5 ml
     How many ml will you administer?

2.   Ordered: SoluMedrol 100 mg IM q8h
     Available: Vial 1 ml in size labeled 125 mg SoluMedrol/3 ml
     How many ml will you administer?

3.   Ordered: Ampicillin 400 mg IM q6h
     Available: Vial with powder. Label reads: For IM injection, add 3.5 ml Diluent (read accompanying circular). Resulting solution contains 250 mg Ampicillin per ml. Use solution within 1 hour.
     How many ml will you administer?

4.   The physician orders Lasix 20 mg IV stat for a child weighing 34 lbs. The Pediatric Drug Handbook states that 1 mg/kg is a safe initial dose. Should you give this dose?

5.   A child with a BSA of 0.32 M^2 has an order for 25 mg of a drug with an average adult dose of 60 mg. Calculate the child's dosage. Is the physician's order correct?

6.   Ordered: D5W 50 ml with 20 mEq KCl to infuse at 8 mEq KCl/hr per IV pump. How many ml of solution will you administer per hour?

Name _____ Date_____ Period _____

7. Ordered: 600,000 units of Penicillin po q6h
    Available: 400,000 units per scored tablet. How many tablets will you administer?

8. The child has a BSA of 0.67 m^2. The adult dose is 40 mg. The physician ordered 8 mg. Is the dosage correct?

9. A child weighing 76 lbs. is ordered to receive 150 mg of Clindamycin q6h. The Pediatric Drug Handbook states the recommended dose is 8–20 mg/kg/day in four divided doses. Clindamycin is supplied in 100 mg scored tablets. What is the child's weight in kilograms (1 kg = 2.2 lbs)? What is the safe recommended daily dose? Is the dose the doctor prescribed within the safe range? How many tablets are needed to give the ordered dose?

BIOLOGY

Time
100 minutes

Materials
Equipment
- Red, Green, and Yellow cards (one each per student)
- Immune Status Cards
- Access to computer lab

Resources
- Vocabulary for Herd Immunity handout
- Simulating Disease Transmission worksheet and answer key
- Disease Transmission Simulator (http://science.education.nih. gov/supplements/nih1/diseases/ activities/flash-detection.htm)
- CNN-HEALTH: "Mumps outbreak now in 8 states" (http://www.cnn.com/2006/ HEALTH/conditions/04/14/ mumps.outbreak/index.html)
- *The New York Times*: "Mumps Epidemic Spreads; More Vaccine Promised" (http://travel.nytimes.com/ 2006/04/20/health/20mumps. html?pagewanted=print)
- CDC Health Update: "Multi-state Mumps Outbreak" (http://www2a.cdc.gov/ HAN/ArchiveSys/ViewMsgV. asp?AlertNum=00244)
- World Health Organization: Disease Outbreak News (http://www.who.int/csr/don/ en/)

Prior Student Learning
Students should have a basic knowledge of viruses, vaccines, and immunity.

Essential Question for This Unit
How has the development of society influenced the evolution of micro-organisms?

Objectives
After completing this lesson, students should be able to

- Describe the characteristics of communicable diseases and how disease spreads.

- Explain *herd immunity* and how it can prevent large epidemics.

- Describe how communicable disease can be controlled by immunization.

Lesson Activities
Lesson Springboard
In 2004–05, the United Kingdom suffered a mumps outbreak that peaked with over 50,000 people infected. Mumps is a very contagious disease, yet in 2006, when the United States suffered its largest mumps epidemic in recent history, fewer than 1,000 people were infected at its peak. The difference in peak infections between the two epidemics primarily comes down to one factor: the percentage of the population vaccinated.

The following excerpt is from the CNN article "Mumps outbreak now in 8 states" (April 14, 2006):

> "Iowa has seen an epidemic of more than 600 suspected cases since December, according to a Centers for Disease Control and Prevention spokesman. Other states reporting cases are Illinois, Kansas, Minnesota, Missouri, Nebraska and Wisconsin. The agency has not yet released the name of the eighth midwestern state.
>
> Most of the Iowa mumps cases are on college campuses, where the typical close living quarters make an ideal breeding ground for the virus…
>
> Before use of the vaccine became common, almost everyone in the United States contracted mumps, and 90 percent of cases occurred among children younger than 15, according to a CDC report.
>
> The CDC report said that in 1977 Iowa law required a single dose of a combined measles, mumps and rubella vaccine for entry to public schools; in 1991 the requirement rose to two doses…"

Lesson Development

Class Discussion

Hand out the Vocabulary for Herd Immunity handout. Go over the definitions with students and then have them read the CNN article "Mumps outbreak now in 8 states." Ask how many of them know a young person who has had the mumps. There should be very few or none, because mumps is rare in the United States. (Since 2001, there have been an average of 265 mumps cases per year, according to the CDC.) Most children receive the MMR vaccine, which protects against mumps, measles, and rubella. Yet, the mumps is endemic in the United Kingdom, and outbreaks occur more frequently and on a larger scale than in the United States.

Ask students for their ideas on how mumps could have spread on a college campus in the United States. Responses may include "students were unvaccinated," "there was a new strain of the mumps that the vaccine didn't work against," or "the vaccine was ineffective."

Next, ask students why mumps outbreaks in the United States are less severe than those in the United Kingdom. Answers should relate to the different vaccination levels within the two populations. During the 2004–05 epidemic, the United Kingdom had an extremely low percentage of its population vaccinated with MMR.

Explain that mumps is a childhood illness, like chicken pox, and most unvaccinated people acquire the disease as children. Ask students for reasons why many of the inadequately vaccinated or unvaccinated didn't become infected with mumps earlier or as children.

Classroom Simulation

Students will conduct simulations of disease transmission through a population. Simulation #1 represents 0% initial population immunity; Simulation #2 represents 10% initial population immunity; and Simulation #3 represents 60% initial population immunity. The number of students infected and the number who are immune should be recorded in order for students to plot a graph at the conclusion of each simulation.

Inform the class that they will be simulating the transmission of an infectious disease. Pass out one card of each color to each student. Each color has a specific meaning:

- Red: infected and contagious

- Yellow: recuperating and contagious

- Green: recovered and immune

Simulation #1: 0% Immune

Day 1—Select one student in the center of the class to be the initial carrier of the virus. That student should display his or her Red Card indicating that he or she is infected and then touch (infect) one other student within arms' reach. Announce the number of students infected at the

end of the first day and have students record the number infected and the number immune.

Day 2—The original infected student is recuperating (but still infectious) and should now display his or her Yellow Card. The student who was touched on day 1 is infected and should display a Red Card. Both students should reach out and touch (infect) one additional student each. Announce the number infected at the end of the second day and have students record the number infected and the number immune.

Day 3—The original student who was in the center is now immune and should display the Green Card. The second student is now recuperating and should display the Yellow Card. The two students infected on day 2 should display Red Cards. The three infected students (1 Yellow and 2 Red) should each touch (infect) another student. Announce the number infected at the end of the third day and have students record the number infected and the number immune.

Day X—Repeat this process until either the disease has died out or all students have been infected (8–10 "days"). At the conclusion of the simulation, graph the data on a transparency for the overhead projector and discuss student observations with the class.

Activity Management
As expected in the demonstration of herd immunity, some of the students without initial immunity will escape infection.

However, in a small population like the classroom, the number of susceptible students protected by herd immunity is largely dependent on the distribution of the immune students. Therefore, you may need to run the simulations more than once.

Simulation #2: 10 percent initial immunity
Simulations #2 and #3 are run to demonstrate the effects of vaccination by using "immune" students in the initial population. Create cards with either "immune" or "not immune" written on them and randomly distribute one to each student. For this simulation, 10 percent of the cards should say "immune," and 90 percent should say "not immune." Students should not reveal the type of card they received, because immunity is often unknown to others.

As with Simulation #1, pick a student in the center of the class as the one who is initially infected and run the simulation as before except that immune students can't be infected. When students with an "immune" card are touched, they will immediately display Green Cards, and they will not pass the infection further. At the end of each round, students will still record the number infected and the number immune.

Simulation #3: 60 percent initial immunity
Run the classroom simulation again—this time with 60% of the class initially immune. Record and graph the data.

Graphing
After all of the simulation data have been collected, plot graphs for each simulation. What differences can be observed among the three simulations? Ask students if there was an epidemic in each simulation, and to explain why or why not? Discuss their reasoning about what caused the differences between the three simulations.

Computer Simulation

Students will need to have access to the Internet to be able to use an on-line Disease Transmission Simulator for this activity (see http://science.education.nih.gov/supplements/nih1/diseases/activities/flash-detection.htm). Hand out the Simulating Disease Transmission worksheet and have students complete it during a class session or for **homework**.

Lesson Closure

Explain that the reason the undervaccinated or unvaccinated don't contract diseases like the mumps as children is that they are often protected through herd immunity—enough of the population was protected so that inadequately vaccinated individuals are not likely to be directly exposed to the virus. If someone is infected in a population with herd immunity, each immunized person acts as a barrier against the virus, protecting the unvaccinated population and reducing the virus's access to hosts until the virus dies out.

Explain that when vaccination levels decrease, viruses can re-emerge.

According to *The New York Times* article cited above, a significant percentage of infected students had received only one of two doses of the MMR vaccine, making them more susceptible. This illustrates the importance of vaccination not only for personal health but also for the public's health. Fortunately, mumps has a low virulence. If it were a highly virulent disease, an outbreak would have been very serious.

Students should also be aware that all characteristics of a disease could change depending on the population affected and the strain of the virus. A disease like the measles is more virulent in developing countries due to lower overall health levels and poorer medical care. Because rates of transmission for diseases are usually higher in crowded settings, schools and similar institutions may require higher percentages of their population to be immunized to achieve herd immunity.

Possible Prior Misconceptions

Some students may believe that vaccination only protects against diseases caused by viruses. However, there are vaccines for many diseases caused by bacterial infections such as tetanus, bacterial meningitis, diphtheria, and pertussis (whooping cough).

Student Assessment Artifacts

Completed Simulating Disease Transmission worksheet
Class simulation graphs

Variations and Extensions

Have students research the disease characteristics for the disease they researched in Lesson 1.2 and use the Disease Transmission Simulator, or other research, to identify the percentage of a population that must be immunized to achieve herd immunity if a vaccine were available.

National and State Academic Standards

NATIONAL
NRC National Science Education Standards

The Interdependence Of Organisms
Organisms both cooperate and compete in ecosystems. The interrelationships and interdependencies of these organisms may generate ecosystems that are stable for hundreds or thousands of years.

The Behavior Of Organisms
Organisms have behavioral responses to internal changes and to external stimuli. Responses to external stimuli can result from interactions with the organism's own species and others, as well as environmental changes; these responses either can be innate or learned. The broad patterns of behavior exhibited by animals have evolved to ensure reproductive success. Animals often live in unpredictable environments, and so their behavior must be flexible enough to deal with uncertainty and change. Plants also respond to stimuli.

CALIFORNIA
Science Content Standards

10. Organisms have a variety of mechanisms to combat disease. As a basis for understanding the human immune response:

    a. Students know the role of the skin in providing non-specific defenses against infection.

    b. Students know the role of antibodies in the body's response to infection.

    c. Students know how vaccination protects an individual from infectious diseases.

    d. Students know there are important differences between bacteria and viruses with respect to their requirements for growth and replication, the body's primary defenses against bacterial and viral infections, and effective treatments of these infections.

Name _____ Date _____ Period _____

Vocabulary for Herd Immunity

Childhood disease: A disease usually contracted as a child.

Endemic: Natural or indigenous to a specific group of people.

Epidemic: The occurrence of more cases of a disease than is expected for a specific population, or a rapidly spreading outbreak of a disease in which a significant percentage of a population is infected.

Mumps: A virus spread by direct contact, saliva, and airborne droplets. Infection is characterized by fever, fatigue, headache, loss of appetite, and swelling in the salivary glands.

Herd Immunity: When unvaccinated people are protected against infection by vaccinating a certain percentage of the population.

Epidemiologist: Someone who studies the infectious diseases that occur within populations and transfer between them.

Name _____ Date_____ Period _____

Simulating Disease Transmission

In this activity, you will be using a computer Disease Transmission Simulator to observe the effect of four different disease characteristics on the spread of disease through a population:

A. **Initial percentage immune**: Percentage of the population already immune. In this simulation, initial immunity can range from 0 percent (no one immune) to 100 percent (everyone is immune).

B. **Virulence**: Likelihood of dying from the disease. In this simulation, virulence ranges from 0 (no victims die) to 0.75 (75 percent of the victims die).

C. **Duration of infection**: Length of time the disease is active. In this simulation, infections can last from 1 to 20 days.

D. **Rate of transmission**: Number of new people infected each day. In this simulation, rate of transmission ranges from 0.1 per day (1 person every 10 days) up to 10 new infections per day.

Disease Transmission Simulator

http://science.education.nih.gov/supplements/nih1/diseases/activities/flash-detection.htm

Simulator Instructions

1. Set the desired values for the disease characteristics.

2. Click Autorun (automatically runs for 30 days) or Run Day-by-Day (allows you to step through 30 or fewer days).

3. Click Reset to start a new run using the same or different values for the disease characteristics.

   Note the dotted line on the graph, which indicates an epidemic has occurred.

A. **Initial Percentage Immune**—Test the impact of different levels of initial percentage immune. Keep other values constant at

Virulence=0.15
Duration of infection=3
Rate of transmission=2

Initial Percentage Immune	Maximum Percentage Sick	The Day Maximum Occurred	Epidemic Level?
0%			
30%			
60%			

Summary: As initial percentage immune increased, did the likelihood of an epidemic increase or decrease? Why?

_____

_____

_____

Name _____ Date_____ Period _____

B. Virulence—Test the impact of different levels of virulence. Keep other values constant at

Initial percent immune=25
Duration of infection=3
Rate of transmission=2

Virulence	Maximum Percentage Sick	The Day Maximum Occurred	Epidemic Level?
0.00			
0.20			
0.40			

Summary: As virulence increased, did the likelihood of an epidemic increase or decrease? Why?

_____

_____

_____

C. Duration of Infection—Test the impact of different durations of infection. Keep other values constant at

Initial immunity=25
Virulence=0.15
Rate of transmission=2

Duration of Infection	Maximum Percentage Sick	The Day Maximum Occurred	Epidemic Level?
1			
5			
10			

Summary: As duration of infection increased, did the likelihood of an epidemic increase or decrease? Why?

_____

_____

_____

Name _____ Date_____ Period _____

D. **Rate of Transmission**—Test the impact of different rates of transmission. Keep other values constant at

Initial immunity=25
Virulence=0.15
Duration of infection=3

Rate of Transmission	Maximum Percentage Sick	The Day Maximum Occurred	Epidemic Level?
0.5			
1.0			
1.1			

Summary: As the **rate of transmission** increases, the likelihood of an epidemic _____ because

_____

_____

_____

Herd Immunization

Using the Disease Transmission Simulator, find the **minimum** percentage of people required to be immunized to achieve herd immunity (the level of immunization that prevents an epidemic).

The minimum level occurs when the red line rises to meet the horizontal "Epidemic Level" line, but does not rise above it.

Disease Characteristics (approximations)

Disease	Transmission	Virulence	Duration of Infection	Rate of Transmission	Immunization Level for Herd Immunity
Mumps	Airborne, droplets	low (0.01)	14 days	high (2.5)	
Meningococcal Meningitis	Direct contact, droplets	med (0. 15)	10 days	low (0.2)	
Chicken Pox	Direct contact, droplet, airborne	low (0.01)	7 days	very high (10)	
Smallpox	Direct contact	high (0.3)	14 days	high (2.5)	
Polio	Fecal-oral route	low-med (0.12)	18 days	average (1)	
Measles	Airborne	low (0.01)	8 days	very high (10)	

Note: Smallpox is the only virus to have been eradicated worldwide through global vaccination efforts. The smallpox virus only exists in laboratories. Also, sources claim the United States stockpiles enough of the vaccine to vaccinate every American.

Certain populations are at more risk for certain diseases such as the many forms of meningitis, which in the United States typically affect students and people in crowded environments. In crowded environments, the disease's rate of transmission will usually be higher.

Name _____ Date_____ Period _____

Simulating Disease Transmission (Answer Key)

In this activity, you will be using a computer Disease Transmission Simulator to observe the effect of four different disease characteristics on the spread of disease through a population:

A. **Initial percentage immune**: Percentage of the population already immune. In this simulation, initial immunity can range from 0 percent (no one immune) to 100 percent (everyone is immune).

B. **Virulence**: Likelihood of dying from the disease. In this simulation, virulence ranges from 0 (no victims die) to 0.75 (75 percent of the victims die).

C. **Duration of infection**: Length of time the disease is active. In this simulation, infections can last from 1 to 20 days.

D. **Rate of transmission**: Number of new people infected each day. In this simulation, rate of transmission ranges from 0.1 per day (1 person every 10 days) up to 10 new infections per day.

Simulator

http://science.education.nih.gov/supplements/nih1/diseases/activities/flash-detection.htm

Simulator Instructions
1. Set the desired values for the disease characteristics.

2. Click Autorun (automatically runs for 30 days) or Run Day-by-Day (allows you to step through 30 or fewer days).

3. Click Reset to start a new run using the same or different values for the disease characteristics.

    Note the dotted line on the graph, which indicates an epidemic has occurred.

A. **Initial Percentage Immune**—Test the impact of different levels of initial percentage immune. Keep other values constant at

Virulence=0.15
Duration of infection=3
Rate of transmission=2

Initial Percentage Immune	Maximum Percentage Sick	The Day Maximum Occurred	Epidemic Level?
0%	69.75	6	Yes
30%	36.69	8	Yes
60%	6.45	12	No

Summary: As initial percentage immune increased, did the likelihood of an epidemic increase or decrease? Why?

_____

_____

_____

Name _____ Date_____ Period _____

B. **Virulence**—Test the impact of different levels of virulence. Keep other values constant at

Initial percent immune=25
Duration of infection=3
Rate of transmission=2

Virulence	Maximum Percentage Sick	The Day Maximum Occurred	Epidemic Level?
0.00	50.72	6	Yes
0.20	43.05	8	Yes
0.40	7.43	14	No

Summary: As virulence increased, did the likelihood of an epidemic increase or decrease? Why?

_____

_____

_____

C. **Duration of Infection**—Test the impact of different durations of infection. Keep other values constant at

Initial immunity=25
Virulence=0.15
Rate of transmission=2

Duration of Infection	Maximum Percentage Sick	The Day Maximum Occurred	Epidemic Level?
1	0.09	1	No
5	55.93	6	Yes
10	67.61	5	Yes

Summary: As duration of infection increased, did the likelihood of an epidemic increase or decrease? Why?

_____

_____

_____

Name _____ Date_____ Period _____

D. **Rate of Transmission**—Test the impact of different rates of transmission. Keep other values constant at

Initial immunity=25
Virulence=0.15
Duration of infection=3

Rate of Transmission	Maximum Percentage Sick	The Day Maximum Occurred	Epidemic Level?
0.5	.90	1	No
1.0	10.06	16	No
1.1	14.34	15	Yes

Summary: As the **rate of transmission** increases, the likelihood of an epidemic _____ because

_____

_____

_____

Herd Immunization

Using the Disease Transmission Simulator, find the **minimum** percentage of people required to be immunized to achieve herd immunity (the level of immunization that prevents an epidemic).

The minimum level occurs when the red line rises to meet the horizontal "Epidemic Level" line, but does not rise above it.

Disease Characteristics (approximations)

Disease	Transmission	Virulence	Duration of Infection	Rate of Transmission	Immunization Level for Herd Immunity
Mumps	Airborne, droplets	low (0.01)	14 days	high (2.5)	≥ 88%
Meningococcal Meningitis	Direct contact, droplets	med (0.15)	10 days	low (0.2)	≤ 0%
Chicken Pox	Direct contact, droplet, airborne	low (0.01)	7 days	very high (10)	≥ 89%
Smallpox	Direct contact	high (0.3)	14 days	high (2.5)	≥ 74%
Polio	Fecal-oral route	low-med (0.12)	18 days	average (1)	≥ 75%
Measles	Airborne	low (0.01)	8 days	very high (10)	≥ 90%

Note: Smallpox is the only virus to have been eradicated worldwide through global vaccination efforts. The smallpox virus only exists in laboratories. Also, sources claim the United States stockpiles enough of the vaccine to vaccinate every American.

Certain populations are at more risk for certain diseases such as the many forms of meningitis, which in the United States typically affect students and people in crowded environments. In crowded environments, the disease's rate of transmission will usually be higher.

How Much of Each Vaccine?

LESSON 2.4

ALGEBRA I OR II

Time
55 minutes

Materials
Equipment
• Graph paper
• Rulers
• Calculators

Resources
How Much of Each Vaccine?
worksheet

Prior Student Learning
Students should already be familiar with inequalities involving at least one variable and how to represent them graphically. They should also be proficient at graphing two-variable linear equations.

Students should also know how to solve systems of equations graphically.

Essential Question for This Unit
How has the development of society influenced the evolution of micro-organisms?

Objectives
After completing this lesson, students should be able to

• Represent real-world constraints symbolically and graphically using the concept of inequality.

• Determine and graph a feasible region that satisfies multiple constraints.

• Solve for the coordinates of intersection points or corners of feasible regions by using systems of equations.

• Use linear programming to optimize a specific function within certain constraints.

Lesson Activities
Lesson Springboard
The influenza (flu) virus is responsible for hundreds of deaths a year in the United States. It is most dangerous in the elderly, young children, and people with impaired immune systems. The flu virus is difficult to contain because it can be transmitted fairly easily through the air and skin contact. It also mutates quickly, and each year new strains arise. Each year, scientists must predict which strains are most likely to be responsible for flu outbreaks and produce vaccines specific to those strains. This is why people must be vaccinated for the flu every flu season—the previous year's vaccine does not protect from new flu strains.

There are two types of flu vaccine. One has intranasal administration, and the other is injected. Pharmaceutical companies that produce these vaccines must decide each year when to start producing the vaccines, and also how much of each type of vaccine to make, given certain constraints on their budget, storage capacity, and so on. The longer they wait to begin production, the more accurate scientists' predictions are likely to be.

Lesson Development
Class Discussion
Introduce the situation to the class and tell students that they will be the production leaders at the pharmaceutical plant, which will produce some of each type of this year's flu vaccine. Collect ideas about the considerations that must be taken into account when making a production decision like this one, and whether some of these considerations can be quantified. Introduce the concept of *mathematical constraints* as it pertains to this situation.

How Much of Each Vaccine?
LESSON 2.4

Pass out the How Much of Each Vaccine? worksheet. After giving students a chance to read it, ask the class to identify which of the five informational statements represents a constraint. They should notice that the first four statements reduce the production choices available to the plant, and are thus constraints. The fifth statement provides information that concerns the amount of time it takes to produce the vaccine, which is what needs to be optimized. Tell students that this will become part of the final solution once all of the constraints are taken care of.

Translating Inequalities Into Algebraic Statements
Have students translate the four constraints into algebraic inequalities and circulate among the class to see if it is necessary to review concepts of inequality. Students may need to be reminded that these inequalities should be *more than or equal to* ($\geq$) and *less than or equal to* ($\leq$). (The situation was intentionally written that way so that the corresponding graphical representation would have solid lines instead of dotted ones, which makes finding the solution much more straightforward.) Tell students that even though it is not stated because it is so obvious, the plant cannot produce negative amounts of intranasal or injected vaccines, and these are also constraints. Students can then record these equations for Question #2 on the worksheet.

For convenience, the four inequalities are

$$N + I \geq 550{,}000$$

$$3N \geq I$$

$$N \leq 400{,}000$$

$$\$1.70N + \$1.40I \leq \$1{,}200{,}000$$

Where N represents the number of intranasal vaccines produced, and I represents the number of injected vaccines produced.

Have students volunteer other phrases that translate into *more than, less than, more than or equal to*, and *less than or equal to*. This is the time for Algebra I students to have more practice translating inequalities before moving on to the next phase of this lesson.

Small Group Work—Graphing Two-Variable Inequalities
Remind students that graphs are a visual way to display all of the solutions to a particular equation or inequality. For example, a first-degree, two-variable equation will produce a linear graph because there are infinite solutions that all happen to map to a straight line on the coordinate plane. Any coordinate that does not fall on that line is not a valid solution.

With that in mind, what would the graph of a two-variable inequality look like? You may choose to split the class into groups and have each group graph one constraint on an overhead transparency to share with the rest of the class. Agree on a scale for each axis that the entire class

How Much of Each Vaccine?

will use before assigning groups a constraint, and give each group a different colored pen to create their graph.

Students will discover that instead of a line, they produce a shaded half-plane. The plane is cut by a boundary line that was created by the constraint they were assigned. Emphasize that any point in the shaded region satisfies the constraint, and any point outside the region does not. Further, points on the boundary line itself also satisfy the constraint because of the way the inequality was written, which is why it is represented with a solid line instead of a dotted one.

Class Discussion—Describing the Feasible Region
If the class produced their graphs on overhead transparencies, project the graphs for the class and check for any errors. Then lie all of the graphs on top of each other to see where the regions overlap. Ask students to explain the significance of this overlapping region. Students should state that this region defines the set of all possible decisions that would satisfy every constraint at the same time. Introduce the term *feasible region*.

Have groups create their own copies of the feasible region on graph paper.

Teachers of Algebra I classes may choose to end the lesson here. Alternatively, teachers of Algebra I classes may choose to skip the optimization part of the lesson and show students how to solve systems of equations to better define the boundaries of the feasible region.

Small Group Work—Optimization
Now that the class has created a feasible region, which choice in that region would take the least amount of time to produce? This is where the last informational statement (#5) in the worksheet is used. Ask students to write an expression describing the amount of production time needed for a certain combination of intranasal and injected vaccine. The expression is

$43N + 50I$ = Production Time

Any production choice in the feasible region will satisfy all of the constraints, but only one choice (in this case) will satisfy all of the constraints in the least amount of production time. The class could take the time to plug every possible production combination into the Production Time formula above to find the best solution, but of course there is an easier and faster method.

It is useful to understand the behavior of the production time function as the time allowed is increased. Ask students to graph the equation that gives the production choices available if the plant has only 100 hours to make flu vaccine. Then increase the allowed time to 500 hours, then 750 hours, then 1000 hours, etc. As the time allowed increases, ask the class to observe what happens to the graphed line. Students should notice that the slope of the lines that they are graphing remains the same, but the line itself shifts "outward" to correspond with the increased produc-

How Much of Each Vaccine?

LESSON 2.4

tion capacity that more time allows. In other words, as you change the equation to increase the amount of time allowed, parallel lines are produced that move progressively farther away from the origin.

This situation calls for finding the least amount of production time possible, so students should realize that that they would like their production time equation to be as close to the origin as possible while still including at least one point in the feasible region. Have students try to decide which is the best production decision. It might be helpful to use a ruler or piece of spaghetti to represent the optimization equation that can be shifted in or out. Students can shift the straightedge towards the origin until it hits the last possible point on the feasible region, the lower corner.

Solving Systems of Equations

The class has now conceptually found the solution to the problem, but must now calculate the exact answer. What are the coordinates of the optimal solution? If your class skipped the conversation about optimization, it is still helpful to know the corners of the feasible region in order to have a precise description of its shape. Hopefully the class chose a scale for the *x*- and *y*- axes that does not make the coordinates of the corners obvious. Show the class that the corners of the feasible region are simply intersections of two constraints, and thus can be found by solving a system of two simultaneous equations. Provide instructions on solving systems of equations algebraically, allowing groups to solve for each of the four corners of the feasible region.

For convenience, the corners of the feasible region are (150,000, 400,000), (371,439, 400,000), (600,000, 200,000), and (412,500, 137,500). The optimal solution is to produce 412,500 injected vaccines, and 137,500 intranasal vaccines.

Lesson Closure

Ask the class to agree on the best production decision for the pharmaceutical plant. Tell students that such major decisions are to be documented for later reference, and have them produce a brief justification of their final decision by summarizing the logic of their decision-making process.

Talk about other contexts in which linear programming would be useful.

Possible Prior Misconceptions

Students might assume that if the feasible region were bounded by exclusive inequalities instead of inclusive ones, the best solution would be the point closest to the corner that would have been the optimal answer if it were part of the feasible region. This is not always the case, however, and finding solutions in situations like those require doing more difficult mathematical calculations.

How Much of Each Vaccine?

Student Assessment Artifacts

Completed How Much of Each Vaccine? worksheet

Variations and Extensions

Invite a flu vaccine specialist to be a guest speaker, perhaps in Science class, about how the flu vaccine is chosen each year.

National and State Academic Standards

NATIONAL
NCTM Standards for School Mathematics

Algebra

- understand the meaning of equivalent forms of expressions, equations, inequalities, and relations;

- write equivalent forms of equations, inequalities, and systems of equations and solve them with fluency—mentally or with paper and pencil in simple cases and using technology in all cases;

- use symbolic algebra to represent and explain mathematical relationships;

- use a variety of symbolic representations, including recursive and parametric equations, for functions and relations;

- judge the meaning, utility, and reasonableness of the results of symbol manipulations, including those carried out by technology.

- approximate and interpret rates of change from graphical and numerical data.

- Create and use representations to organize, record, and communicate mathematical ideas

- Select, apply, and translate among mathematical representations to solve problems

- Use representations to model and interpret physical, social, and mathematical phenomena

CALIFORNIA
Mathematics Content Standards

Algebra I

5.0   Students solve multistep problems, including word problems, involving linear equations and linear inequalities in one variable and provide justification for each step.

6.0   Students graph a linear equation and compute the x- and y- intercepts (e.g., graph $2x + 6y = 4$). They are also able to sketch the region defined by linear inequality (e.g., they sketch the region defined by $2x + 6y < 4$).

9.0   Students solve a system of two linear equations in two variables algebraically and are able to interpret the answer graphically. Students are able to solve a system of two linear inequalities in two variables and to sketch the solution sets.

Algebra II

2.0   Students solve systems of linear equations and inequalities (in two or three variables) by substitution, with graphs, or with matrices.

Name _____ Date _____ Period _____

How Much of Each Vaccine?

You are the production leader of one of the few pharmaceutical plants that produce the yearly influenza vaccine for the United States. The flu vaccine can be produced in two forms—an inhaled (intranasal) live vaccine and an injected killed vaccine. Both are equally effective in preventing the flu, although only the injected vaccine is recommended for children under 5 years old.

Because the flu virus mutates quickly, scientists decide on which specific strains of the disease are in the vaccine each year. The closer this decision is made to the beginning of flu season, the more likely it is that scientists are correct in their conclusions about which flu strain will be most virulent. It is in everyone's best interest, then, that production of the virus is delayed as long as possible while still allowing enough time to produce enough vaccine for the population.

As the production leader for the plant, your job is to optimize the production time of the vaccines by deciding how much of each vaccine to produce.

Here is the information your production and research team has provided to help with your decision:

1) Public health officials state that this year **at least** 550,000 vaccines will be needed from your company.

2) Because intranasal administration is preferred by some patients who don't like injections, it is wise that **at least** one-third of the vaccines are intranasal.

3) The intranasal vaccine must be kept frozen until use. Your plant has enough freezer capacity for **no more than** 400,000 intranasal vaccines.

4) It costs $1.40 to produce each injected vaccine, and $1.70 for each intranasal vaccine. Your plant can spend **no more than** $1.2 million on producing flu vaccines this year.

5) On average, it takes 50 hours of production time to manufacture 1,000 injected vaccines, and 43 hours to manufacture the same amount of intranasal vaccine.

Instructions

1. Let N represent the number of intranasal vaccines produced, and I represent the number of injected vaccines. Represent each of the five statements above as algebraic equations or inequalities. Label each of your algebraic statements as a constraint or the optimization equation.

2. There are two other constraints that are not stated but assumed to be true. Describe each constraint with words and translate the constraint into algebraic language.

3. Let N lie on the y-axis and I lie on the x-axis. Graph all of the possible production choices that your plant could make that would satisfy all four constraints. This area of the graph is called the *feasible region*.

4. Determine the coordinates of all the corners of the feasible region.

5. Either graphically or algebraically, decide on the best production amounts based on making production time as short as possible. How much time would it take to produce these amounts of vaccine?

6. Document your optimization process and the reason behind your final production decision for your boss. Produce a brief (no longer than one-page) summary of what you did.

Alternative Medical Practices in Hispanic Culture

LESSON 2.5

SPANISH I

Time
200 minutes

Materials
Equipment
• Blank paper
• Note cards
• Computer lab

Resources
• Guest Speaker Notes Form
• Research Project worksheet
• Student Presentations worksheet

Prior Student Learning
Students should have experience doing research using Internet resources.

Students should have experience using PowerPoint.

Essential Question for This Unit
How has the development of society influenced the evolution of micro-organisms?

Objectives
After completing this lesson, students should be able to

• Identify examples of alternative medical practices used in other cultures, specifically Spanish-speaking cultures; present the rationale for using them to prevent or cure disease.

• Explain the differences in healthcare and lifestyles of a Latin/Hispanic country relative to those in the United States.

• Describe a range of researched information about their country in an oral presentation.

Lesson Activities
Lesson Springboard
Ask students what kind of alternative medications they think they might currently use in their homes. Have two or three students share an example with the class.

Lesson Development
Guest Speaker
Invite a guest speaker who has medical training and works with Hispanic communities (possibly a midwife). Ask the speaker to identify and introduce specific conventional and alternative medications for common diseases and symptoms to the class.

Have students take notes on the guest speaker's presentation using the Guest Speaker Notes Form (alter handout as necessary to match the guest speaker's presentation). The speaker can discuss her or his personal experience with treating some of the diseases being researched by the students, as well as the role and effectiveness of various alternative remedies. Students can take this opportunity to ask questions about their own home remedies. This discussion may continue into the next class session as students are conducting more research for their final presentations.

Internet Research
Finish discussing the various alternative medicines identified by students. Distribute the Research Project worksheet and have students begin research on their assigned country. Each student will use Internet resources to locate general geographical information, as well as local cures, remedies, and other alternative medical practices used in their

Classroom Management
During the presentation, circulate among students and check that they are accurately filling in the Guest Speaker Notes Form.

Alternative Medical Practices in Hispanic Culture

country of interest. Ideally, these cures would be related to the disease students are studying for this unit, but that is not required. Students will also investigate details of lifestyles in their country of interest, and whether sociocultural norms and values contribute to and/or inhibit the spread of infectious disease.

Support Strategy
Allow students to work in pairs on their computer research. Circulate and answer student questions individually.

During this time, circulate through the computer lab and ask students to share their research and allow them to discuss any interesting topics they have found. Two days in the computer lab should be sufficient time for students to find all the necessary information.

After students have completed their research, ask them to summarize their findings in a PowerPoint presentation. Each slide should contain only summary points (maximum seven words per slide), and the presentation should include appropriate graphics.

Presentations
Students will use their PowerPoint presentations to share their research with the class. During each presentation, have students take notes on the Student Presentations worksheet. Ask students to review what they learned in their own research and from the guest speaker as they listen to their classmates' presentations.

Lesson Closure
After all the presentations have been made, have students write a brief essay describing what they have learned and what they have enjoyed learning while working on this project. Then discuss how they might use what they have learned to improve health-related practices in their own homes in the future.

Student Assessment Artifacts
Guest Speaker Notes Form
Research Project notes
PowerPoint presentation

Possible Prior Misconceptions
Students may believe that diseases and their symptoms can only be cured by prescription or over-the-counter drugs developed by modern medical science.

Variations and Extensions
To introduce the lesson, assemble a panel of speakers from the various Spanish-speaking countries to give brief overviews of their use of alternative medications and to describe how they became interested in the field. You may wish to include one or two healthcare professionals who do not promote alternative or complementary medications to present an opposing view.

Have students conduct more in-depth research on the differences in healthcare available in their assigned country versus the United States,

Alternative Medical Practices in Hispanic Culture

and describe how those differences, along with lifestyle, can affect public health. You may also have students expand the amount of cultural information in their presentations.

Have students discuss their perceptions of the advantages and disadvantages of each alternative medication. Have students discuss the remedies that might be best suited for each symptom of their assigned disease.

National and State Academic Standards

NATIONAL
ACTFL Standards for Foreign Language Learning

Standard 2.1: Students demonstrate an understanding of the relationship between the practices and perspectives of the culture studied.
Standard 2.2: Students demonstrate an understanding of the relationship between the products and perspectives of the culture studied.
Standard 3.1: Students reinforce and further their knowledge of other disciplines through the foreign language.
Standard 3.2: Students acquire information and recognize the distinctive viewpoints that are only available through the foreign language and its cultures.
Standard 4.2: Students demonstrate understanding of the concept of culture through comparisons of the cultures studied and their own.

CALIFORNIA
California has no academic standards for foreign language at this time.

National and State Career Technical Education Standards

NATIONAL
NCHSTE National Healthcare Skill Standards

3.41   Analyze the cause and effect on healthcare system change based on the influence of: technology, epidemiology, bio-ethics, socio-economics, and various forms of complementary (non-traditional) medicines

6.31   Discuss the impact of religions and cultures on those giving and receiving healthcare with an understanding of past and present events

CALIFORNIA
Health Science and Medical Technology Standards

7.6   Know and appreciated cultural differences and provide culturally competent care to patients and clients

7.7   Understand and demonstrate methods for promoting health and wellness

Name _____ Date_____ Period _____

Guest Speaker Notes Form

A. What is the presenter's name, and where is she or he from?

B. What are her or his qualifications?

C. What are five items/medications that were described, and what do they cure?

1. _____

_____

2. _____

_____

3. _____

_____

4. _____

_____

5. _____

_____

D. What is a midwife, and what experience does the presenter have in this field?

E. Does the presenter believe alternative medications are better than modern-day medications/drugs? Why?

F. Does your family use any of the alternative medications in your house? If so, which ones? And if not, would you consider using them. Why or why not?

G. What was the best part of this presentation and why?

H. What did you learn from this presentation that you didn't already know from your own research?

Name _____ Date_____ Period _____

Research Project

Remember to note your websites in the given boxes; you will be turning this research document in as part of your grade. This document should also serve as an outline for your research and the information you will use in your presentation. Also, remember to take note of pictures for your PowerPoint presentation; you MUST have 10 slides with pictures! Remember some of this information might have been presented by the guest speaker.

1. What country are you researching? Where is this country located in relation to the United States? What is their flag? (Talk about this during your presentation and include two or three slides with pictures.)

   _____

   _____

   _____

   _____

   _____

   Sources:

   _____

2. What are some cures, remedies, or alternative, nontraditional healing practices found within Spanish cultures? (They do not have to be related to the disease you have chosen for this unit—just practices used within Spanish-speaking communities in Central and South America or Spain.) (For example: medicine man, herbal medicines, midwifery, etc.)

   _____

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   _____

   Sources:

   _____

3. Could certain elements of lifestyles in Hispanic countries increase the spread of diseases within their countries? Why or why not? (Please give researched opinions, showing evidence of why or why not.)

   _____

   _____

   _____

   _____

   _____

   Sources:

   _____

Name _____ Date_____ Period _____

Student Presentations

Fill in the following chart based on the information presented by your classmates in each presentation.

Presenter's Name	Country	Flag Colors	Cure #1	Cure #2	Interesting Fact

Name _____ Date _____ Period _____

Write a brief (10-sentence) summary presenting what you have learned while listening to your class-mates' presentations and researching your country. Make sure to talk about why or why not the lifestyles of Hispanics could lead to the spread of diseases within their countries. Also discuss what you liked and didn't like about this project, ways to improve it the future, and what part of the project helped you learn most effectively.

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Essential Question for This Unit

How has the development of society influenced the evolution of microorganisms?

Subunit Goals

In Subunit 3, students examine the impact of epidemics on society. They will examine different views regarding the study of viruses, balancing perspectives aimed at advancing scientific knowledge against concerns about the potential for abuse. Students will examine how literature can be used as a vehicle for conveying a realistic sense of the events and anxiety accompanying the spread of infectious disease. Students will also compare the actual events surrounding and contributing to historical epidemics. Students will conclude the unit by preparing an in-depth presentation on a communicable disease of their choice.

Subunit Key Questions

- What can be learned from studying past viruses? Could past viruses be used today as weapons? Should we be concerned? (English Language Arts)

- What would it be like to be in the middle of an epidemic? How would you react? (English Language Arts)

- How can intense reactions to handling disease outbreaks be conveyed through writing? (English Language Arts)

- Does biology totally determine the outcome of an epidemic? How can social factors contribute to the spread of disease? Is there a right or wrong way to deal with an epidemic? (World History)

- What would happen if there was an outbreak of disease at our school? (All subjects)

Lesson Summaries

Lesson	Subject	Description
3.1	English Language Arts	**Reading a Virus: How Science and Politics Treat the Flu** Students read and discuss a technical article that presents a controversy regarding the study of viruses.
3.2	English Language Arts	**The Hot Zone** Students read *The Hot Zone, A Terrifying True Story* by Richard Preston (1994), an account of the Ebola outbreak in Reston, Virginia. They discuss the book's major themes and literary techniques.
3.3	World History	**Macro Societies, Micro Invaders** Students examine the social factors that can contribute to the spread of disease and compare the events surrounding different historical epidemics.
3.4	English Language Arts	**Infectious Disease Research Presentations** Students select a pathogen and conduct research from various perspectives. They prepare and deliver an oral presentation on the biology, transmission, treatment, prevention, and history of the pathogen and associated disease.

Reading a Virus: How Science and Politics Treat the Flu

LESSON 3.1

Time
45 minutes

Materials
• "1918 Flu Virus Is Resurrected"—article from *Nature* (October 5, 2005)
• "Recipe for Destruction"—Op-Ed from *The New York Times* (http://www.nytimes.com/2005/10/17/opinion/17kurzweiljoy.html?ex=1287201600&en=0fa5296d130c0e2f&ei=5088&partner=rssnyt&emc=rss)
• "1918 Flu and Responsible Science"—Editorial in *Science* (http://www.sciencemag.org/cgi/content/short/310/5745/17)

Prior Student Learning
Students should have a basic knowledge of genes, genome sequences, and viruses.

Essential Question for This Unit
How has the development of society influenced the evolution of micro-organisms?

Objectives
After completing this lesson, students will be able to

• Critically read a technical article.

• Compare divergent views in a leading scientific dispute.

• Write a well-reasoned editorial that supports an opinion with facts.

Lesson Activities
Lesson Springboard
Ask students to think about the scientific articles they have read. What is characteristic about the style of these articles? Tell them that the *word choice* is formal and that this is closely related to *tone*, the attitude toward the topic and the audience that the writer's language conveys. Scientific and technical fields also have created special vocabularies, called *jargon*, that enable their members to speak and write concisely to one another. An important characteristic of scientific style is *explicitness*. Ideas must be stated clearly and unambiguously and be supported by facts, with no emotional appeals to the reader.

Lesson Development
Class Discussion
Pass out and have students read the "1918 Flu Virus Is Resurrected" article from *Nature* magazine. (You may wish to assign this reading for **homework** prior to this lesson. *Note: This article is not freely available online, but can be found and copied for classroom use at your local library.*) Begin by asking the class whether the characteristics of scientific style mentioned above are evident in this article. For example, ask them to identify examples of scientific word choice, tone, jargon, and explicit-ness. In this article, there are disagreements among authorities that may arise from different factual understandings, and sometimes from diver-gent points of view. Ask students if it is clear when the authority's argument is based on facts, and when it is arises from a point of view (e.g., the authority's moral or political values).

Tell students that scientific prose is sometimes difficult to decipher and that they must read it with a strong sense of purpose. Critical read-ers will focus their attention by asking three questions: What is the author's main point? How much and what kind of evidence supports that point? How persuasive is the evidence? Apply these questions to the article "1918 Flu Virus Is Resurrected." Have one student summarize the main point—that the sequencing of the influenza gene has provoked

Reading a Virus: How Science and Politics Treat the Flu

a far-reaching dispute between scientists who hope to detect the next pandemic strain and biosecurity experts who worry that the virus may escape or be exploited by terrorists. Then have one student describe the evidence that supports the scientists and have another describe the evidence that supports the security experts. Finally, ask the class which side they support and why.

Tell the students that they will now be taking a closer look at the article. The chief scientist responsible for sequencing the 1918 flu virus genome, Jeffery Taubenberger, concluded that it differed from the viruses that struck this country later in the century. To delve deeper, ask students: What was his reasoning? Why was the 1918 virus particularly virulent? What appears to be the specific source of its virulence? Why is it important to pinpoint "exactly which genetic mutations allowed the virus to jump to humans"?

According to the article, Taubenberger and his supporters believe that "government bureaucracies" have a selfish reason for interfering with the publication of scientific research. Ask the class: What do they believe is this reason? Is it possible that scientists have selfish interests of their own? Why might a scientist want to publish the results of the genome sequencing even if there is some risk to public health or national security?

To conclude the class discussion, ask students if there is a way to find a compromise between the positions of the scientists and the public officials. For example, in future research on "dangerous" genomes, would it be appropriate to do the sequencing but not publish the results? Should scientists who perform this work be investigated ("cleared") by the government prior to conducting the research? Are there ways to balance scientific freedom and the public's right to safety?

Tell students that additional articles on the opposing viewpoints surrounding the 1918 flu virus controversy can be found at http://www.pbs.org/wgbh/nova/sciencenow/3318/02-poll-sources.html.

Lesson Closure

Assign students to write a 300- to 400-word editorial for their school newspaper on the main issue raised in the *Nature* article, in which they will address the following questions: Was it proper to reconstruct this deadly virus in a lab and publish the results for all the world to see? What are the benefits and risks of this project? Should similar projects be undertaken in the future? Tell students that their editorial should begin with a description of the project itself and briefly summarize the positions of its supporters and critics.

Possible Prior Misconceptions

Some students may not realize that scientists have social responsibilities. Others may believe that scientists are subject to government control.

Reading a Virus: How Science and Politics Treat the Flu

L E S S O N 3 . 1

Student Assessment Artifacts

Editorial (300–400 words)

Variations and Extensions

If you cannot get a copy of the *Nature* article, you may choose to have students read about the two opposing viewpoints in the online documents listed in the Materials section above.

Have students watch a NOVA video segment about the resurrection of the 1918 flu virus, found at http://www.pbs.org/wgbh/nova/sciencenow/ 3318/02.html.

Ask students to read a lengthier article on some controversy in the life sciences. Ask them to summarize the main idea and competing positions, and to evaluate the evidence that supports those positions. If time permits, have them write a 500- to 600-word editorial in which they present their own opinion on the controversy.

National and State Academic Standards

NATIONAL
NCTE Standards for the English Language Arts

1. Students read a wide range of print and non-print texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.

3. Students apply a wide range of strategies to comprehend, interpret, evaluate, and appreciate texts. They draw on their prior experience, their interactions with other readers and writers, their knowledge of word meaning and of other texts, their word identification strategies, and their understanding of textual features (e.g., sound-letter correspondence, sentence structure, context, graphics).

4. Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.

5. Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences for a variety of purposes.

6. Students apply knowledge of language structure, language conventions (e.g., spelling and punctuation), media techniques, figurative language, and genre to create, critique, and discuss print and non-print texts.

CALIFORNIA
English Language Arts Content Standards

Reading

2.7 Critique the logic of functional documents by examining the sequence of information and procedures in anticipation of possible reader misunderstandings.

2.8 Evaluate the credibility of an author's argument or defense of a claim by critiquing the relationship between generalizations and evidence, the comprehensiveness of evidence, and the way in which the author's intent affects the structure and tone of the text (e.g., in professional journals, editorials, political speeches, primary source material).

Writing

2.4 Write persuasive compositions:

a. Structure ideas and arguments in a sustained and logical fashion.

b. Use specific rhetorical devices to support assertions (e.g., appeal to logic through reasoning; appeal to emotion or ethical belief; relate a personal anecdote, case study, or analogy).

c. Clarify and defend positions with precise and relevant evidence, including facts, expert opinions, quotations, and expressions of commonly accepted beliefs and logical reasoning.

d. Address readers' concerns, counterclaims, biases, and expectations.

ENGLISH LANGUAGE ARTS

Time
150 minutes

Materials
Equipment
• Overhead projector
• Latex gloves (1 pair/student), some previously pricked with a pin
• Bowl of water
• Red food coloring

Resources
Class set of *The Hot Zone, A Terrifying True Story*

Prior Student Learning
Students should have a basic understanding of viruses, including their genetic makeup and their ability to adapt to environmental changes. They should be familiar with recent developments in safety precautions related to infectious disease.

Students should be familiar with the literary concepts of *foreshadowing* and *prediction*.

Essential Question for This Unit
How has the development of society influenced the evolution of micro-organisms?

Objectives
After completing this lesson, students should be able to

• Analyze and interpret nonfiction texts.

• Identify the use of foreshadowing and anticipate future events in a text.

Lesson Activities
Lesson Springboard
Ask students to imagine they are healthcare workers and a patient with an incurable and contagious deadly disease has come into the medical facility for treatment. What would their personal reaction be? What precautions could personnel at the facility take? What if they didn't find out until after the patient arrived how sick he was?

Lesson Development
Initial Reading and Discussion
Give each student a copy of *The Hot Zone, A Terrifying True Story* by Richard Preston (1994). Have students read the first section, the story of Charles Monet, and discuss the following questions:

• Where did the disease start?

• Where did the disease spread?

• How was the pathogen spread from one person to another?

• How did the pathogen affect the body?

• What behaviors contributed to the spread of the disease?

Reaction Writing
Review with students the story of Charles Monet, a character in *The Hot Zone*. Ask students to identify some of the changes that have occurred in the medical field since that time. Students should be able to identify important safety precautions when treating patients with infectious diseases.

After the initial discussion, hand each student a glove. Note that some of the gloves have been pricked with a pin, but students should not be told about this. Ask the students what they have already learned about handling viruses. Tell them that they are going to immerse their hands into some " bloody water" that contains an unknown virus, and they are to feel the substance in the water. Some of the students' hands will be come wet and covered by the water.

Ask students to write down their reactions to the leak. Tell them that this is the same experience that happened to another character in *The Hot Zone*, Nancy Jaax. Remind students that this is a nonfiction book, which makes the episode even more frightening.

Reading and Discussion

Remind students of the terms *foreshadowing* and *prediction*. Ask students to look for sentences in the text that illustrate either of these two terms. Students will read the following excerpt from *The Hot Zone* and write predictions on their paper:

> "Jaax and Johnson moved slowly out of the room, carrying the monkey, and turned left and then turned left again, and entered the necropsy room, and laid the monkey down on a stainless-steel table. The monkey's skin was rashy and covered with red blotches, visible through his sparse hair.
>
> 'GLOVE UP,' Johnson said.
>
> They put on latex rubber gloves, pulling them over the space-suit gloves. They now wore three layers of glove: the inner-lining glove, the space-suit glove, and the outer glove. Johnson said, 'WE'LL DO THE CHECK LIST. SCISSORS. HEMOSTATS.' He laid the tools in a row at the head of the table. Each tool was numbered, and he called the numbers out loud.
>
> They went to work. Using blunt-ended scissors, Johnson opened the monkey while Jaax assisted with the procedure. They worked slowly and with exquisite care. They did not use any sharp blades, because a blade is a deadly object in a hot zone. A scalpel can nick your gloves and cut your fingers, and before you even feel the sensation of pain, the agent has already entered your bloodstream.
>
> Nancy handed tools to him, and she reached her fingers inside the monkey to tie off blood vessels and mop up excess blood with small sponges. The animal's body cavity was a lake of blood. It was Ebola blood, and it had run everywhere inside the animal: there had been a lot of internal hemorrhaging. The liver was swollen, and she noticed some blood in the intestines.
>
> She had to tell herself to slow her hands down. Perhaps her hands were moving too quickly. She talked herself through the procedure, keeping herself alert and centered. Keep it clean, keep it clean, she thought. Okay, pickup the hemostat. Clamp that artery 'cause it's leaking blood. Break off and rinse gloves. She could feel the Ebola blood through her gloves: it felt wet and slippery, even though her hands were clean and dry and dusted with baby power."

After students have written their predictions about what will happen next, have them read the next two excerpts:

> "Johnson was handing her a tube containing a sample when he stopped and looked at her gloved hands. He pointed to her right glove.
>
> She glanced down. Her glove. It was drenched in blood, but now she saw the hole. It was a rip across the palm of the outer glove on her right hand.
>
> Nancy tore off the glove. Now her main suit glove was covered with blood. It spidered down the outer sleeve of her space suit. Great, just great—Ebola blood all over my suit. She rinsed her glove and arm in disinfectant, and they came up clean and shiny wet. Then she noticed that her hand, inside the remaining two gloves, felt cold and clammy. There was something wet

inside her space-suit glove. She wondered if that glove was a leaker, too. She wondered if she had sustained a breach in her right main glove. She inspected that glove carefully. Then she saw it. It was a crack in the wrist. She had a breach in her space suit. Her hand felt wet. She wondered if there might be Ebola blood inside her space suit, somewhere close to that cut on the palm of her hand. She pointed to her glove and said, 'HOLE.' Johnson bent over and inspected her glove. He saw the crack in the wrist. She saw his face erupt in surprise, and then he looked into her eyes. She saw that he was afraid.

That terrified her. She jerked her thumb toward the exit. 'I'M OUTTA HERE, MAN. CAN YOU FINISH?'

He replied, 'I WANT YOU TO LEAVE IMMEDIATELY. I'LL SECURE THE AREA AND FOLLOW YOU OUT.'"

❖

"The main question was whether or not any blood had penetrated the last glove to the cut. Five or ten Ebola-virus particles suspended in a droplet of blood could easily slip through a pinhole in a surgical glove, and that might be enough to start an explosive infection. This stuff could amplify itself. A pinhole in a glove might not be visible to the eye. She went over to the sink and put her hand under the faucet to rinse off the blood and held it there for a while. The water carried the blood down the drain, where wastewater would be cooked in heated tanks.

Then she pulled off the last glove, holding it delicately by the cuff. Her right hand came out caked with baby powder, her fingernails cut short, not nail polish, no rings, knuckles scarred by a bite from a goat that had nipped her when she was a child, and a Band-Aid on the palm.

She saw blood mixed with the baby powder.

Please, please, make it my blood.

Yes—it was her own blood. She had bled around the edges of the Band-Aid. She did not see any monkey blood on her hand.

She put the last glove under the faucet. The water was running, and it filled up the glove. The glove swelled up like a water balloon. She dreaded the sudden appearance of a thread of water squirting from the glove, the telltale of a leak, a sign that her life was over. The glove fattened and held. No leaks."

Ask students to imagine that they are Nancy Jaxx. What would they be feeling? What would their reaction have been? Have them write a journal entry describing their feelings.

In many ways, *The Hot Zone* is a suspense novel. As students continue reading, have them note the ways in which the author builds tension in the story. What techniques did they find most effective?

Reading and Discussion
If scheduling allows, have students finish reading the novel. The author has provided an excellent study guide with questions that can be found at http://www.richardpreston.net/guide/hz/.

Lesson Closure

Read the last chapter of the book in class. At what point has the author left the story? Why has he returned to the Kitum Cave? Have students imagine that they are standing at the mouth of the cave. Have them discuss how they feel: Are they nervous, excited? Are students reassured by the ending?

Student Assessment Artifacts

Journal entries and reaction papers

Variations and Extensions

Have students compare this account with other reports of outbreaks. Compare and contrast the style of writing used in *The Hot Zone* with traditional nonfiction reporting.

Watch and discuss the movie *Outbreak*, which was based on *The Hot Zone*.

National and State Academic Standards

NATIONAL
NCTE Standards for the English Language Arts

1. Students read a wide range of print and non-print texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.

3. Students apply a wide range of strategies to comprehend, interpret, evaluate, and appreciate texts. They draw on their prior experience, their interactions with other readers and writers, their knowledge of word meaning and of other texts, their word identification strategies, and their understanding of textual features (e.g., sound-letter correspondence, sentence structure, context, graphics).

5. Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences for a variety of purposes.

CALIFORNIA
English Language Arts Content Standards

3.0 Literary Response and Analysis

Structural Features of Literature

3.2 Compare and contrast the presentation of a similar theme or topic across genres to explain how the selection of genre shapes the theme or topic.

2.0 Writing Applications (Genres and Their Characteristics)

2.2 Write responses to literature:

   a. Demonstrate a comprehensive grasp of the significant ideas of literary works.

   b. Support important ideas and viewpoints through accurate and detailed references to the text or to other works.

Macro Societies, Micro Invaders

LESSON 3.3

WORLD HISTORY

Time
50 minutes

Materials
Equipment
Computer lab with Internet access

Resources
• PBS Program Transcript of Film "Influenza 1918" (http://www.pbs.org/wgbh/amex/influenza/filmmore/transcript/transcript1.html)
• 1918 Influenza site (http://virus.stanford.edu/uda/)
• Kolata, Gina. (1999). *Flu: The Story of The Great Influenza Pandemic*, chapters 1, 2
• Social Factors in Epidemics worksheet

Prior Student Learning
Students should have a basic knowledge of the biology of epidemics.

Essential Question for This Unit

What is the effect of human intervention on the evolution of microorganisms?

Objectives

After completing this lesson, students will be able to

• Understand epidemics as social as well as biological phenomena.

• Interpret American society in the early 20th century, particularly its systems of medicine and public health, through the lens of the flu pandemic of 1918.

• Compare two historical epidemics and show their major similarities and differences in the form of a chart.

Lesson Activities

Lesson Springboard

Tell students that epidemics are caused by microbes, but the scope and severity of epidemics are determined by social factors, not only by biological ones. A *microbe* is transmitted through human contact, and the path it travels will depend on the density of population, patterns of transport, and the segregation or intermingling of groups, as well as by a host of other factors that affect human interaction. As the microbe makes its "wickd way," social agents of many sorts rise to do battle against it, with varying degrees of success.

Inform students that local governments, scientists, researchers, and the medical community mount their own distinct campaigns, collaborating, competing, or working independently of one another. Social workers, churches, prophets, politicians, and the media enter the fray. And as all these agencies struggle to comprehend and contain the microbe, they must contend with the great tides of public opinion—the gossip, rumor, and folklore that rise like mushrooms after a rain among people who are suffering great duress. Sooner or later, the epidemic dwindles and ends. But even then social forces are at work, for societies differ greatly in how they adapt to, and remember, the traumatic event. Some societies learn from it, others do not. Among the latter, one may find a kind of Post Traumatic Stress Disorder, a collective amnesia that lasts for many years.

Lesson Development
Direct Instruction

There are five factors that influence the spread of epidemics.

• **Patterns of transmission** based on where people live and how much they circulate, as well as on demographic characteristics of the population

Macro Societies, Micro Invaders

- **Government response** ranging from quarantines and curfews to mass inoculations, the conscription of doctors and nurses, and attempts to control the movement of food and water, garbage, and sewage

- **The medical community** that engages in diagnosis, treatment, care, and research

- **Popular opinion** as it is shaped by the media, but even more by religion, folklore, gossip, and rumor

- **Social learning** that determines whether a society will "remember" the epidemic and learn from it, or "repress" the trauma and fail to learn

Ask students what they know about epidemics that have occurred in the recent or distant past. Can they identify any social factors that influenced the outcome of an epidemic? Give the following examples and ask students to classify them using the five social factors listed above.

- Asia is the world epicenter of influenza. The virus thrives in ducks, especially, that are omnipresent in southern China. For centuries, the flu virus has become converted into human flu due to an ingenious system devised by Chinese rice farmers, who use ducks to keep their rice crops free of weeds and insects. The farmers also keep pigs that live alongside the ducks, providing an opportunity for the virus to jump from ducks to pigs to people.

- The communication system of 19th-century London was a strange mix of speed and sluggishness. The postal service was famously efficient, delivering mail three times a day, but there were only several newspapers, sold at only a few locations. When cholera broke out in 1854, word of the terrible plague was carried by gossip and rumor rather than by the press.

- More Americans were killed by the flu pandemic of 1918 than in all the wars of the 20th century combined. But few have heard of this plague, and it is rarely studied in schools.

- The Black Death of the 14th century dragged on for decades and was fought by local communities with no coordination among them. By contrast, the Avian Flu that broke out in Hong Kong during 1997 was short-lived, in part because the authoritarian government was strong enough to kill 1.5 million chickens in 6 months.

Class Discussion
Hand out two copies of the Social Factors in Epidemics worksheet to each student and tell them to take careful notes during the class discussion. Have them read two articles on the flu pandemic of 1918 and chapters 1 and 2 from the book *Flu, The Story of The Great Influenza Pandemic* by Gina Kolata (1999). They will use this information, as well as the class discussion, to fill out one copy of the worksheet. As **homework**, have students research another epidemic somewhere in the world and fill out a second copy of the worksheet. By comparing the social factors at work in two historical cases, students will see that epidemics are a human process as well as a biological one.

Macro Societies, Micro Invaders

Questions like the following will help students to understand the 1918 pandemic as a human process and to compare it with other epidemics in history:

- Both the PBS website and Gina Kolata try to explain why Americans have largely forgotten the worst disaster to befall them in the 20th century. How do they explain this? Do their explanations make sense to you?

- "For over a century, the booming science of medicine had gone from one triumph to another. Researchers had developed vaccines for many diseases such as smallpox, anthrax, rabies, diphtheria, and meningitis. It seemed that the masters of medicine could control life and death: there was nothing Americans couldn't do. We could even win the war that no one could win." (PBS Program Transcript). How was this both an advantage and a liability when America was stricken by the flu in 1918?

- During an epidemic, it's best to "shut everything down," while during wartime, it's best to "speed everything up." For example, epidemics require quarantines and minimal contact among people, while wars require rallies, bond drives, troop movements, and around-the-clock production. How did the U.S. government balance these competing requirements? Did it balance them at all?

- War fuels nationalism, and both nationalism and war produce strong governments. In what respect was a wartime government more able to fight this pandemic? If the government had been even stronger, such as Hong Kong's in 1997, what else could it have done?

- How did the medical community respond to the 1918 pandemic? Given that science was powerless to detect the virus (or any virus), how did ordinary people try to cope with the flu?

- America in 1918 was both more rural and more religious than the country is today. How did these factors influence the ways Americans responded to the pandemic?

Lesson Closure

Remind students that the ways in which societies respond to epidemics is a question not only for historians but also a pressing issue for us all. For a variety of reasons, epidemics are likely to remain, and those that do may have greater scope or severity than we are prepared for. In the past decade alone, the world has been rocked by outbreaks of bird flu, mad cow disease, and the West Nile virus. Perhaps even now a new plague is gathering deadly force. If so, it is best to be armed with a good understanding of the past so that we can survive the next pandemic.

Remind students that as **homework** they will complete the same worksheet as they did in this lesson, using a different epidemic.

Possible Prior Misconceptions

Students may not realize that societies respond to epidemics (and other mass catastrophes) very differently due to their different social structures.

Macro Societies, Micro Invaders

Student Assessment Artifacts

Two versions of the worksheet that compare historical epidemics along five dimensions

Variations and Extensions

Have students read the transcript of the documentary "Influenza 1918," which aired on the PBS series "The American Experience" in 1998. The transcript is available at http://www.pbs.org/wgbh/amex/influenza.

Have students pose questions like the ones in this lesson, but ask students to base them on their own case studies, which they documented on the worksheet. Organize a discussion around the case studies, using these questions where they're appropriate. Ask students if they see any common patterns in social responses to epidemics.

During epidemics, the healthcare system must rapidly expand. Have students examine three historical cases in which civilians were incorporated into healthcare, e.g., as hospital workers. Ask them to describe how was this carried out and what the results were.

National and State Academic Standards

NATIONAL
NCSS Curriculum Standards for Social Studies

IV. Individual Development and Identity

e.   examine the interactions of ethnic, national, or cultural influences in specific situations or events;

V. Individuals, Groups, and Institutions

b.   analyze group and institutional influences on people, events, and elements of culture in both historical and contemporary settings;

IX. Global Connections

d.   analyze the causes, consequences, and possible solutions to persistent, contemporary, and emerging global issues, such as health, security, resource allocation, economic development, and environmental quality;

CALIFORNIA
History-Social Science Content Standards

Chronological and Spatial Thinking

1.   Students compare the present with the past, evaluating the consequences of past events and decisions and determining the lessons that were learned.

2.   Students analyze how change happens at different rates at different times; understand that some aspects can change while others remain the same; and understand that change is complicated and affects not only technology and politics but also values and beliefs.

Historical Interpretation

1.   Students show the connections, causal and otherwise, between particular historical events and larger social, economic, and political trends and developments.

2.   Students recognize the complexity of historical causes and effects, including the limitations on determining cause and effect.

3.   Students interpret past events and issues within the context in which an event unfolded rather than solely in terms of present-day norms and values.

4.   Students understand the meaning, implication, and impact of historical events and recognize that events could have taken other directions.

Name _____ Date_____ Period _____

Social Factors in Epidemics

Patterns of Transmission **Geographic** **Demographic** **Other**	
Government Response	
Response by Medical Community	
Popular Opinion **(Media, Churches, Folklore,** **Gossip, and Rumor)**	
Social Learning **(Positive, Negative, or None)**	

Infectious Disease Research Presentations

LESSON 3.4

ENGLISH LANGUAGE ARTS

Time
150 minutes for presentations

Materials
Catch the Fever! Student Presentations handout

Prior Student Learning
Students can be introduced to this assignment at the beginning of the unit, and work on it throughout the various lessons.

Students should have experience doing research using Internet resources.

Students should have experience using PowerPoint and Microsoft Publisher (optional).

Essential Question for This Unit
How has the development of society influenced the evolution of micro-organisms?

Objectives
After completing this lesson, students should be able to

- Provide an in-depth overview of a single communicable disease, including information about the pathogen, historical outbreaks, conventional and alternative treatments, and public health efforts to limit the spread of the disease.

- Synthesize information from a variety of sources to produce presentation materials for specific audiences.

- Deliver an oral presentation in front of the class.

Lesson Activities

Lesson Springboard
Introduce this research assignment as a culminating event that students will be working on in many different classes. You may wish to introduce the assignment early in the unit, so that students will have a chance to think about what pathogen and disease they would like to research. Provide a list of possible topics for students (perhaps the same list of pathogens used in Lesson 1.2). Have students select their topic as early as possible. Pass out the Catch the Fever! Student Presentations handout and review the different components of the project.

Lesson Development
Research for this final effort can be spread across the different academic classes as the topics arise.

Biology and Health Science
The presentation can begin with an overview of pathogens and communicable diseases in general. For example, students might ask: What are the major types of pathogens, and how do they differ as infectious agents? Students should introduce their particular pathogen; identify its method of transmission between organisms; and determine the pathogen's major effects on the body. Information on how the disease can be prevented and how it can be treated should be covered. Students should also address whether the disease has undergone any major changes over time—i.e., becoming easier or more difficult to treat or prevent.

World History and Health Science
Students should include information about the history of the spread of the disease around the world, and how the disease has been dealt with in modern times. Students should present information about where the

Infectious Disease Research Presentations

disease is endemic, how has it spread, and how is it currently being controlled. Students should also include information about public health efforts that have reduced the spread of communicable disease in general, as well as demonstrate how modern technology (e.g., air travel) has made it easier for disease to spread.

Spanish and Health Science
Where applicable, students should examine how their pathogen is viewed, prevented, and treated in other countries and by other cultures.

Algebra and Health Science
Students should include specific statistics and graphs about the incidence of their disease in the United States and around the world.

English Language Arts and Health Science
Students should compose a written summary of their research. You may ask students to write a report or create an informational brochure, depending on how extensive a project you wish to assign.

Presentations
There will be an overall grade for the final in-class presentation of the schoolwide project. While the research will be done in teams, each member will receive an individual grade. Each team member will present a portion of the presentation. Grades will be given for

- Oral presentation

- PowerPoint Presentation or Tri-fold Display

- Report or Brochure

Lesson Closure
Have students evaluate each other's presentations. Give students the opportunity to ask questions and offer constructive criticism. Discuss the school's policies regarding a communicable disease outbreak.

Possible Prior Misconceptions
None

Student Assessment Artifacts
Oral presentation
Visual aid (PowerPoint presentation or poster board)
Report and/or brochure

Variations and Extensions
Hold an evening event and invite parents and community leaders to watch and evaluate the presentations. Use the event as an opportunity to invite healthcare industry and postsecondary partners to participate in evaluating the student presentations.

Have students research, write, and present individually, rather than in groups.

Infectious Disease Research Presentations

National and State Academic Standards

NATIONAL
NCTE Standards for the English Language Arts

1. Students read a wide range of print and non-print texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.

3. Students apply a wide range of strategies to comprehend, interpret, evaluate, and appreciate texts. They draw on their prior experience, their interactions with other readers and writers, their knowledge of word meaning and of other texts, their word identification strategies, and their understanding of textual features (e.g., sound-letter correspondence, sentence structure, context, graphics).

4. Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.

5. Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences for a variety of purposes.

6. Students apply knowledge of language structure, language conventions (e.g., spelling and punctuation), media techniques, figurative language, and genre to create, critique, and discuss print and non-print texts.

7. Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of sources (e.g., print and non-print texts, artifacts, people) to communicate their discoveries in ways that suit their purpose and audience.

8. Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.

CALIFORNIA
English Language Arts Content Standards

Reading

2.4 Synthesize the content from several sources or works by a single author dealing with a single issue; paraphrase the ideas and connect them to other sources and related topics to demonstrate comprehension.

Writing

1.5 Synthesize information from multiple sources and identify complexities and discrepancies in the information and the different perspectives found in each medium (e.g., almanacs, microfiche, news sources, in-depth field studies, speeches, journals, technical documents).

Listening and Speaking

1.3 Choose logical patterns of organization (e.g., chronological, topical, cause and effect) to inform and to persuade, by soliciting agreement or action, or to unite audiences behind a common belief or cause.

1.4 Choose appropriate techniques for developing the introduction and conclusion (e.g., by using literary quotations, anecdotes, references to authoritative sources).

1.7 Use props, visual aids, graphs, and electronic media to enhance the appeal and accuracy of presentations.

1.8 Produce concise notes for extemporaneous delivery.

1.9 Analyze the occasion and the interests of the audience and choose effective verbal and nonverbal techniques (e.g., voice, gestures, eye contact) for presentations.

2.6 Deliver descriptive presentations.

Name _____ Date_____ Period _____
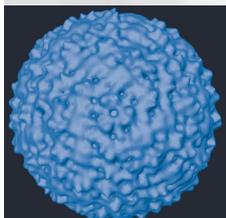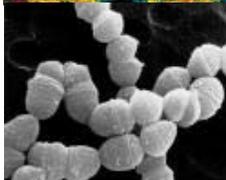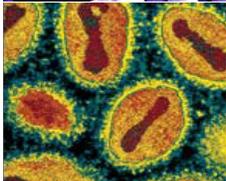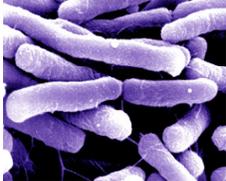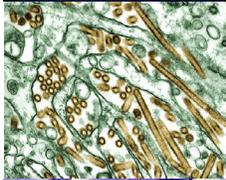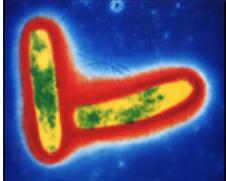
Catch The Fever!
Student Presentations

Overview
Over the next several weeks, you will be participating in a schoolwide research project that will take place in all of your classes. You will be working in groups of four students each that will be formed in your English classes. Each group will prepare a visual and oral (spoken) presentation along with an informational brochure to answer the following question about a specific microorganism:

"How has the development of society influenced the evolution of microorganisms?"

Presentation Format
1. Visual Presentation (PowerPoint OR Tri-fold Poster)
2. Oral Presentation
3. Brochure

General Resources
Epidemiology

www.who.int/en	World Health Organization
www.cdc.gov	Centers for Disease Control and Prevention
www.surgeongeneral.gov	Office of the Surgeon General

Public Health/Epidemiology

www.hsph.harvard.edu	Harvard School of Public Health
www.epibiostat.ucsf.edu	Epidemiology

Medical News

www.ama-assn.org	Journal of the American Medical Association
www.thelancet.org	Lancet Journals
www.nejm.org	The New England Journal of Medicine
www.reutershealth.com	Reuters Health
www.healthfinder.gov	Healthfinder

Research

www.agi-usa.org	Guttmacher Institute
www.mayoclinic.com	Mayo Clinic
www.nih.gov	National Institutes of Health

Grading
Each of your class subjects will contribute to one portion of the overall project. Grades will be awarded in each class subject for each piece of the overall project.

Name _____ Date _____ Period _____

Individual Subject Requirements

Biology

1. How does healthcare influence the natural selection of microorganisms?
2. How is species variation important for disease-causing microorganisms?
3. What benefits are there in variation for the microorganism?

Medical Science

1. In your research on one infectious disease, examine how the disease has spread throughout history. Where did the disease start? Where did the disease spread?
2. Describe how the pathogen is transmitted from one organism to the next
3. How does the pathogen affect body systems?
4. Has the pathogen changed over time? In what ways has it become more difficult to treat or prevent?
5. Describe at least two examples of how modern technology has prevented or treated infectious disease.
6. What kind of habits or behaviors contribute to the spread of the disease?

World History

1. What are two examples of public health efforts that have greatly reduced the spread of disease?
2. What laws have been passed to help stop the spread of this disease?

Spanish

1. What are some cures, remedies, or alternative, nontraditional healing processes found within Spanish cultures?
2. Could Hispanic lifestyles lead to the spread of diseases within Hispanic/Latin American countries? Why or why not?

Mathematics

1. Over the last 50 years, how many cases of your disease were found in the United States each year?
2. Over the last 50 years, what was the population of the United States each year?
3. Calculate the number of cases per million in the United States each year.
4. Form a table containing all of the above information.
5. Graph the number of cases per million as the independent variable (y), and the time in years as the dependent variable (x), using the Cartesian coordinate system.
6. Estimate and draw a "line of best fit."
7. Determine if the disease is spreading or declining.
8. Estimate the number of cases per million in 1 year, 5 years, and 10 years.

English

- There will be an overall grade for the final in-class presentation of the schoolwide project.
- While the project will be done in teams, each member will receive an individual grade. Each team member will present a portion of the presentation.
- Grades will be given for
  - Oral presentation
  - PowerPoint Presentation or Tri-fold Poster.
  - Brochure about steps that can be taken to prevent the disease (done on Microsoft Publisher).