

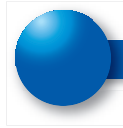
# UNIT 4

## TIMELINE

# Simple Organisms, Fungi, and Plants

Do you know how important plants are? Plants provide oxygen and food for other living things.

Throughout history, people have been trying to understand plants. In this unit, you will join them. You'll also learn about some other fascinating organisms—bacteria, protists, and fungi. Some of these organisms cause disease, but others provide food and medicines. Read on, and be amazed!



**Around  
250**

Mayan farmers build terraces to control the flow of water to crops.



**1864**

Louis Pasteur uses heat to eliminate microbes. This process is later called *pasteurization*.

**1897**

Beatrix Potter, the author of *The Tale of Peter Rabbit*, completes her collection of 270 watercolors of fungi. Today, she is considered an expert in mycology, the study of fungi.



**1971**

Ananda Chakrabarty uses genetics to design bacteria that can break down oil in oil spills.





**1580**

Prospero Alpini discovers that plants have both male structures and female structures.

**1683**

Anton van Leeuwenhoek is the first person to describe bacteria.



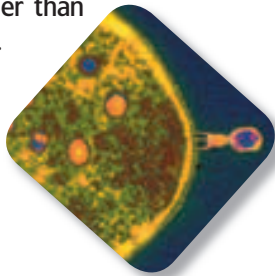
*E. coli under an electron microscope*

**1763**

Joseph Kolreuter studies orchid pollination and discovers that both parent plants contribute traits to the offspring.

**1898**

Martinus Beijerinck gives the name *virus* to infectious material that is smaller than a bacterium.



**1928**

Alexander Fleming observes that certain molds can eliminate bacterial growth, and he discovers penicillin.



**1955**

A vaccine for the polio virus developed by Dr. Jonas Salk becomes widely used.

**1983**

HIV, the virus responsible for AIDS, is isolated.



*Ebola virus*

**1995**

An outbreak of the deadly Ebola virus occurs in Zaire.

**2002**

An international team decodes the DNA sequences for both the protist that causes malaria and the mosquito that carries this protist. As a result, the door to more-effective antimalaria drugs is opened.



# Bacteria and Viruses

## Chapter Planning Guide

**Compression guide:**  
To shorten instruction  
because of time limitations,  
omit Section 2.

OBJECTIVES	LABS, DEMONSTRATIONS, AND ACTIVITIES	TECHNOLOGY RESOURCES
<b>PACING • 90 min</b> pp. 244–251 <b>Chapter Opener</b>	<b>SE</b> Start-up Activity, p. 245 <b>GENERAL</b>	<b>OSP</b> Parent Letter ■ <b>CD</b> Student Edition on CD-ROM <b>CD</b> Guided Reading Audio CD ■ <b>TR</b> Chapter Starter Transparency* <b>VID</b> Brain Food Video Quiz
<b>Section 1 Bacteria and Archaea</b> <ul style="list-style-type: none"> <li>Describe the characteristics of prokaryotes.</li> <li>Explain how prokaryotes reproduce.</li> <li>Relate the characteristics of archaea.</li> </ul>	<b>SE</b> Quick Lab Spying on Spirilla, p. 247 <b>GENERAL</b> <b>CRF</b> Datasheet for Quick Lab* <b>TE</b> Connection Activity Math, p. 248 <b>GENERAL</b> <b>TE</b> Activity Bacteria in the Air, p. 249 <b>GENERAL</b> <b>SE</b> Connection to Language Arts Colorful Names, p. 250 <b>GENERAL</b>	<b>OSP</b> Lesson Plans (also in print) <b>TR</b> Bellringer Transparency* <b>TR</b> L34 The Most Common Shapes of Bacteria* <b>TR</b> L35 Binary Fission* <b>TR</b> <b>LINK TO PHYSICAL SCIENCE</b> P47 Parts of an Atom* <b>CRF</b> SciLinks Activity* <b>GENERAL</b> <b>CD</b> Science Tutor
<b>PACING • 90 min</b> pp. 252–255 <b>Section 2 Bacteria's Role in the World</b> <ul style="list-style-type: none"> <li>Explain how life on Earth depends on bacteria.</li> <li>List three ways bacteria are useful to people.</li> <li>Describe two ways in which bacteria can be harmful to people.</li> </ul>	<b>SE</b> School-to-Home Activity Make a Meal Plan, p. 253 <b>GENERAL</b> <b>TE</b> Connection Activity Real World, p. 253 <b>GENERAL</b> <b>SE</b> Inquiry Lab Aunt Flossie and the Intruder, p. 260 <b>GENERAL</b> <b>CRF</b> Datasheet for Chapter Lab* <b>LB</b> EcoLabs & Field Activities Ditch's Brew* <b>GENERAL</b> <b>LB</b> Labs You Can Eat Bacterial Buddies* <b>GENERAL</b> <b>LB</b> Inquiry Labs It's an Invasion!* <b>GENERAL</b> <b>LB</b> Long-Term Projects & Research Ideas Bacteria to the Rescue!* <b>ADVANCED</b>	<b>OSP</b> Lesson Plans (also in print) <b>TR</b> Bellringer Transparency* <b>VID</b> Lab Videos for Life Science <b>CD</b> Interactive Explorations CD-ROM Scope It Out! <b>GENERAL</b> <b>CD</b> Science Tutor
<b>PACING • 45 min</b> pp. 256–259 <b>Section 3 Viruses</b> <ul style="list-style-type: none"> <li>Explain how viruses are similar to and different from living things.</li> <li>List the four major virus shapes.</li> <li>Describe the two kinds of viral reproduction.</li> </ul>	<b>TE</b> Demonstration Characteristics of Viruses, p. 256 <b>GENERAL</b> <b>TE</b> Connection Activity History, p. 257 <b>GENERAL</b> <b>SE</b> Connection to Chemistry Viral Crystals, p. 258 <b>GENERAL</b> <b>SE</b> Science in Action Math, Social Studies, and Language Arts Activities, p. 266–267 <b>GENERAL</b> <b>SE</b> Model-Making Lab Viral Decorations, p. 772 <b>GENERAL</b> <b>CRF</b> Datasheet for LabBook*	<b>OSP</b> Lesson Plans (also in print) <b>TR</b> Bellringer Transparency* <b>TE</b> Internet Activity p. 258 <b>GENERAL</b> <b>TR</b> L36 The Basic Shapes of Viruses* <b>TR</b> L37 The Lytic Cycle* <b>CD</b> Science Tutor

**PACING • 90 min**

### CHAPTER REVIEW, ASSESSMENT, AND STANDARDIZED TEST PREPARATION

- CRF** Vocabulary Activity\* **GENERAL**  
**SE** Chapter Review, pp. 262–263 **GENERAL**  
**CRF** Chapter Review\* **GENERAL**  
**CRF** Chapter Tests A\* **GENERAL**, B\* **ADVANCED**, C\* **SPECIAL NEEDS**  
**SE** Standardized Test Preparation, pp. 264–265 **GENERAL**  
**CRF** Standardized Test Preparation\* **GENERAL**  
**CRF** Performance-Based Assessment\* **GENERAL**  
**OSP** Test Generator, Test Item Listing

### Online and Technology Resources



Holt  
Online  
Learning



**One-Stop  
Planner** CD-ROM

Visit [go.hrw.com](http://go.hrw.com) for access to Holt Online Learning, or enter the keyword **HL7 Home** for a variety of free online resources.

This CD-ROM package includes:

- Lab Materials QuickList Software
- Holt Calendar Planner
- Customizable Lesson Plans
- Printable Worksheets
- ExamView® Test Generator
- Interactive Teacher's Edition
- Holt PuzzlePro®
- Holt PowerPoint® Resources

# KEY

**SE** Student Edition  
**TE** Teacher Edition

**CRF** Chapter Resource File  
**OSP** One-Stop Planner  
**LB** Lab Bank  
**TR** Transparencies

**SS** Science Skills Worksheets  
**MS** Math Skills for Science Worksheets  
**CD** CD or CD-ROM  
**VID** Classroom Video/DVD

**IT** Interactive Textbook  
\* Also on One-Stop Planner  
◆ Requires advance prep  
■ Also available in Spanish

SKILLS DEVELOPMENT RESOURCES	SECTION REVIEW AND ASSESSMENT	CORRELATIONS
<b>SE</b> Pre-Reading Activity, p. 244 <b>GENERAL</b> <b>OSP</b> Science Puzzlers, Twisters & Teasers* <b>GENERAL</b>		National Science Education Standards UCP 2; SAI 1; LS 1b, 1c, 2a, 3a, 3b, 4b
<b>CRF</b> Directed Reading A* <b>BASIC</b> , B* <b>SPECIAL NEEDS</b> <b>IT</b> Interactive Textbook* <b>Struggling Readers</b> <b>CRF</b> Vocabulary and Section Summary* <b>GENERAL</b> <b>SE</b> Reading Strategy Prediction Guide, p. 246 <b>GENERAL</b> <b>TE</b> Inclusion Strategies, p. 247 <b>TE</b> Support for English Language Learners, p. 248 <b>CRF</b> Reinforcement Worksheet Bacteria Bonanza* <b>BASIC</b>	<b>SE</b> Reading Checks, pp. 246, 248 <b>GENERAL</b> <b>TE</b> Homework, p. 247 <b>ADVANCED</b> <b>TE</b> Reteaching, p. 250 <b>BASIC</b> <b>TE</b> Quiz, p. 250 <b>GENERAL</b> <b>TE</b> Alternative Assessment, p. 250 <b>GENERAL</b> <b>SE</b> Section Review,* p. 251 <b>GENERAL</b> <b>CRF</b> Section Quiz* <b>GENERAL</b>	UCP 1, 3, 5; SAI 1; LS 1b, 1c, 2a, 3a, 3b, 4b
<b>CRF</b> Directed Reading A* <b>BASIC</b> , B* <b>SPECIAL NEEDS</b> <b>IT</b> Interactive Textbook* <b>Struggling Readers</b> <b>CRF</b> Vocabulary and Section Summary* <b>GENERAL</b> <b>SE</b> Reading Strategy Reading Organizer, p. 252 <b>GENERAL</b> <b>TE</b> Support for English Language Learners, p. 253 <b>TE</b> Inclusion Strategies, p. 254	<b>SE</b> Reading Checks, pp. 252, 254 <b>GENERAL</b> <b>TE</b> Reteaching, p. 254 <b>BASIC</b> <b>TE</b> Quiz, p. 254 <b>GENERAL</b> <b>TE</b> Alternative Assessment, p. 254 <b>ADVANCED</b> <b>SE</b> Section Review,* p. 255 <b>GENERAL</b> <b>CRF</b> Section Quiz* <b>GENERAL</b>	UCP 2, 3, 4, 5; ST 1, 2; SPSP 5; HNS 3; LS 1f; <i>Chapter Lab</i> : UCP 2; SAI 1, 2; LS 1c
<b>CRF</b> Directed Reading A* <b>BASIC</b> , B* <b>SPECIAL NEEDS</b> <b>IT</b> Interactive Textbook* <b>Struggling Readers</b> <b>CRF</b> Vocabulary and Section Summary* <b>GENERAL</b> <b>SE</b> Reading Strategy Discussion, p. 256 <b>GENERAL</b> <b>SE</b> Math Practice Sizing Up a Virus, p. 257 <b>GENERAL</b> <b>TE</b> Support for English Language Learners, p. 257 <b>MS</b> Math Skills for Science Multiplying Whole Numbers* <b>GENERAL</b> <b>CRF</b> Reinforcement Worksheet The Lytic Cycle* <b>BASIC</b> <b>CRF</b> Critical Thinking Bacterial Blastoff* <b>ADVANCED</b>	<b>SE</b> Reading Checks, pp. 257, 258 <b>GENERAL</b> <b>TE</b> Reteaching, p. 258 <b>BASIC</b> <b>TE</b> Quiz, p. 258 <b>GENERAL</b> <b>TE</b> Alternative Assessment, p. 258 <b>GENERAL</b> <b>SE</b> Section Review,* p. 259 <b>GENERAL</b> <b>TE</b> Homework, p. 259 <b>ADVANCED</b> <b>CRF</b> Section Quiz* <b>GENERAL</b>	UCP 1, 2, 5; SAI 1, 2; SPSP 4, 5; LS 1f, 2a



www.scilinks.org

Maintained by the **National Science Teachers Association**. See Chapter Enrichment pages that follow for a complete list of topics.



Check out **Current Science** articles and activities by visiting the HRW Web site at **go.hrw.com**. Just type in the keyword **HL5CS10T**.



**Classroom Videos**

- **Lab Videos** demonstrate the chapter lab.
- **Brain Food Video Quizzes** help students review the chapter material.



**Classroom CD-ROMs**

- **Guided Reading Audio CD** (Also in Spanish)
- **Interactive Explorations**
- **Virtual Investigations**
- **Visual Concepts**
- **Science Tutor**



**Holt Lab Generator CD-ROM**

Search for any lab by topic, standard, difficulty level, or time. Edit any lab to fit your needs, or create your own labs. Use the Lab Materials QuickList software to customize your lab materials list.



## Visual Resources

CHAPTER STARTER  
TRANSPARENCY

Bacteria and Viruses

CHAPTER STARTER



## Imagine . . .

It was a dark and stormy night—the kind of night where bizarre things happen. Suzanne sat quietly in her bedroom reading her science book. She tried to concentrate, but the constant pitter of rain against her window soon lulled her to sleep.

Suzanne woke with a start. What a strange dream! Were those creatures real? Then she remembered what she had just read in her science book. The things she had dreamed about were called bacteria and viruses. Bacteria and viruses are all around you. They are in the air you breathe and the food you eat. They are inside your body and all over the ground. Most of them are so small that they can only be seen with a high-powered microscope. Despite their tiny size, bacteria and viruses have a huge impact on the world around you. You'll read all about them in this chapter.

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BELLRINGER  
TRANSPARENCIES

Bacteria and Viruses

BELLRINGER TRANSPARENCY

## Section: Bacteria

If you can't see bacteria without a microscope, how do you know when you have come into contact with them? What kinds of things do you do to avoid bacteria? Do you know of any foods that have *good* bacteria in them?

Write your answers in your science journal.

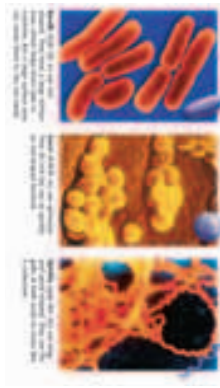
## Section: Bacteria's Role in the World

Are harmful bacteria more of a problem or less of a problem to people now than they were 200 years ago? Name some major historical events involving the spread of bacteria. How would your life change if you had to worry about getting clean water each day?

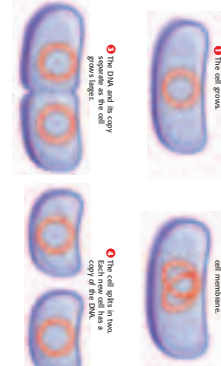
Record your answers in your science journal.

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## TEACHING TRANSPARENCIES

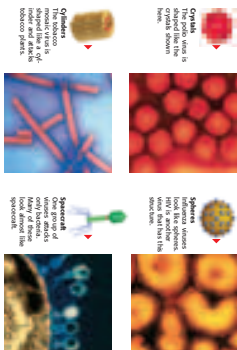
Bacteria and Viruses  
The Most Common Shapes of Bacteria

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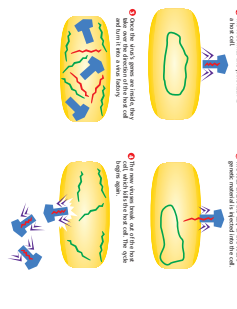
Bacteria and Viruses  
Binary Fission

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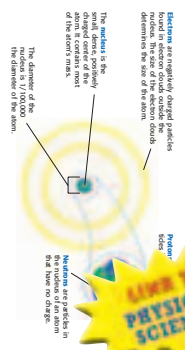
## TEACHING TRANSPARENCIES

Bacteria and Viruses  
The Basic Shapes of Viruses

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Bacteria and Viruses  
The Lytic Cycle

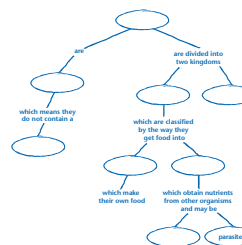
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Bacteria and Viruses  
Parts of an Atom

Chapter: Introduction to Atoms

CONCEPT MAPPING  
TRANSPARENCY

Use the following terms to complete the concept map below:  
bacteria, archaeobacteria, decomposers, eubacteria, prokaryotes, nucleus, consumers, producers



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## Planning Resources

## LESSON PLANS

## Lesson Plan

SAMPLE

## Section: Waves

## Pacing

Regular Schedule: with lab(s) 2 days without lab(s) 2 days

Block Schedule: with lab(s) 1 1/2 days without lab(s) 1 day

## Objectives

1. Relate the seven properties of life to a living organism.
2. Describe seven theories that can help you to organize what you learn about biology.
3. Identify the tiny structures that make up all living organisms.
4. Differentiate between reproduction and heredity and between metabolism and homeostasis.

## National Science Education Standards Covered

- 1. **Unifying Concepts and Processes:**
  - 1.1. **Systems:** Cells have particular structures that underlie their functions.
  - 1.2. **Models:** Most cell functions involve chemical reactions.
  - 1.3. **Interactions:** Cells store and use information to guide their functions.
  - 1.4. **Change:** Cells can differentiate and form complete multicellular organisms.
  - 1.5. **Evolution:** Cells can evolve over time.
  - 1.6. **Energy:** The great diversity of organisms is the result of more than 3.5 billion years of evolution.
  - 1.7. **Science as Inquiry:**
    - 1.7.1. **Formulating a Question:** The complexity and organization of organisms accommodates the need for obtaining, transferring, transporting, releasing, and eliminating the matter and energy used to sustain the organism.
    - 1.7.2. **Designing an Investigation:** The complexity and organization of organisms accommodates the need for obtaining, transferring, transporting, releasing, and eliminating the matter and energy used to sustain the organism.
    - 1.7.3. **Collecting Data:** The complexity and organization of organisms accommodates the need for obtaining, transferring, transporting, releasing, and eliminating the matter and energy used to sustain the organism.
    - 1.7.4. **Analyzing Data:** The complexity and organization of organisms accommodates the need for obtaining, transferring, transporting, releasing, and eliminating the matter and energy used to sustain the organism.
    - 1.7.5. **Interpreting Data:** The complexity and organization of organisms accommodates the need for obtaining, transferring, transporting, releasing, and eliminating the matter and energy used to sustain the organism.
    - 1.7.6. **Communicating Results:** The complexity and organization of organisms accommodates the need for obtaining, transferring, transporting, releasing, and eliminating the matter and energy used to sustain the organism.
    - 1.7.7. **Using Tools and Technology:** The complexity and organization of organisms accommodates the need for obtaining, transferring, transporting, releasing, and eliminating the matter and energy used to sustain the organism.
    - 1.7.8. **Understanding Scientific Inquiry:** The complexity and organization of organisms accommodates the need for obtaining, transferring, transporting, releasing, and eliminating the matter and energy used to sustain the organism.

## PARENT LETTER

SAMPLE

Dear Parent,

Your son or daughter's science class will soon begin exploring the chapter entitled "The World of Physical Science." In this chapter, students will learn about how the scientific method applies to the world of physical science and the role of physical science in the world. By the end of the chapter, students should demonstrate a clear understanding of the chapter's main ideas and be able to discuss the following topics:

1. physical science as the study of energy and matter (Section 1)
2. the role of physical science in the world around them (Section 1)
3. careers that rely on physical science (Section 1)
4. the steps used in the scientific method (Section 1)
5. examples of technology (Section 2)
6. how the scientific method is used to answer questions and solve problems (Section 2)
7. how our knowledge of science changes over time (Section 2)
8. how models represent real objects or systems (Section 3)
9. examples of different ways models are used in science (Section 3)
10. the importance of the International System of Units (Section 4)
11. the appropriate units to use for particular measurements (Section 4)
12. how area and density are derived quantities (Section 4)

## Questions to Ask Along the Way

You can help your son or daughter learn about these topics by asking interesting questions such as the following:

- What are some surprising careers that use physical science?
- What is a characteristic of a good hypothesis?
- When is it a good idea to use a model?
- Why do Americans measure things in terms of inches and yards and meters?

ALSO IN SPANISH

## TEST ITEM LISTING

TEST ITEM LISTING  
The World of Science

SAMPLE

## MULTIPLE CHOICE

1. A variation of models is that
  - a. they are too complex to use.
  - b. they do not fit exactly like the things they model.
  - c. they are simpler than the things they model.
  - d. they model everything.
 Answer: c Difficulty: 1 Section: 3 Objective: 2
2. The length 10 m is equal to
  - a. 100 cm.
  - b. 100 mm.
  - c. 100 dm.
  - d. both (a) and (b).
 Answer: d Difficulty: 1 Section: 3 Objective: 2
3. To be valid, a hypothesis must be
  - a. testable.
  - b. supported by evidence.
  - c. made into a law.
  - d. both (a) and (b).
 Answer: d Difficulty: 1 Section: 3 Objective: 2
4. The statement "There is a stain on her shirt" is an example of (a)
  - a. fact.
  - b. hypothesis.
  - c. observation.
  - d. prediction.
 Answer: c Difficulty: 1 Section: 3 Objective: 2
5. A hypothesis is often developed out of
  - a. observations.
  - b. experiments.
  - c. laws.
  - d. both (a) and (b).
 Answer: d Difficulty: 1 Section: 3 Objective: 2
6. How many milliliters are in 0.5 L?
  - a. 500 mL.
  - b. 5,000 mL.
  - c. 50,000 mL.
  - d. 500,000 mL.
 Answer: a Difficulty: 1 Section: 3 Objective: 2
7. A map of Seattle is an example of a
  - a. law.
  - b. theory.
  - c. model.
  - d. unit.
 Answer: c Difficulty: 1 Section: 3 Objective: 2
8. A lab has the safety items shown below. These items mean that you should use
  - a. safety goggles and a lab apron.
  - b. safety goggles, a lab apron, and gloves.
  - c. safety goggles and gloves.
  - d. safety goggles and a lab apron.
 Answer: b Difficulty: 1 Section: 3 Objective: 2
9. The law of conservation of mass says the total mass before a chemical change is
  - a. more than the total mass after the change.
  - b. less than the total mass after the change.
  - c. the same as the total mass after the change.
  - d. not the same as the total mass after the change.
 Answer: c Difficulty: 1 Section: 3 Objective: 2
10. In which of the following areas might you find a geometer at work?
  - a. studying the chemistry of rocks.
  - b. studying the atmosphere.
  - c. studying the history of a city.
  - d. studying the structure of a building.
 Answer: d Difficulty: 1 Section: 3 Objective: 2

One-Stop  
Planner® CD-ROM

This CD-ROM includes all of the resources shown here and the following time-saving tools:

- Lab Materials QuickList Software
- Customizable lesson plans
- Holt Calendar Planner
- The powerful ExamView® Test Generator



## Meeting Individual Needs

### DIRECTED READING A

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_  
**Skills Worksheet**  
**Directed Reading A** SAMPLE

**Section:**  
**THAT'S SCIENCE!**  
 1. How did James Curlewski get his idea for the penguin boat, Proteus?

**ALSO IN SPANISH**

**BASIC**

### DIRECTED READING B

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_  
**Skills Worksheet**  
**Directed Reading B** SAMPLE

**Section:**  
**THAT'S SCIENCE!**  
 1. How did James Curlewski get his idea for the penguin boat, Proteus?

2. What is unusual about the way that Proteus moves through the water?

**SPECIAL NEEDS** PHYSICAL SCIENCE

### VOCABULARY ACTIVITY

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_  
**Activity**  
**Vocabulary Activity** SAMPLE

**Getting the Dirt on the Soil**  
 After you finish reading Chapter 10 (pages 1164), try this puzzle! Use the clues below to unscramble the vocabulary words. Write your answer in the space provided.

**GENERAL**

### VOCABULARY AND SECTION SUMMARY

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_  
**Skills Worksheet**  
**Vocabulary & Notes** SAMPLE

**Section:**  
**VOCABULARY**  
 In your own words, write a definition of the following term in the space provided.

1. scientific method

2. technology

**GENERAL**

**ALSO IN SPANISH**

### REINFORCEMENT

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_  
**Skills Worksheet**  
**Reinforcement** SAMPLE

**The Plane Truth**  
 Complete this worksheet after you finish reading the Section: [Unique Section Title]

**BASIC**

### CRITICAL THINKING

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_  
**Skills Worksheet**  
**Critical Thinking** SAMPLE

**A Solar Solution**  
 One of the great ideas for a new product called the Solar House. It's a portable, solar-powered space heater.

**ADVANCED**

### SCILINKS ACTIVITY

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_  
**Activity**  
**Scilinks Activity** SAMPLE

**MARINE ECOSYSTEMS**  
 Go to [www.scilinks.com](http://www.scilinks.com). To find links related to marine ecosystems, type in the keyword **MARINE**. Then, use the links to answer the questions about marine ecosystems.

**GENERAL**

### SCIENCE PUZZLERS, TWISTERS & TEASERS

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_  
**CHAPTER 10**  
**SCIENCE PUZZLERS, TWISTERS & TEASERS**  
**Bacteria and Viruses**

**Parallel Puzzles**  
 1. What do all the words in the left column have in common that is not shared by any of the words in the right column?

lyme disease AIDS  
 strep throat flu  
 leprosy common cold  
 tuberculosis polio

**GENERAL**

yogurt milk  
 cheese pudding  
 buttermilk cereal

## Labs and Activities

### ECOLABS & FIELD ACTIVITIES

Name \_\_\_\_\_ Date \_\_\_\_\_ Class \_\_\_\_\_  
**Field Activity**  
**2 STUDENT WORKSHEET**  
**Ditch's Brew**

Double double, toil and trouble  
 Compost helps diminish the trouble!  
 Veggie scraps, some grass, and leaves  
 Give strength that feeds our needs.  
 Wood chips, dry leaves, lint, and dust  
 Provide the carbon—that's a must!

Herbicides, plastic, ashes and mud—  
 don't use them for they're no good.  
 Worms, bugs, and plants desired  
 Are not what compost heaps will need.

Double double, toil and trouble  
 Compost helps cut up your rubbish!

**Objective**  
 Compost a variety of materials to learn how different microorganisms work together to break down organic matter.

**Compost Containers 101**  
 Decomposing organisms use the carbon and nitrogen in plants as nutrients. With the proper materials, the organisms will survive in a compost pile. You will collect materials to collect to add to a compost pile. Find out what materials to collect by reading the introduction and answering the questions below.

1. Which items can go into the compost pile?

2. Which items cannot go into the compost pile?

3. What is the perfect recipe for a compost pile?

**GENERAL**

### LONG-TERM PROJECTS & RESEARCH IDEAS

Name \_\_\_\_\_ Date \_\_\_\_\_ Class \_\_\_\_\_  
**PROJECT**  
**10 STUDENT WORKSHEET**  
**Bacteria to the Rescue!**

Imagine the alteration of a supermajor accident. The clear blue ocean turns a murky black. The sea floats with flames. Millions of liters of spilled oil threaten the lives of fish, birds, and other sea life. That microscopic organism—bacteria—may be able to solve them. Believe it or not, some bacteria eat oil like it was ice cream. Learn how the *Devilfish* and *Crudefish* love all sorts of oil and can actually make them disappear. Using bacteria to clean up pollution is called *bioremediation*.

**Keywords**  
 bioremediation  
 oil spill cleanup  
 ocean pollution

**An Oil Spill**  
 1. How does bioremediation work? In what situations does bioremediation work best? Which major oil spills has it been used? Is it more or less effective than more traditional cleanup methods? Are there disadvantages to using bioremediation? Ask your teacher to obtain copies of bacteria that are used to clean up oil spills, or to get an oil spill kit from a scientific supply house. Create a model oil spill and use the bacteria to clean the oil from the water. Summarize the effectiveness of this form of bioremediation in a paper, stating your criteria and supporting your claims.

**Other Long-Term Project Ideas**  
 2. Are you being exposed to more germs than you should be? Visit a restaurant and either a hospital or biology lab, and compare the procedures used for sanitation at each. Ask a staff member to demonstrate the steps taken to prevent the spread of bacteria and viruses. How are the sanitation standards different? Do you think that each institution's procedures are thorough enough? Prepare a display board that shows what you have learned.

3. Your drinking water may have been through bioremediation! Visit a water treatment plant that uses bioremediation in its processing. Interview the water treatment manager. Turn the plant, taking pictures or videotaping during your tour, and prepare a presentation or documentary to share your discoveries with the class.

**Research Idea**  
 4. The bacterial and viral diseases that Europeans brought to the Americas devastated Native American populations. Native Americans had never been exposed to these diseases, and therefore, they had no natural immunity. Write a historical account of the devastation of an American Indian community as a result of contact with foreign diseases.

**ADVANCED**

### INQUIRY LABS

Name \_\_\_\_\_ Date \_\_\_\_\_ Class \_\_\_\_\_  
**LAB**  
**3 STUDENT WORKSHEET**  
**It's an Invasion!**

Each day, your home is invaded by small, undetected, bizarre-looking life-forms. Are they bacteria? No, they're bacteria, and they're everywhere! While most bacteria are harmless, others can cause infection and illness. In this activity, you will seek out places in your home that are experiencing a "bacterial invasion."

**Materials**  
 1. 16 oz. bottle of dish soap  
 2. 16 oz. bottle of bleach

**Ask a Question**  
 1. Not including your bathroom, where do you expect to find the highest concentration of bacteria in your home?

**Make a Prediction**  
 1. Not including your bathroom, where do you expect to find the highest concentration of bacteria in your home?

**GENERAL**

### LABS YOU CAN EAT

Name \_\_\_\_\_ Date \_\_\_\_\_ Class \_\_\_\_\_  
**LAB**  
**4 STUDENT WORKSHEET**  
**Bacterial Buddies**

Many people think of bacteria as nasty and life-threatening, even though not all bacteria are harmful. In fact, some bacteria actually help us. Bacteria or not, people add bacteria to food to help preserve it.

Milk will spoil quickly if it is not refrigerated. Ancient cultures found a way to preserve milk without refrigeration. They used certain types of bacteria to ferment the milk and turn it into yogurt. These bacteria feed on sugar in the milk, producing lactic acid in the process. The acid helps to prevent the growth of other, harmful bacteria and gives yogurt its tangy taste.

In this lab, you will observe the fermentation of milk and the resulting change in acidity as some milk turns into yogurt.

**Materials**  
 1. 200 mL of natural milk

**GENERAL**

**Ask a Question**  
 1. How do some bacteria help to preserve milk by turning it into yogurt?

### DATASHEETS FOR QUICK LABS

Name \_\_\_\_\_ Date \_\_\_\_\_ Class \_\_\_\_\_  
**TEACHER RESOURCE PAGE**  
**Quick Lab** DATASHEET FOR QUICK LAB  
**Reaction to Stress** SAMPLE

**Background**  
 The graph below illustrates changes that occur in the membrane potential of a neuron during an action potential. Use the graph to answer the following questions. Refer to Figure 3 as needed.

**Does It All Add Up?**

**Teacher's Notes**  
 TIME REQUIRED  
 One 45-minute class period.

**Does It All Add Up?**

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 TIME REQUIRED  
 One 45-minute class period.

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**Teacher's Notes**  
 TIME REQUIRED  
 One 45-minute class period.

## Review and Assessments

### SECTION QUIZ

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_  
**Assessment**  
**Section Quiz** SAMPLE

**Section:**  
**Section Quiz**  
 In the space provided, write the letter of the description that best matches the term or phrase.

1. Building molecules that can be used as an energy source, or breaking down molecules in which energy is stored.

2. The process by which light energy is converted to chemical energy.

3. An organism that uses sunlight or inorganic substances to make organic compounds.

**GENERAL**

**ALSO IN SPANISH**

### SECTION REVIEW

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_  
**Skills Worksheet**  
**Section Review** SAMPLE

**Section:**  
**KEY TERMS**  
 1. What do photosynthetic plants do?

2. How does a trace fossil differ from a body fossil?

**GENERAL**

**ALSO IN SPANISH**

### CHAPTER REVIEW

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_  
**Skills Worksheet**  
**Chapter Review** SAMPLE

**USING VOCABULARY**  
 1. Define home in your own words.

2. Describe the characteristics of a tsunami and a drought.

**GENERAL**

**ALSO IN SPANISH**

### CHAPTER TEST A

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_  
**Assessment**  
**Chapter Test A** SAMPLE

**MULTIPLE CHOICE**  
 In the space provided, write the letter of the term or phrase that best completes each statement or best answers each question.

1. Surface currents are formed by

a. the moon's gravity. b. the sun's gravity. c. wind. d. increased water density.

2. When waves come near the shore,

a. they speed up. b. they maintain their speed. c. they wave up. d. they wave down.

3. Longshore currents transport sediment

a. out to the open ocean. b. only during low tide. c. only during high tide. d. only during the summer.

4. Which of the following does NOT control surface currents?

**GENERAL**

**ALSO IN SPANISH**

### CHAPTER TEST B

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_  
**Assessment**  
**Chapter Test B** SAMPLE

**MULTIPLE CHOICE**  
 In the space provided, write the letter of the term or phrase that best completes each statement or best answers each question.

1. Surface currents are formed by

a. the moon's gravity. b. the sun's gravity. c. wind. d. increased water density.

2. When waves come near the shore,

a. they speed up. b. they maintain their speed. c. they wave up. d. they wave down.

3. Longshore currents transport sediment

a. out to the open ocean. b. only during low tide. c. only during high tide. d. only during the summer.

4. Which of the following does NOT control surface currents?

**ADVANCED**

### CHAPTER TEST C

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_  
**Assessment**  
**Chapter Test C** SAMPLE

**MULTIPLE CHOICE**  
 In the space provided, write the letter of the term or phrase that best completes each statement or best answers each question.

1. Surface currents are formed by

a. the moon's gravity. b. the sun's gravity. c. wind. d. increased water density.

2. When waves come near the shore,

a. they speed up. b. they maintain their speed. c. they wave up. d. they wave down.

3. Longshore currents transport sediment

a. out to the open ocean. b. only during low tide. c. only during high tide. d. only during the summer.

4. Which of the following does NOT control surface currents?

**SPECIAL NEEDS**

### STANDARDIZED TEST PREPARATION

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_  
**Assessment**  
**Standardized Test Preparation** SAMPLE

**READING**  
 Read the passages below. Then, read each question that follows the passage. Decide which is the best answer to each question.

**Passage 1** A television news anchor in the world. Billy can't

to lead for the outdoors. Billy checked the recommended

light, light, summer clothes, sneakers, rain gear, heavy

an fitted jacket, ski mask, and thick gloves. What a mistake! Billy

thought he was heading to only one destination, so why does he

need to bring such a wide variety of clothes? To further investigate,

**GENERAL**

### PERFORMANCE-BASED ASSESSMENT

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_  
**Assessment**  
**Performance-Based Assessment** SAMPLE

**OBJECTIVE**  
 Determine which factors cause some sugar cubes to break down faster than others.

**KNOW THE SCORE**  
 As you work through the activity, keep in mind that you will be earning a grade for the following:

• how you form and test the hypothesis (30%)

• the quality of your analysis (40%)

• the clarity of your conclusions (30%)

**Using Scientific Methods**

**TESTIONS**  
 How sugar cubes break down more rapidly than others?

**MATERIALS AND EQUIPMENT**  
 • 1 regular sugar cube • 50 mL of water

**GENERAL**

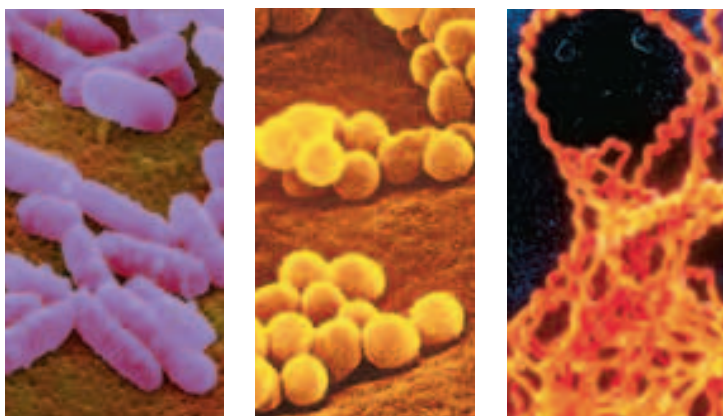
*This Chapter Enrichment provides relevant and interesting information to expand and enhance your presentation of the chapter material.*

## Section 1

### Bacteria and Archaea

#### Domains of Prokaryotes

- The classification of living things is an ever-changing process. This book uses a three-domain system of classification. Prokaryotes are divided into two domains: Bacteria and Archaea. In five-kingdom systems of classification, all prokaryotes are classified in the kingdom Monera.
- Bacteria are sometimes classified by shape or by how they live (for example, *saprophytes* decompose dead matter and *symbionts* live on or in living matter). Many are also classified as Gram positive or Gram negative. Gram-positive bacteria have a thick peptidoglycan cell wall that appears purple when stained with crystal violet, iodine, and safranin. Gram-negative bacteria have a much thinner peptidoglycan cell wall, as well as additional layers of lipids and polysaccharides not found in gram-positive cells. Gram-negative bacteria appear red when stained with the same combination of dyes.



#### Mistaken Identity

- Cyanobacteria were once classified as blue-green algae because they use photosynthesis and sometimes grow together in long filaments that resemble algae. However, cyanobacteria are prokaryotes, which do not have nuclei or membrane-bound organelles. Blue-green algae, in contrast, are eukaryotes, which have nuclei and membrane-bound organelles.

## Section 2

### Bacteria's Role in the World

#### Bacteria and Plants

- When the nitrogen-fixing bacteria *Rhizobium* enters a plant's roots, it forms a nodule. *Rhizobium* inhabits only the roots of legumes, which include beans, peas, soybeans, alfalfa, clover, peanuts, and vetch.
- One example of the effective biological control of insects involves the bacteria *Bacillus thuringiensis*. When ingested by leaf-eating insects, the bacteria begin to secrete enzymes that dissolve the insects' digestive system. Within 24 hours after ingesting the bacteria, the insect stops eating and dies.

#### Is That a Fact!

- ◆ Bacteria are used in a number of industrial applications. They can peel and eat the paint off old aircraft. Bacteria are also being used to remove the sulfur from coal before it is burned, which helps reduce acid rain.

#### Poison Producers

- Botulism, a type of food poisoning, is caused by a toxin produced by the bacteria *Clostridium botulinum*. Consumption of very small amounts—sometimes as little as one-millionth of a gram—can cause paralysis and eventually death. *C. botulinum* grows in foods that have been improperly canned and sterilized.
- The intestinal disorder that many travelers refer to as traveler's diarrhea is frequently caused by a strain of the common intestinal bacteria *Escherichia coli*, commonly called *E. coli*. In many countries, contraction of the disease can be avoided by not drinking tap water and by not eating uncooked fruits and vegetables.

#### Is That a Fact!

- ◆ The water droplets in the air produced in a sneeze can carry between 10,000 and 100 million bacteria. The bacteria that cause whooping cough, tuberculosis, diphtheria, and scarlet fever can be carried through the air from one person to another on droplets such as these.



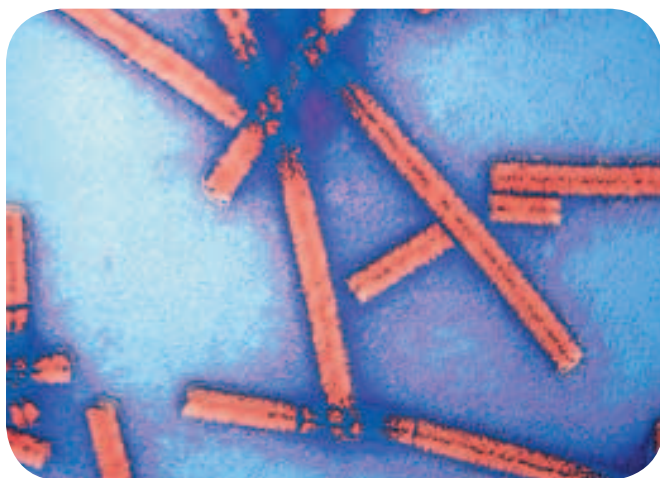


## Section 3

### Viruses

#### The Discovery of Viruses

- Viruses were discovered when scientists were trying to find the cause of tobacco mosaic disease, a disease in which the leaves of tobacco plants become wrinkled, blotchy, and yellow and have stunted growth.



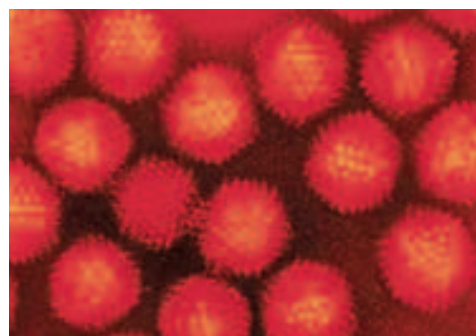
- In 1883, a German scientist named Adolf Mayer discovered that tobacco mosaic disease was contagious, and he suspected that “very small” bacteria caused the disease. Russian biologist Dmitri Ivanovsky tested Mayer’s hypothesis in 1892. Ivanovsky passed the liquid from a diseased plant through extremely fine filters to isolate the small bacteria. He found no bacteria but discovered that the filtered sap from an infected plant caused the disease in a healthy plant. He concluded that “poison” from the bacteria was the cause of the disease. In 1897, Dutch biologist Martinus Beijernick discovered that the disease-causing agent was something smaller and simpler than bacteria. In 1898, Beijernick used the word *virus* to describe these tiny disease-causing agents.
- American biochemist Wendell Stanley (1904–1971) first isolated the tobacco mosaic virus in 1935. He treated the sap from infected plants in such a way that the viruses formed needle-shaped crystals. When Stanley spread the crystals from the diseased plant onto the leaves of a healthy plant, the healthy plant developed the disease. Even though Stanley isolated and chemically analyzed viruses in 1935, viruses were not seen until 1940, when the electron microscope was invented.

### Smallpox

- Vaccines eliminated smallpox infections from the world. Smallpox causes permanent disfigurement and, in many cases, death. The use of smallpox vaccines began in the 1700s and rapidly spread in industrialized countries around the world.
- Some of the smallpox virus still exists in labs around the world, and there is debate over whether this virus should be eliminated completely so that it could never be used for the purposes of bioterrorism. However, many scientists and health officials hesitate to destroy the virus completely because if any were to escape, the disease would be much harder to control without the laboratory stock of the virus.

#### Is That a Fact!

- A man named Ali Maow Maalin of Merka, Somalia, contracted the last known naturally occurring case of smallpox in the world in 1977.



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Topic: **Bacteria**  
SciLinks code: **HSM0133**

Topic: **Genetic Engineering**  
SciLinks code: **HSM0654**

Topic: **Archaeobacteria**  
SciLinks code: **HSM0091**

Topic: **Viruses**  
SciLinks code: **HSM1607**

Topic: **Antibiotics**  
SciLinks code: **HSM0082**



## Overview

Tell students that this chapter will help them learn about bacteria and viruses. The chapter discusses the characteristics of bacteria, three types of archaeobacteria, and bacteria's role in the world. Finally, the chapter describes viruses, how they are classified, how they reproduce, and how they are treated.

## Assessing Prior Knowledge

Students should be familiar with the following topics:

- cells
- classification

## Identifying Misconceptions

Students may be confused by the idea that viruses are not considered living organisms by many scientists. Help them understand the characteristics of living things—living things have cells, they sense and respond to change, they reproduce, they have DNA, they use energy, and they grow and develop. Then, explain to students that viruses do not meet all of these criteria. For example, viruses do not grow, and they cannot reproduce on their own. Viruses must use the living cells of other organisms to reproduce. A simple way to think of viruses is that they are capsules filled with genetic material.

# Bacteria and Viruses

## The Big Idea

Bacteria, archaea, and viruses can play important roles in the environment and human health.

### SECTION

- 1 Bacteria and Archaea ..... 246
- 2 Bacteria's Role in the World ..... 252
- 3 Viruses ..... 256

### About the



Bacteria are everywhere. Some provide us with medicines, and some make foods we eat. Others, such as the one pictured here, can cause illness. This bacterium is a kind of *Salmonella*, and it can cause food poisoning. *Salmonella* can live inside chickens and other birds. Cooking eggs and chicken properly helps make sure that you don't get sick from *Salmonella*.

## PRE-READING ACTIVITY

### FOLDNOTES

**Double Door** Before you read the chapter, create the FoldNote entitled "Double Door" described in the **Study Skills** section of the Appendix. Write "Bacteria" on one flap of the double door and "Viruses" on the other flap. As you read the chapter, compare the two topics, and write characteristics of each on the inside of the appropriate flap.



## Standards Correlations

### National Science Education Standards

The following codes indicate the National Science Education Standards that correlate to this chapter. The full text of the standards is at the front of the book.

#### Chapter Opener

UCP 2; SAI 1; LS 1b, 1c, 2a, 3a, 3b, 4b

#### Section 1 Bacteria and Archaea

UCP 1, 3, 5; SAI 1; LS 1b, 1c, 2a, 3a, 3b, 4b

#### Section 2 Bacteria's Role in the World

UCP 2, 3, 4, 5; ST 1, 2; SPSP 5; HNS 3; LS 1f

### Section 3 Viruses

UCP 1, 2, 5; SAI 1, 2; SPSP 4, 5; LS 1f, 2a

#### Chapter Lab

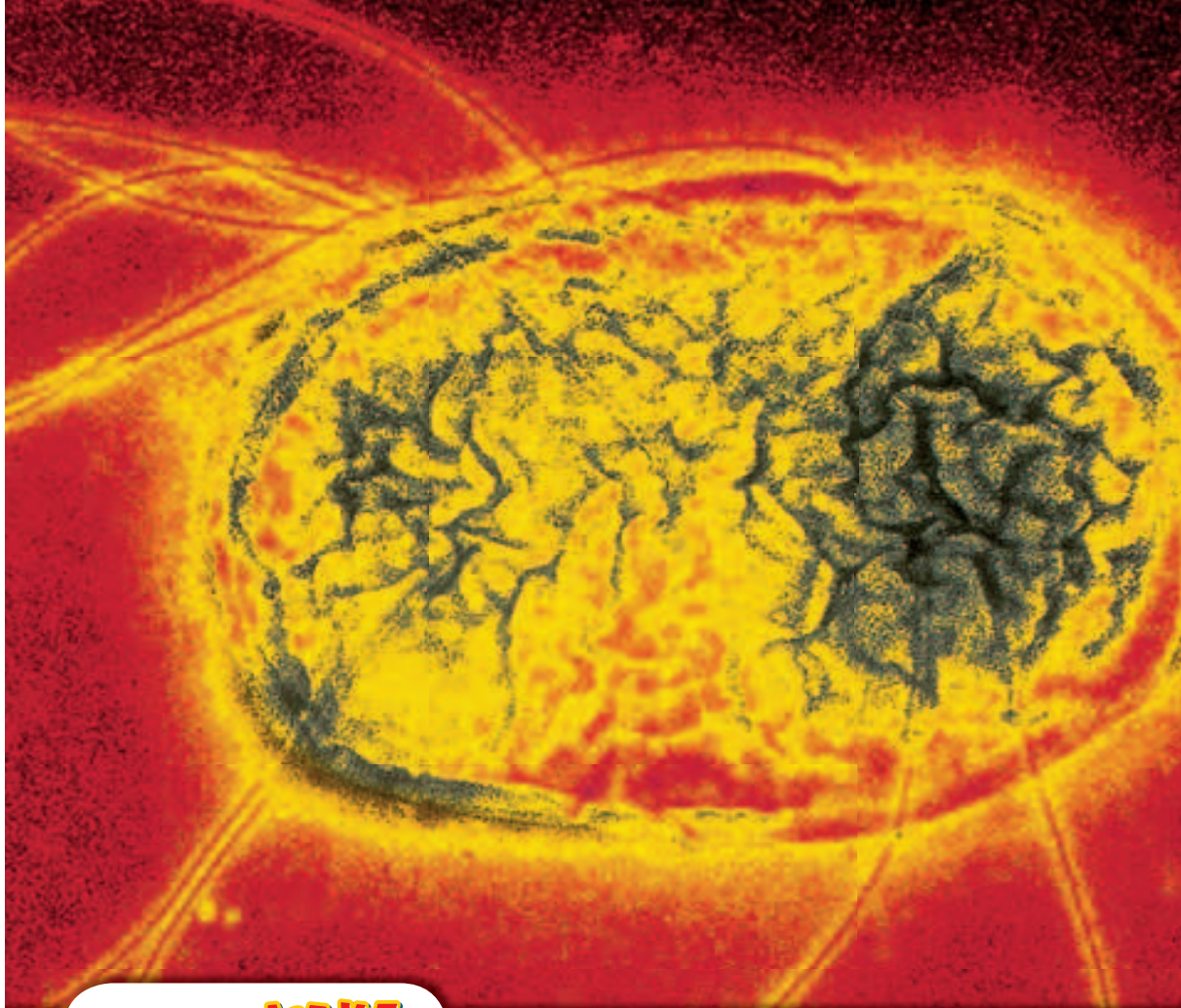
UCP 2; SAI 1, 2; LS 1c

#### Chapter Review

UCP 1, 2, 3, 4, 5; SAI 1, 2; ST 1, 2; SPSP 4, 5; HNS 3; LS 1b, 1c, 1f, 2a, 3a, 3b, 4b

#### Science in Action

SAI 2; SPSP 5; HNS 1, 2, 3



## START-UP Activity

### Our Constant Companions

Bacteria are in the soil, in the air, and even inside your body. When grown in a laboratory, microscopic bacteria form colonies that you can see. In this activity, you will observe some of the bacteria that share your world.

#### Procedure

1. Get **three plastic Petri dishes containing nutrient agar** from your teacher. Label one dish "Hand," another "Breath," and another "Soil."
2. Wipe your finger across the agar in the dish labeled "Hand." Breathe into the dish labeled "Breath." Place a **small amount of soil** in the dish labeled "Soil."



3. Secure the Petri dish lids with **transparent tape**. Wash your hands. Keep the dishes upside down in a warm, dark place for about one week. **Caution:** Do not open the Petri dishes after they are sealed.
4. Observe the Petri dishes each day. What do you see? Record your observations.

#### Analysis

1. How does the appearance of the colonies growing on the agar in each dish differ? What do bacterial colonies look like?
2. Which source caused the most bacterial growth—your hand, your breath, or the soil? Why do you think this source caused the most growth?

## START-UP Activity

### MATERIALS

#### FOR EACH GROUP

- Petri dishes, plastic, filled with nutrient agar (3)
- soil
- tape, transparent

**Safety Caution:** Plastic dishes are safer than glass dishes.

**Teacher's Notes:** Prepoured agar plates can be purchased from a biological supply house.

To minimize the risk of contamination from airborne bacteria, have students lift the Petri dish lids only slightly when treating the agar. Do not allow students to open the Petri dishes after the dishes have been inoculated and sealed.

Tell students to label the Petri dishes on the bottom rather than the lid, because lids can easily be switched.

### Answers

1. Answers may vary, but students should mention color differences, variations in colony shapes and sizes, and differing amounts of growth.
2. Answers may vary. Most likely, the Petri dish that is exposed to soil will have the most bacterial growth.

Bacteria and Viruses
CHAPTER STARTER

**Imagine . . .**

It was a dark and stormy night—the kind of night where bizarre things happen. Suzanne sat quietly in her bedroom reading her science book. She tried to concentrate, but the constant patter of rain against her window soon lulled her to sleep.

Thunder roared through the air. Suzanne looked down at her hands and

Suzanne woke with a start. What a strange dream! Were these creatures real? Then she remembered what she had just read in her science book. The things she had dreamed about were called bacteria and viruses. Bacteria and viruses are all around Suzanne, just as they are all around you. They are in the air you breathe and the food you eat. They are inside your body

**Chapter Starter Transparency**  
Use this transparency to help students begin thinking about bacteria and viruses.

## CHAPTER RESOURCES

### Technology

- Transparencies**
  - Chapter Starter Transparency
- Student Edition on CD-ROM**
- Guided Reading Audio CD**
  - English or Spanish
- Classroom Videos**
  - Brain Food Video Quiz

**READING SKILLS**

### Workbooks

- Science Puzzlers, Twisters & Teasers**
  - Bacteria and Viruses **GENERAL**



## Focus

## Overview

This section introduces students to bacteria. Students will compare bacteria and archaea. They will distinguish between bacterial producers and consumers. Finally, students will describe the three main groups of archaea.

## Bellringer

Pose the following questions to your students:

- What are the two domains of single-celled organisms without a nucleus? (**Bacteria and Archaea**)
- What are three shapes of bacteria? (**bacilli, cocci, and spirilla**)

## Motivate

## Discussion

GENERAL

**Types of Cells** Ask students, “What is the difference between eukaryotic and prokaryotic cells?” (**Prokaryotic cells don’t have a nucleus, and eukaryotic cells do have a nucleus.**) “Are bacteria prokaryotes or eukaryotes?” (**prokaryotes**) Remind students that prokaryotic cells are usually much smaller than eukaryotic cells. **Verbal**

## Answer to Reading Check

Bacteria are usually one of three main shapes: bacilli, cocci, or spirilla.

## What You Will Learn

- Describe the characteristics of prokaryotes.
- Explain how prokaryotes reproduce.
- Relate the characteristics of archaea.

## Vocabulary

prokaryote  
binary fission  
endospore

## READING STRATEGY

**Prediction Guide** Before reading this section, predict whether each of the following statements is true or false:

- There are only a few kinds of bacteria.
- Most bacteria are too small to see.

## Bacteria and Archaea

How many bacteria are in a handful of soil? Would you believe that a single gram of soil—which is about the mass of a pencil eraser—may have more than 2.5 billion bacteria? A handful of soil may contain trillions of bacteria!

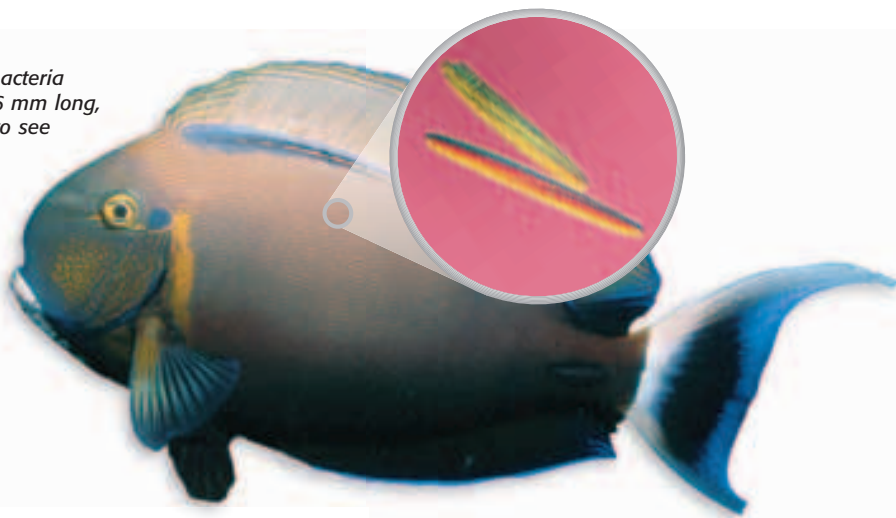
All living things fit into one of three domains: Bacteria, Archaea, or Eukarya. The domains Bacteria and Archaea consist of single-celled organisms that do not have a nucleus. Members of the domain Bacteria live in soil, water, and other organisms. The domain Archaea includes organisms that are found in extreme environments, such as hot springs. These two domains consist of the oldest forms of life on Earth.

## Some Characteristics of Bacteria and Archaea

There are more bacteria on Earth than there are all other living things combined. Most bacteria are too small to be seen without a microscope. But not all bacteria are the same size. In fact, the largest known bacteria are 1,000 times as large as the average bacterium. One of these types of giant bacteria was found inside a surgeonfish and is shown in **Figure 1**. Members of the domain Bacteria are usually one of three main shapes: rod shaped, spherical, and spiral shaped.

**Reading Check** What are the three shapes of bacteria? (See the Appendix for answers to Reading Checks.)

**Figure 1** The giant bacteria inside this fish are 0.6 mm long, which is big enough to see without a microscope.



## CHAPTER RESOURCES

## Chapter Resource File

- Lesson Plan
- Directed Reading A **BASIC**
- Directed Reading B **SPECIAL NEEDS**

## Technology

- Transparencies
  - Bellringer
  - L34 The Most Common Shapes of Bacteria

## Workbooks

- Interactive Textbook **Struggling Readers**

## Answer to Reading Strategy

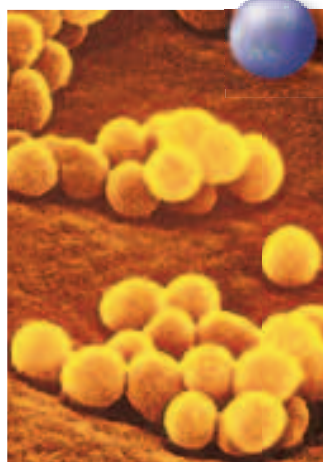
- false; There are more types of bacteria on Earth than all other living things combined.
- true; Most bacteria can only be seen with a microscope.



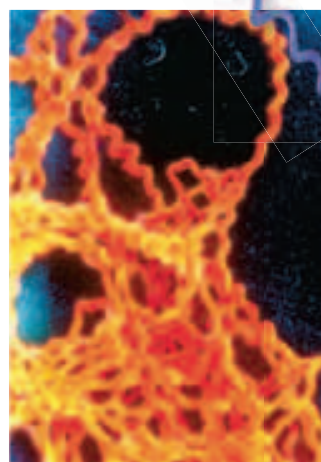
**Figure 2** The Most Common Shapes of Bacteria



**Bacilli** (buh SIL iE) are rod shaped. They have a large surface area, which helps them take in nutrients. But a large surface area can cause them to dry out easily.



**Cocci** (KAHK siE) are spherical. They do not dry out as quickly as rod-shaped bacteria.



**Spirilla** (spie RIL uh) are long and spiral shaped. They use flagella at both ends to move like a corkscrew.

### The Shape of Bacteria

Most bacteria have a rigid cell wall that gives them their shape. **Figure 2** shows the three most common shapes of bacteria. Bacilli (buh SIL iE) are rod shaped. Cocci (KAHK siE) are spherical. Spirilla (spie RIL uh) are long and spiral shaped. Each shape helps bacteria in a different way.

Some bacteria have hairlike parts called *flagella* (fluh JEL uh) that help them move around. Flagella spin to push a bacterium through water or other liquids.

### No Nucleus!

All bacteria and archaea are single-celled organisms that do not have a nucleus. An organism that does not have a nucleus is called a **prokaryote** (proh KAR ee OHT). A prokaryote is able to move, get energy, and reproduce like cells that have a nucleus, which are called *eukaryotes* (yoo KAR ee OHTZ).

Prokaryotes function as independent organisms. Some bacteria stick together to form strands or films, but each bacterium is still functioning as a single organism. Most prokaryotes are much simpler and smaller than eukaryotes. Prokaryotes also reproduce differently than eukaryotes do.

**prokaryote** an organism that consists of a single cell that does not have a nucleus

### Quick Lab

#### Spying on Spirilla

1. Using a **microscope**, observe prepared **slides of bacteria**. Draw each type of bacteria you see.
2. What different shapes do you see? What are these shapes called?

## Teach

### Homework

ADVANCED



#### Bacterial Cell Walls

Have students research the differences in cell-wall structure between gram-positive and gram-negative bacteria. Students should identify how the structures differ and how each type of bacteria can be identified using microscopic staining techniques. They should also research how the differences in cell-wall structure relate to the type of antibiotic used to fight infections. Have students write a report about their findings. **LS Verbal**

### Quick Lab

#### MATERIALS

##### FOR EACH GROUP

- microscope
- prepared slides of bacteria

**Safety Caution:** Caution students to be careful when handling microscope slides.

#### Answer

2. Students should see rod-shaped, spherical, and spiral-shaped bacteria. These bacteria are called *bacilli*, *cocci*, and *spirilla*.

### INCLUSION Strategies

- Visually Impaired
- Developmentally Delayed
- Learning Disabled

Some students may still be confused about the shape of bacteria even after they read that bacteria are rod shaped, spherical, and spiral shaped. Use marbles, cylinder-shaped candies, and rotini pasta to help students understand the three common shapes of bacteria.

**LS Kinesthetic**

English Language Learners

### WEIRD SCIENCE

Bacteria called *Thiobacillus ferrooxidans* are used to mine copper from copper ore. Copper ore contains metal sulfides. The bacteria take in copper sulfides and separate them into copper and sulfur. The bacteria excrete the purified copper as a waste product.

## SUPPORT FOR

### English Language Learners

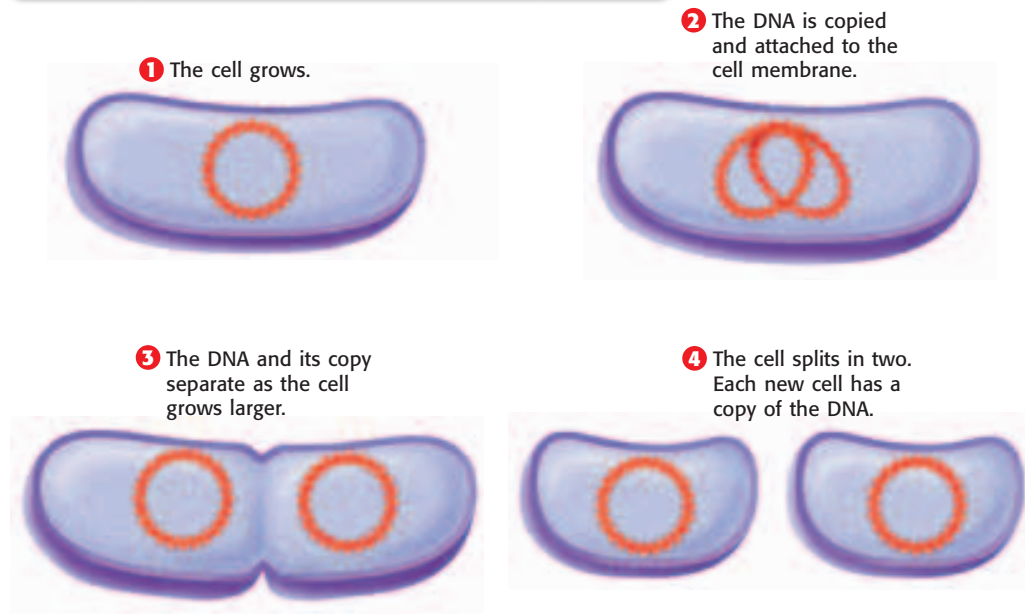
**Binary Fission** Students will need help combining the information in the diagram on this page with the content on binary fission. Before beginning this activity, check to be sure that students understand the basic meaning of binary (*dual or double*). After students have read the page and studied the diagram, review it with them orally. Ask students to discuss what takes place at each stage of the process in their own words. Remind them to use information from the text, not just the diagram itself, and point out the important structures involved. Call on students to ensure full participation.

**LS Visual/Verbal**

## CONNECTION *Activity* Math GENERAL

**Bacterial Reproduction** Some species of bacteria undergo binary fission every 30 min. If they began with one bacterium, have students calculate how many bacteria there would be after 1 h (4 bacteria), after 2 h (16 bacteria), after 3 h (64 bacteria), after 4 h (256 bacteria), and after 5 h (1,024 bacteria). **LS Logical**

**Figure 3** Binary Fission



**binary fission** a form of asexual reproduction in single-celled organisms by which one cell divides into two cells of the same size



### Prokaryote Reproduction

Prokaryotes reproduce by the process shown in **Figure 3**. This process is called binary fission (BIE nuh ree FISH uh). **Binary fission** is reproduction in which one single-celled organism splits into two single-celled organisms.

Prokaryotes have no nucleus, so their DNA is not surrounded by a membrane. The DNA of prokaryotes is in circular loops. In the first step of binary fission, the cell's DNA is copied. The DNA and its copy then bind to different places on the inside of the cell membrane. As the cell and its membrane grow bigger, the loops of DNA separate. Finally, when the cell is about double its original size, the membrane pinches inward as shown in **Figure 4**. A new cell wall forms and separates the two new cells. Each new cell has one exact copy of the parent cell's DNA.

**✓ Reading Check** What is binary fission?

**Figure 4** This bacterium is about to complete binary fission.

## CHAPTER RESOURCES

### Technology



#### Transparencies

- L35 Binary Fission
- **LINK TO PHYSICAL SCIENCE** P47 Parts of an Atom

### Answer to Reading Check

Binary fission is a process of cell division in which one cell splits into two. All prokaryotes reproduce by binary fission.

## Endospores

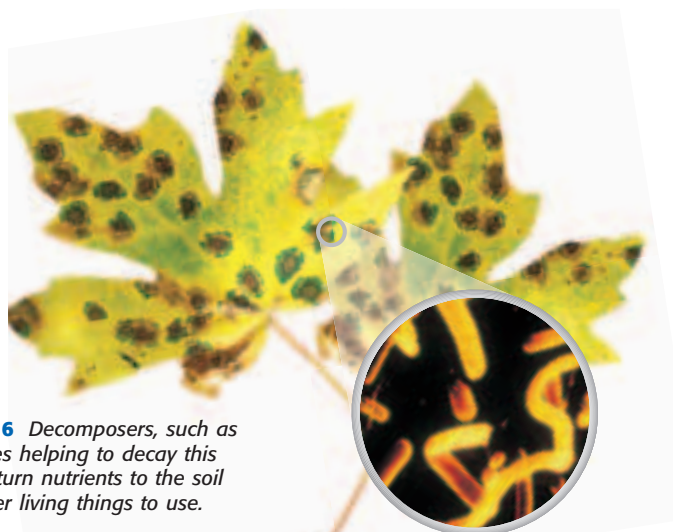
Most species of bacteria do well in warm, moist places. In dry or cold surroundings, some species of bacteria will die. In these conditions, other bacteria become inactive and form endospores (EN doh SPAWRZ). An **endospore** contains genetic material and proteins and is covered by a thick, protective coat. Many endospores can survive in hot, cold, and very dry places. When conditions improve, the endospores break open, and the bacteria become active again. Scientists found endospores inside an insect that was preserved in amber for 30 million years. When the endospores were moistened in a laboratory, bacteria began to grow! A similar piece of amber can be seen in **Figure 5**.

## The Domain Bacteria

Most known prokaryotes are bacteria. The domain Bacteria has more individuals than all other domains combined do. Scientists think that bacteria have lived on Earth for more than 3.5 billion years.

## Classification of Bacteria

Bacteria are classified in part by the way they get food. Most bacteria, such as those breaking down the leaf in **Figure 6**, are consumers. Consumers get their food by eating other organisms. Many bacteria are decomposers, which feed on dead organisms. Other bacterial consumers live in or on the body of another organism. Bacteria that make their own food are called *producers*. These bacteria use energy from sunlight to make food and are often green.



**Figure 6** Decomposers, such as the ones helping to decay this leaf, return nutrients to the soil for other living things to use.



**Figure 5** Endospores found in a preserved insect like this one showed scientists that bacteria can survive for millions of years.

**endospore** a thick-walled protective spore that forms inside a bacterial cell and resists harsh conditions



## Largest Species of Bacteria

*Thiomargarita namibiensis* is a bacterial species so large that an individual bacterium is visible to the naked eye. It is the largest known bacterium, with cells as large as 750  $\mu\text{m}$  (0.03 in.) in diameter. Even large bacteria are single-celled organisms, and their surface-area-to-volume ratio is far less than that of smaller bacteria. Ask students, “What problems might a small surface-area-to-volume ratio cause in an organism?”

(A small surface-area-to-volume ratio makes it difficult to take in a sufficient quantity of nutrients and to eliminate wastes efficiently.)

## ACTiViTy

GENERAL

**Bacteria in the Air** Tell students that air typically has around 4,000 bacteria per cubic meter. Ask students to measure the dimensions of your classroom and then calculate the number of bacteria in the air of the classroom. (Answers may vary depending on the size of the classroom. Students should measure the length, width, and height of the classroom in meters and then calculate the volume of the classroom. The volume of the classroom in cubic meters multiplied by 4,000 will give the number of bacteria in the air of the classroom.) You may want to point out that not all bacteria cause diseases and that our bodies have many defenses to protect us from harmful bacteria. **LS Logical**

## CONNECTION to Physical Science—ADVANCED

**Breaking It Down** We often try to understand the size of bacteria by comparing them to bigger things. However, comparing them to smaller components may also be helpful. Use the teaching transparency entitled “Parts of an Atom” to give students another way to understand the size of bacteria. **LS Verbal**



## Close

### Reteaching

BASIC

**Bacterial Trivia** Have the class work in two teams, and provide each team with 10 large index cards. Have each team look through this section and write 10 questions, one per index card, about the characteristics of bacteria. Bring the teams together to play a trivia game about bacteria.

LS Verbal Co-op Learning

### Quiz

GENERAL

1. How are prokaryotes different from eukaryotes? (**Prokaryotes lack a nucleus, are smaller and simpler than eukaryotes, and reproduce in a different way from eukaryotes.**)
2. What are the three main types of archaea? (**methane makers, heat lovers, and salt lovers**)

### Alternative Assessment

GENERAL

**Concept Mapping** After students read this section, have them create a concept map using the following terms: *bacteria, archaea, prokaryotes, nucleus, binary fission, endospore, eukaryotes, and harsh environments.* LS Logical

### CONNECTION TO Language Arts

**Colorful Names** *Cyanobacteria* means "blue bacteria." Many other names also refer to colors. You might not recognize these colors because the words for the colors are in another language. Look at the list of Greek color words below. Write down two English words that have one of the color roots in them. (Hint: Many words have the color as the first part of the word.)

*melano* = black

*chloro* = green

*erythro* = red

*leuko* = white

### Cyanobacteria

*Cyanobacteria* (SIE uh noh bak TIR ee uh) are producers. Cyanobacteria usually live in water. These bacteria contain the green pigment chlorophyll. Chlorophyll is important to photosynthesis (the process of making food from the energy in sunlight). Many cyanobacteria have other pigments as well. Some have a blue pigment that helps in photosynthesis. This pigment gives those cyanobacteria a blue tint. Other cyanobacteria have red pigment. Flamingos get their pink color from eating red cyanobacteria.

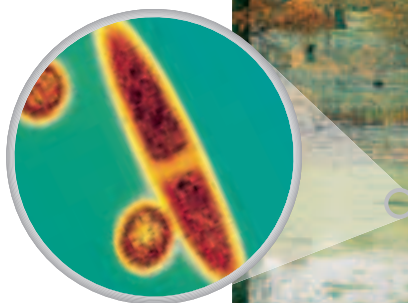
Some scientists think that billions of years ago, bacteria similar to cyanobacteria began to live inside larger cells. According to this theory, the bacteria made food, and the cells provided protection. This combination may have given rise to the first plants on Earth.

### The Domain Archaea

The three main types of archaea are *heat lovers*, *salt lovers*, and *methane makers*. Heat lovers live in ocean vents and hot springs. They live in very hot water, usually from 60°C to 80°C, but they can survive temperatures of more than 250°C. Salt lovers live in environments that have high levels of salt, such as the Dead Sea and Great Salt Lake. Methane makers give off methane gas and live in swamps and animal intestines.

**Figure 7** shows one type of methane maker found in the mud of swamps.

**Figure 7** These archaea are methane makers. This micrograph shows two archaea sliced across their narrow side and a dividing archaean sliced lengthwise.



### Answer to Connection to Language Arts

Sample answer:

- *melano*: melanoma (dark-colored skin cancer), melanin (pigment that makes skin dark)
- *chloro*: chlorophyll (green pigment found in photosynthetic organisms), chloroplast (in plants, organelle that contains chlorophyll)
- *erythro*: erythrocyte (red blood cell), erythroblast (cells in bone marrow from which red blood cells form)
- *leuko*: leukocyte (white blood cell), leukemia (a disease that causes an overproduction of white blood cells)

## Harsh Environments

Archaea often live where nothing else can. Most archaea prefer environments where there is little or no oxygen. Scientists have found them in the hot springs at Yellowstone National Park and beneath 430 m of ice in Antarctica. Archaea have even been found living 8 km below the Earth's surface! Even though they are often found in these harsh environments, many archaea can also be found in moderate environments in Earth's oceans.

Archaea are very different from bacteria. Not all archaea have cell walls. When they do have them, the cell walls are chemically different from those of bacteria.

## INTERNET ACTIVITY

For another activity related to this chapter, go to [go.hrw.com](http://go.hrw.com) and type in the keyword **HL5VIRW**.

## SECTION Review

### Summary

- Bacteria and archaea are prokaryotes, which are single-celled organisms that lack a nucleus.
- Most bacteria have a cell wall. The main shapes of bacteria are rod shaped, spherical, and spiral shaped.
- Prokaryotes reproduce by binary fission. In binary fission, one cell divides into two cells.
- Bacteria are classified in part by the way that they get food. Consumers eat other organisms. Producers can make their own food.
- Archaea live in harsh environments. The three main types of archaea are heat lovers, salt lovers, and methane makers.

### Using Key Terms

The statements below are false. For each statement, replace the underlined term to make a true statement.

1. Bacteria are eukaryotes.
2. Bacteria reproduce by primary fission.

### Understanding Key Ideas

3. The structure that helps some bacteria survive harsh conditions is called a(n)
  - a. endospore.
  - b. shell.
  - c. exospore.
  - d. exoskeleton.
4. How are bacteria and archaea different?
5. Draw and label the four stages of binary fission.
6. Describe one advantage of each shape of bacteria.
7. What two things do producer bacteria and plants have in common?

### Math Skills

8. An ounce (oz) is equal to about 28 g. If 1 g of soil contains 2.5 billion bacteria, how many bacteria are in 1 oz of soil?

### Critical Thinking

9. **Applying Concepts** Many bacteria cannot reproduce in cooler temperatures and are destroyed at high temperatures. How do humans take advantage of this fact when preparing and storing food?
10. **Making Comparisons** Scientists are studying cold and dry environments on Earth that are like the environment on Mars. What kind of prokaryotes do you think they might find in these environments on Earth? Explain.
11. **Forming Hypotheses** You are studying a lake and the prokaryotes that live in it. What conditions of the lake would you measure to form a hypothesis about the kind of prokaryotes that live in the lake?

SciLINKS

Developed and maintained by the  
National Science Teachers Association

For a variety of links related to this chapter, go to [www.scilinks.org](http://www.scilinks.org)

Topic: Bacteria  
SciLinks code: HSM0133

## Answers to Section Review

1. prokaryotes
2. binary fission
3. a
4. Sample answer: Archaea do not always have cell walls, and when they do, the cell walls are different from those of bacteria. Also, archaea often live where nothing else can live.
5. Students' drawings should show four basic stages: the cell grows, the DNA is copied and attached to the cell membrane, the DNA and its copy separate as the cell grows larger, and the cell splits in two.
6. Sample answer: Bacilli have a large surface area, which helps them take in nutrients. Cocci do not dry out as quickly as bacilli. Spirilla can move easily.
7. Sample answer: Like plants, producer bacteria use sunlight to make their own food. Like most plants, many of these bacteria are green.
8. 70 billion bacteria;  $(28 \text{ g} \times 2,500,000,000 \text{ bacteria/g} = 70,000,000,000 \text{ bacteria})$
9. Sample answer: Humans store food in a refrigerator or freezer, which keeps bacteria from reproducing. Humans also cook many foods, which destroys bacteria that might be living in the uncooked food.
10. Sample answer: They will probably find archaea because archaea can live in harsh environments such as those found on Mars.
11. Sample answer: I would measure the level of salt, methane, and the temperature of the lake to form a hypothesis about what kind of prokaryotes might live in the lake.

## CHAPTER RESOURCES

### Chapter Resource File

- Section Quiz **GENERAL**
- Section Review **GENERAL**
- Vocabulary and Section Summary **GENERAL**
- Reinforcement Worksheet **BASIC**
- SciLinks Activity **GENERAL**
- Datasheet for Quick Lab

## Focus

## Overview

This section explains how life on Earth depends on bacteria. Students learn how bacteria are both beneficial and harmful to people and other organisms.

## Bellringer

Ask students the following question, “Are harmful bacteria more of a problem or less of a problem to people now than they were 200 years ago?” (Students should recognize that harmful bacteria usually cause fewer problems today because people now maintain more hygienic conditions, which eliminate many bacteria. The discovery of antibiotics and vaccines has also helped people overcome some of the health problems posed by bacteria.)

## Motivate

## Discussion — GENERAL

**Bacterial Products** Ask students to name products that are made by using bacteria. (Sample answer: yogurt, cheese, sour cream, sauerkraut, and some medicines)

**Verbal**

## What You Will Learn

- Explain how life on Earth depends on bacteria.
- List three ways bacteria are useful to people.
- Describe two ways in which bacteria can be harmful to people.

## Vocabulary

bioremediation  
antibiotic  
pathogenic bacteria

## READING STRATEGY

**Reading Organizer** As you read this section, create an outline of the section. Use the headings from the section in your outline.

## Bacteria's Role in the World

Have you ever had strep throat or a cavity in your tooth? Did you know that both are caused by bacteria?

Bacteria live in our water, our food, and our bodies. Much of what we know about bacteria was learned by scientists fighting bacterial diseases. But of the thousands of types of bacteria, only a few hundred cause disease. Many bacteria do things that are important and even helpful to us.

## Good for the Environment

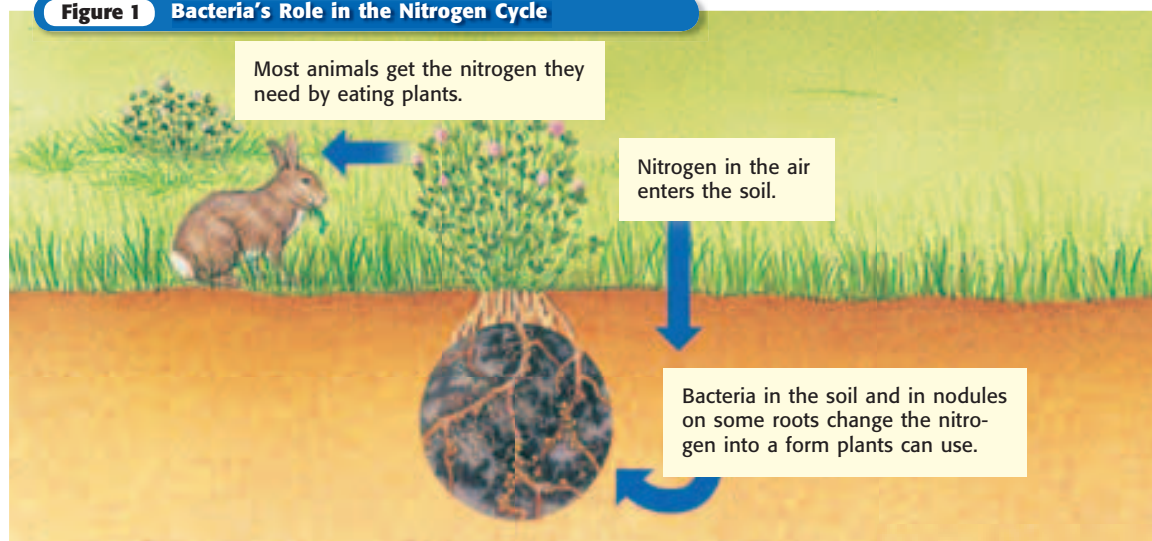
Life as we know it could not exist without bacteria. Bacteria are very important to the health of Earth. They help recycle dead animals and plants. Bacteria also play an important role in the nitrogen cycle.

## Nitrogen Fixation

Most living things depend on plants. Plants need nitrogen to grow. Nitrogen gas makes up about 78% of the air, but most plants cannot use nitrogen directly from the air. They need to take in a different form of nitrogen. Nitrogen-fixing bacteria take in nitrogen from the air and change it to a form that plants can use. This process, called *nitrogen fixation*, is described in **Figure 1**.

**Reading Check** What is nitrogen fixation? (See the Appendix for answers to Reading Checks.)

**Figure 1** Bacteria's Role in the Nitrogen Cycle



## CHAPTER RESOURCES

## Chapter Resource File

- Lesson Plan
- Directed Reading A **BASIC**
- Directed Reading B **SPECIAL NEEDS**

## Technology

- Transparencies
- Bellringer

## Workbooks

- Interactive Textbook **Struggling Readers**

## Answer to Reading Check

Nitrogen fixing is the process by which nitrogen gas in the air is transformed into a form that plants can use.



## Teach

### CONNECTION **Activity** Real World GENERAL



**Canning** Fresh foods are susceptible to bacteria, but canning food enables people to keep food year-round. In 1804, a chef named Nicolas Appert discovered that liquids, such as soups, and small fruits, such as cherries, could be preserved by packing them into champagne bottles and plunging the sealed bottles into a bath of boiling water. Although Appert didn't know it at the time, he was killing bacteria that would have otherwise spoiled the food. Ask interested students to research how canning techniques have changed over the years. Have students create a timeline showing their findings. **LS Visual/Logical**

### CONNECTION to Earth Science GENERAL

**Bacteria and Soil** Bacteria are a vital component of healthy, productive soil. Ask interested students to research how bacteria are important to healthy soil. Then, ask students to research how bacteria are used in the bioremediation of polluted soil. Have students present their findings to the class. **LS Verbal**

### Answer to School-to-Home Activity

Answers may vary. Students should recognize that bacteria are used to make many different foods.

## Recycling

Have you ever seen dead leaves and twigs on a forest floor? These leaves and twigs are recycled over time with the help of bacteria. Decomposer bacteria break down dead plant and animal matter. Breaking down dead matter makes nutrients available to other living things.

## Cleaning Up

Bacteria and other microorganisms are also used to fight pollution. **Bioremediation** (BIE oh ri MEE dee AY shuhn) means using microorganisms to change harmful chemicals into harmless ones. Bioremediation is used to clean up hazardous waste from industries, farms, and cities. It is also used to clean up oil spills. The workers in **Figure 2** are using bacteria to remove pollutants from the soil.

## Good for People

Bacteria do much more than help keep our environment clean. Bacteria also help produce many of the foods we eat every day. They even help make important medicines.

## Bacteria in Your Food

Believe it or not, people raise bacteria for food! Every time you eat cheese, yogurt, buttermilk, or sour cream, you are also eating bacteria. Lactic acid-producing bacteria break down the sugar in milk, which is called *lactose*. In the process, the bacteria change lactose into lactic acid. Lactic acid preserves and adds flavor to the food. All of the foods shown in **Figure 3** were made with the help of bacteria.



**Figure 3** Bacteria are used to make many kinds of foods.



**Figure 2** Bioremediating bacteria are added to soil to eat pollutants. The bacteria then release the pollutants as harmless waste.

**bioremediation** the biological treatment of hazardous waste by living organisms

## SCHOOL to HOME

### Make a Meal Plan

With an adult, create a week's meal plan without any foods made with bacteria. What would your diet be like without bacteria?

## Activity

## Cultural Awareness

GENERAL

**George Washington Carver** George Washington Carver (1864–1903), an African American agricultural chemist, described the importance of composting dead plant material. Carver and his students at the Tuskegee Institute added leaves, weeds, and potato peels to soil. Bacteria broke down this material into nutrients that other plants could use. Ask students to research Carver's other accomplishments. **LS Verbal**

## SUPPORT FOR

### English Language Learners

**Recycling** Students' knowledge of material recycling in their community may help them understand the recycling helped by bacteria. Ask students how such recycling is similar to material recycling. (Like cans processed in a recycling plant, dead leaves can be "taken apart" by bacteria and the "parts" re-used.) Call on students to ensure participation. Point to the text that explains bacterial recycling, if necessary. **LS Verbal**

## Close

### Reteaching

BASIC

**Bacterial Review** On the board, write the headings “Helpful bacteria” and “Harmful bacteria.” Have volunteers go to the board and write an example of how bacteria can be either helpful or harmful. **LS Verbal**

### Quiz

GENERAL

1. How is bioremediation helpful? (Sample answer: Bioremediation is helpful because it uses microorganisms to treat hazardous waste and pollution in the environment.)
2. Explain why bacteria are important in helping plants obtain nitrogen. (Sample answer: Nitrogen-fixing bacteria that live in the soil or in a plant’s roots consume nitrogen gas and change it into a form that can be used by plants.)

### Alternative Assessment

ADVANCED



**Short Story** Have students imagine what it was like before people realized that bacteria existed. Then, have students research what life was like before people knew how to deal with bacteria and write a creative story using their research. **LS Verbal**

**Figure 4** Genes from the *Xenopus* frog were used to produce the first genetically engineered bacteria.



**antibiotic** medicine used to kill bacteria and other microorganisms

**pathogenic bacteria** bacteria that cause disease



**Figure 5** Vaccines can protect you from bacterial diseases such as tetanus and diphtheria.

### Making Medicines

What’s the best way to fight disease-causing bacteria? Would you believe that the answer is to use other bacteria? **Antibiotics** are medicines used to kill bacteria and other microorganisms. Many antibiotics are made by bacteria.

### Insulin

The human body needs insulin to break down and use sugar and carbohydrates. People who have diabetes do not make enough insulin. In the 1970s, scientists discovered how to put genes into bacteria so that the bacteria would make human insulin. The insulin can then be separated from the bacteria and given to people who have diabetes.

### Genetic Engineering

When scientists change the genes of bacteria, or any other living thing, the process is called *genetic engineering*. Scientists have been genetically engineering bacteria since 1973. In that year, researchers put genes from a frog like the one in **Figure 4** into the bacterium *Escherichia coli* (ESH uh RIK ee uh KOH LIE). The bacterium then started making copies of the frog genes. Scientists can now engineer bacteria to make many products, such as insecticides, cleansers, and adhesives.

**✓ Reading Check** What is genetic engineering?

### Harmful Bacteria

Humans couldn’t live without bacteria, but bacteria can also cause harm. Scientists learned in the 1800s that some bacteria are pathogenic (PATH uh JEN ik). **Pathogenic bacteria** are bacteria that cause disease. Pathogenic bacteria get inside a host organism and take nutrients from the host’s cells. In the process, they harm the host. Today, we are protected from many bacterial diseases by vaccination, as shown in **Figure 5**. Many bacterial diseases can also be treated with antibiotics.

### INCLUSION Strategies

- Learning Disabled
- Developmentally Delayed
- Hearing Impaired

Many students can handle new vocabulary words better if they are given a chance to work with the words. Have students create a crossword puzzle using the bacterial diseases mentioned in the section. Then, have students trade papers and solve each other’s puzzles. **LS Verbal**

### Answer to Reading Check

In genetic engineering, scientists change the genes of bacteria and other living things.

## Diseases in Other Organisms

Bacteria cause diseases in other organisms as well as in people. Have you ever seen a plant with odd-colored spots or soft rot? If so, you've seen bacterial damage to plants. Pathogenic bacteria attack plants, animals, protists, fungi, and even other bacteria. They can cause damage to grain, fruit, and vegetable crops. The branch of the pear tree in **Figure 6** shows the effects of pathogenic bacteria. Plants are sometimes treated with antibiotics. Scientists have also genetically engineered certain plants to be resistant to disease-causing bacteria.

**Figure 6** This branch of a pear tree has a bacterial disease called fire blight.



## SECTION Review

### Summary

- Bacteria are important to life on Earth because they fix nitrogen and decompose dead matter.
- Bacteria are useful to people because they help make foods and medicines.
- Scientists have genetically engineered bacteria to make medicines.
- Pathogenic bacteria are harmful to people. Bacteria can also harm the crops we grow for food.

### Using Key Terms

1. In your own words, write a definition for the term *bioremediation*.
2. Use the following terms in the same sentence: *pathogenic bacteria* and *antibiotic*.

### Understanding Key Ideas



3. What are two ways that bacteria affect plants?
4. How can bacteria both cause and cure diseases?
5. Explain two ways in which bacteria are crucial to life on Earth.
6. Describe two ways your life was affected by bacteria today.

### Math Skills

7. Nitrogen makes up about 78% of air. If you have 2 L of air, how many liters of nitrogen are in the air?

### Critical Thinking

8. **Identifying Relationships** Legumes, which include peas and beans, are efficient nitrogen fixers. Legumes are also a good source of amino acids. What chemical element would you expect to find in amino acids?
9. **Applying Concepts** Design a bacterium that will be genetically engineered. What do you want it to do? How would it help people or the environment?



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National Science Teachers Association

For a variety of links related to this chapter, go to [www.scilinks.org](http://www.scilinks.org)

Topic: Antibiotics; Genetic Engineering  
SciLinks code: HSM0082; HSM0654

## Answers to Section Review

1. Sample answer: During bioremediation, bacteria are used to clean up hazardous waste.
2. Sample answer: Antibiotics are medicines used to fight infections caused by pathogenic bacteria.
3. Sample answer: Bacteria help plants by changing nitrogen in the air to a form that plants can use. Bacteria can also cause diseases in plants.
4. Sample answer: Bacteria can cause diseases by taking nutrients from an organism's cells, but bacteria can also be used to fight diseases by making antibiotics.
5. Sample answer: Bacteria fix nitrogen for plants, and they act as decomposers, making nutrients available to other living things.
6. Sample answer: I ate cheese, and someone in my family used insulin, which may have been made by bacteria.
7. 1.56 L of nitrogen ( $2 \text{ L} \times 0.78 = 1.56 \text{ L}$ )
8. Sample answer: Because legumes are good nitrogen fixers, I would expect to find nitrogen in the amino acids.
9. Sample answer: I would genetically engineer a bacterium that would eat carbon dioxide and change it into water. The bacterium could be used to supply clean water to places that need it and remove carbon dioxide from the air.

## CHAPTER RESOURCES

### Chapter Resource File

- Section Quiz **GENERAL**
- Section Review **GENERAL**
- Vocabulary and Section Summary **GENERAL**

### Technology

- Interactive Explorations CD-ROM
- Scope It Out! **GENERAL**



## Focus

## Overview

This section describes the characteristics of viruses. Students will learn that viruses can be classified by their shape, the disease that they cause, their life cycle, or the kind of genetic material they contain. Students will also learn how viruses reproduce.

## Bellringer

Ask students to answer the following question: “Are viruses living?” (Students should recognize that viruses do not have all the characteristics of living things. They do not grow, eat, or reproduce on their own.)

## Motivate

## Demonstration — GENERAL

**Characteristics of Viruses** Show students a picture or diagram of a typical plant or animal cell (whose organelles are labeled). Then, show students pictures of one or more viruses (especially a bacteriophage). Help students compare the parts of the plant or animal cell with the parts of the viruses. Review with students parts of a cell or virus that may not be visible, such as DNA. Ask students to predict whether viruses are alive and how viruses cause disease.

Visual

English Language Learners

## What You Will Learn

- Explain how viruses are similar to and different from living things.
- List the four major virus shapes.
- Describe the two kinds of viral reproduction.

## Vocabulary

virus  
host

## READING STRATEGY

**Discussion** Read this section silently. Write down questions that you have about this section. Discuss your questions in a small group.

**virus** a microscopic particle that gets inside a cell and often destroys the cell

**host** an organism from which a parasite takes food or shelter

## Viruses

One day, you discover red spots on your skin. More and more spots appear, and they begin turning into itchy blisters. What do you have?

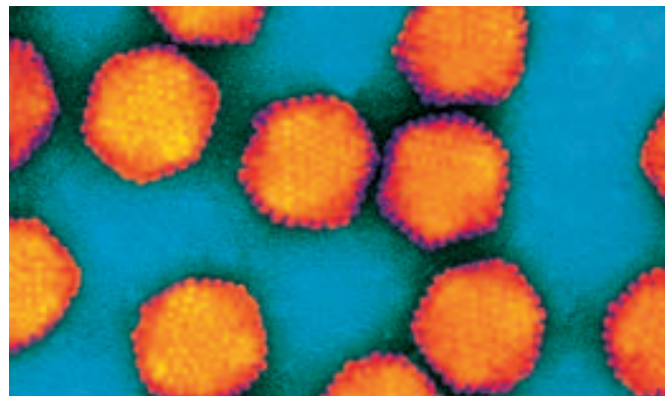
The spots could be chickenpox. Chickenpox is a disease caused by a virus. A **virus** is a microscopic particle that gets inside a cell and often destroys the cell. Many viruses cause diseases, such as the common cold, flu, and acquired immune deficiency syndrome (AIDS).

## It's a Small World

Viruses are tiny. They are smaller than the smallest bacteria. About 5 billion virus particles could fit in a single drop of blood. Viruses can change rapidly. So, a virus's effect on living things can also change. Because viruses are so small and change so often, scientists don't know exactly how many types exist. These properties also make them difficult to fight.

## Are Viruses Living?

Like living things, viruses contain protein and genetic material. But viruses, such as the ones shown in **Figure 1**, don't act like living things. They can't eat, grow, break down food, or use oxygen. In fact, a virus cannot function on its own. A virus can reproduce only inside a living cell that serves as a host. A **host** is a living thing that a virus or parasite lives on or in. Using a host's cell as a tiny factory, the virus forces the host to make viruses rather than healthy new cells.



**Figure 1** Viruses are not cells. They do not have cytoplasm or organelles.

## CHAPTER RESOURCES

## Chapter Resource File

- Lesson Plan
- Directed Reading A **BASIC**
- Directed Reading B **SPECIAL NEEDS**

## Technology

- Transparencies
  - Bellringer
  - L36 The Basic Shapes of Viruses

## Workbooks

- Interactive Textbook **Struggling Readers**
- Math Skills for Science
  - Multiplying Whole Numbers **BASIC**

## Is That a Fact!

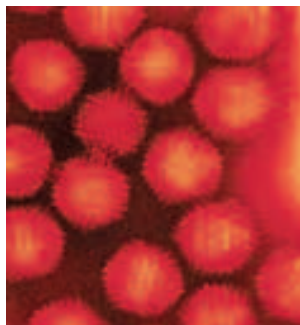
Bacteria are small, but viruses are even smaller. Millions of viruses can fit inside a single bacterium.

**Figure 2** The Basic Shapes of Viruses



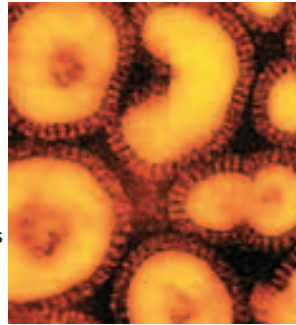
**Crystals**

The polio virus is shaped like the crystals shown here.



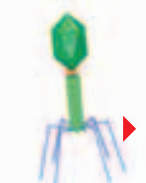
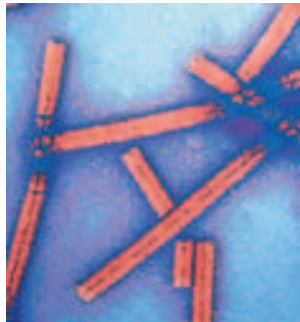
**Spheres**

Influenza viruses look like spheres. HIV is another virus that has this structure.



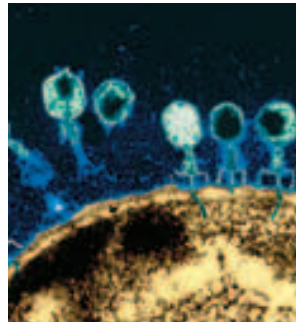
**Cylinders**

The tobacco mosaic virus is shaped like a cylinder and attacks tobacco plants.



**Spacecraft**

One group of viruses attacks only bacteria. Many of these look almost like spacecraft.



## Classifying Viruses

Viruses can be grouped by their shape, the type of disease they cause, their life cycle, or the kind of genetic material they contain. The four main shapes of viruses are shown in **Figure 2**. Every virus is made up of genetic material inside a protein coat. The protein coat protects the genetic material and helps a virus enter a host cell. Many viruses have a protein coat that matches characteristics of their specific host.

The genetic material in viruses is either DNA or RNA. Most RNA is made up of one strand of nucleotides. Most DNA is made up of two strands of nucleotides. Both DNA and RNA contain information for making proteins. The viruses that cause warts and chickenpox contain DNA. The viruses that cause colds and the flu contain RNA. The virus that causes AIDS, which is called the *human immunodeficiency virus* (HIV), also contains RNA.

**✓ Reading Check** What are two ways in which viruses can be classified? (See the Appendix for answers to Reading Checks.)

### Answer to Reading Check

Viruses can be classified by shape or by the type of genetic material they contain. Other possible answers are that viruses can be classified by life cycle or by the kind of disease that they cause.

### Answer to Math Practice

This answer will vary depending on the student's height. Sample answer: If a student is 1.6 m (5 ft 4 in.) tall, he or she would be 960,000 m (3,149,606 ft) tall if enlarged 600,000 times. ( $1.6 \times 600,000 = 960,000$  m)

## MATH PRACTICE

### Sizing Up a Virus

If you enlarged an average virus 600,000 times, it would be about the size of a small pea. How tall would you be if you were enlarged 600,000 times?

## Teach

## CONNECTION Activity

### History

GENERAL



**Yellow Fever** The Panama Canal, which connects the Caribbean Sea to the Pacific Ocean, was completed in 1906. Before it was built, traveling by sea from the east coast of the United States to the west coast required going all the way around the tip of South America. The canal drastically shortened the trip. A major obstacle to building the canal was the disease yellow fever. Thousands of people died of yellow fever while digging the canal. The disease shut down the project. Doctors discovered that yellow fever was a viral disease spread from person to person by mosquitoes. Ask students to research how the builders of the Panama Canal were able to control the spread of yellow fever. Have students write an informative magazine article about their findings. **Verbal**

## SUPPORT FOR

### English Language Learners

**Viruses vs. Bacteria** Up to this point, everything students have studied has been alive, so the point that viruses are not technically alive needs to be reinforced. Have groups of 3 students read the section explaining that viruses are not alive. When they are finished reading, have them fill in a T-chart comparing living bacteria to nonliving viruses. Allow them to refer to the previous section on bacteria if needed. Collect the charts, and evaluate for accuracy of information and language correctness. Have students make corrections, and save their charts for later reference.

**Verbal/Interpersonal**

## Close

### Reteaching

BASIC

**Lytic Cycle** Have students work in pairs to review the lytic cycle. Students should take turns summarizing the cycle to each other. Students should stop each other if they find a concept confusing or need clarification. **LS Verbal/ Interpersonal**

### Quiz

GENERAL

1. List three shapes of viruses, and give an example of each. (Sample answer: crystals—polio virus; spheres—influenza virus; cylinders—tobacco mosaic virus)
2. How are viruses like and unlike living things? (Sample answer: Like living things, viruses contain protein and genetic material, but unlike living things, viruses don't eat, grow, break down food, or use oxygen.)

### Alternative Assessment

GENERAL



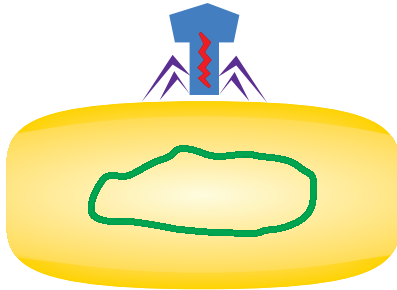
**New Virus** Have students write a short story in which they discover a new type of disease-causing virus. Ask students to include specific details about the structure of the new virus and the way it reproduces. **LS Verbal**

### Answer to Reading Check

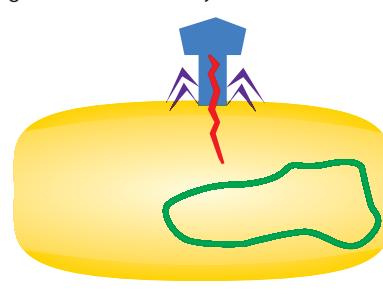
when a virus attacks living cells and turns them into virus factories

Figure 3 The Lytic Cycle

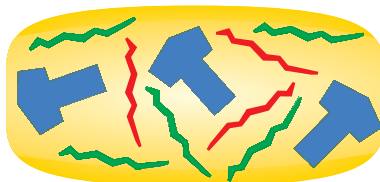
- 1 The virus finds and joins itself to a host cell.



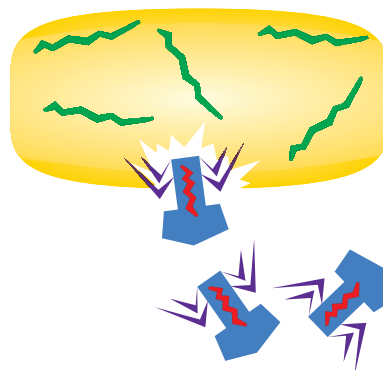
- 2 The virus enters the cell, or the virus's genetic material is injected into the cell.



- 3 Once the virus's genes are inside, they take over the direction of the host cell and turn it into a virus factory.



- 4 The new viruses break out of the host cell, which kills the host cell. The cycle begins again.



### CONNECTION TO Chemistry

**Viral Crystals** Many viruses can form into crystals. Scientists can study X rays of these crystals to learn about the structure of viruses. Why do you think scientists want to learn more about viruses?

### A Destructive House Guest

The one thing that viruses do that living things also do is make more of themselves. Viruses attack living cells and turn them into virus factories. This cycle is called the *lytic cycle* (LIT ik SIE kuhl), and it is shown in **Figure 3**.

**Reading Check** What is the lytic cycle?

### A Time Bomb

Some viruses don't go straight into the lytic cycle. These viruses also put their genetic material into the host cell. But new viruses are not made right away. In the lysogenic (LIE soh JEN ik) cycle, each new cell gets a copy of the virus's genes when the host cell divides. The genes can stay inactive for a long time. When the genes do become active, they begin the lytic cycle and make copies of the virus.

### Answer to Connection to Chemistry

Sample answer: Scientists want to learn more about viruses so they can design new ways of fighting viral diseases.

### INTERNET ACTIVITY

#### Essay

GENERAL

For an internet activity related to this chapter, have students go to [go.hrw.com](http://go.hrw.com) and type in the keyword **HL5VIRW**.



## Treating a Virus

Antibiotics do not kill viruses. But scientists have recently developed antiviral (AN tie VIE ruh) medications. Many of these medicines stop viruses from reproducing. Because many viral diseases do not have cures, it is best to prevent a viral infection from happening in the first place. Childhood vaccinations give your immune system a head start in fighting off viruses. Having current vaccinations can prevent you from getting a viral infection. It is also a good practice to wash your hands often and never to touch wild animals. If you do get sick from a virus, like the boy in **Figure 4**, it is often best to rest and drink extra fluids. As with any sickness, you should tell your parents or a doctor.

**Figure 4** The chickenpox virus resides inside your body even after the red spots are gone.



## SECTION Review

### Summary

- Viruses have characteristics of living and nonliving things. They reproduce in living cells.
- Viruses may be classified by their shape, the kind of disease they cause, or their life cycle.
- To reproduce, a virus must enter a cell, reproduce itself, and then break open the cell. This is called the lytic cycle.
- In the lysogenic cycle, the genes of a virus are incorporated into the genes of the host cell.

### Using Key Terms

- Use the following terms in the same sentence: *virus* and *host*.

### Understanding Key Ideas



- One characteristic viruses have in common with living things is that they
  - eat.
  - reproduce.
  - sleep.
  - grow.
- Describe the four steps in the lytic cycle.
- Explain how the lytic cycle and the lysogenic cycle are different.

### Math Skills

- A bacterial cell infected by a virus divides every 20 min. After 10,000 divisions, the new viruses are released from their host cell. About how many weeks will this process take?

### Critical Thinking

- Making Inferences** Do you think modern transportation has had an effect on the way viruses spread? Explain.
- Identifying Relationships** What characteristics of viruses do you think have made finding drugs to attack them difficult?
- Expressing Opinions** Do you think that vaccinations are important even in areas where a virus is not found?



Developed and maintained by the  
National Science Teachers Association

For a variety of links related to this chapter, go to [www.scilinks.org](http://www.scilinks.org)

Topic: **Viruses**  
SciLinks code: **HSM1607**

## Homework

ADVANCED

**Viral Diseases** After students read this section, have them research three viruses that cause disease. Have them make a chart that includes the name of the disease, the symptoms of the disease, and the treatment for the disease. **LS Logical**

## CHAPTER RESOURCES

### Chapter Resource File

- Section Quiz **GENERAL**
- Section Review **GENERAL**
- Vocabulary and Section Summary **GENERAL**
- Reinforcement Worksheet **BASIC**
- Critical Thinking **ADVANCED**

### Technology

- Transparencies
- L37 The Lytic Cycle

## Answers to Section Review

- Sample answer: A virus infects a host, forcing the host's cells to make more viruses.
- b
- Sample answer: The virus joins itself to a host cell. The virus enters the cell or injects its genetic material into the host cell. The virus's genes take over the host cell, and the host starts making copies of the virus. The new viruses break out of the host cell, killing the host cell. These viruses look for new host cells.
- Sample answer: In the lysogenic cycle, a virus invades a host cell but does not start making copies of itself right away. The genes stay inactive for a long time. When the genes do become active, the lytic cycle begins.
- $19.8 \text{ weeks} (10,000 \text{ divisions} \times 20 \text{ min/division} = 200,000 \text{ min}; 200,000 \text{ min} \div 60 \text{ min/h} = 3,333 \text{ h}; 3,333 \text{ h} \div 24 \text{ h/d} = 139 \text{ days}; 139 \text{ days} \div 7 \text{ days/week} = 19.8 \text{ wk})$
- Sample answer: Modern transportation makes it possible for a virus to spread to a larger area faster. Airplanes can travel half-way around the world in less than a day. A virus carried by someone on the plane could also travel halfway around the world in that period of time.
- Sample answer: Viruses reproduce very quickly, and viruses can change rapidly.
- Sample answer: Vaccinations are important because people travel and a virus can turn up in places where it has not historically been found.

## Aunt Flossie and the Intruder

### Teacher's Notes



#### Time Required

Three 20-minute brainstorming and design sessions and five 5-minute observation periods on successive days


#### Lab Ratings



Teacher Prep 

Student Set-Up  

Concept Level  

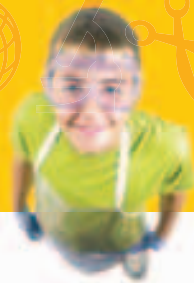
Clean Up 

#### MATERIALS

Students will need to submit a list of supplies and equipment they will need for their experiment to you for approval.

#### Safety Caution

Be sure students address any safety concerns in the design of their experiments.



#### OBJECTIVES

**Design** an experiment that will answer a specific question.

**Investigate** what kind of organisms make food spoil.

#### MATERIALS

- gloves, protective
- items, such as sealable plastic bags, food samples, a scale, or a thermometer, to be determined by the students and approved by the teacher as needed for each experiment

#### SAFETY



## Aunt Flossie and the Intruder

Aunt Flossie is a really bad housekeeper! She never cleans the refrigerator, and things get really gross in there. Last week she pulled out a plastic bag that looked like it was going to explode! The bag was full of gas that she did not put there! Aunt Flossie remembered from her school days that gases are released from living things as waste products. Something had to be alive in the bag!

Aunt Flossie became very upset that there was an intruder in her refrigerator. She refuses to bake another cookie until you determine the nature of the intruder.

#### Ask a Question

- 1 How did gas get into Aunt Flossie's bag?

#### Form a Hypothesis

- 2 Write a hypothesis which answers the question above. Explain your reasoning.

#### Test the Hypothesis

- 3 Design an experiment that will determine how gas got into Aunt Flossie's bag. Make a list of the materials you will need, and prepare all the data tables you will need for recording your observations.
- 4 Get your teacher's approval of your experimental design and your list of materials before you begin.
- 5 Dispose of your materials according to your teacher's instructions at the end of your experiment. **Caution:** Do not open any bags of spoiled food or allow any of the contents to escape.



#### Holt Lab Generator CD-ROM

Search for any lab by topic, standard, difficulty level, or time. Edit any lab to fit your needs, or create your own labs. Use the Lab Materials QuickList software to customize your lab materials list.



**Elizabeth Rustad**  
Crane Junior High School  
Yuma, Arizona

#### CHAPTER RESOURCES

##### Chapter Resource File

- Datasheet for Chapter Lab
- Lab Notes and Answers

##### Technology

- Classroom Videos
- Lab Video



- Viral Decorations



## Analyze the Results

- 1 Organizing Data** What data did you collect from your experiment?

## Draw Conclusions

- 2 Drawing Conclusions** What conclusions can you draw from your investigation? Where did the gas come from?
- 3 Evaluating Methods** If you were going to perform another investigation, what would you change in the experiment to give better results? Explain your answer.

### Communicating Your Data

**WRITING SKILL** Write a letter to Aunt Flossie describing your experiment. Explain what produced the gas in the bag and your recommendations for preventing these intruders in her refrigerator in the future.



## Analyze the Results

1. Answers may vary depending on the student's design.

## Draw Conclusions

2. Answers may vary. Students should conclude that living organisms from the food or air produce gas.
3. Answers may vary.

## Communicating Your Data

Students should explain (in a letter to Aunt Flossie) that mold or bacteria in the bag produced the gas. The gas was a product of the respiration of the mold or bacteria on the food. Preventing future intruders could be as simple as lowering the temperature of the refrigerator or freezing food.

Analyze  
the Results

Draw Conclusions

Do they support  
your hypothesis?

No

Yes

## CHAPTER RESOURCES

### Workbooks



#### Labs You Can Eat

- Bacterial Buddies **GENERAL**



#### Inquiry Labs

- It's an Invasion! **GENERAL**



#### EcoLabs & Field Activities

- Ditch's Brew **GENERAL**



#### Long-Term Projects & Research Ideas

- Bacteria to the Rescue! **ADVANCED**



## Chapter Review

### Assignment Guide

SECTION	QUESTIONS
1	2, 7–10, 18, 22–25
2	1, 3, 5, 12, 13, 16, 19–21
3	4, 6, 11, 14–15, 17

## ANSWERS

### Using Key Terms

1. Sample answer: Pathogenic bacteria are bacteria that cause disease.
2. binary fission
3. antibiotics
4. virus

### Understanding Key Ideas

5. d
6. a
7. b
8. b
9. c
10. d
11. c
12. d

## Chapter Review

### USING KEY TERMS

- 1 In your own words, write a definition for the term *pathogenic bacteria*.

Complete each of the following sentences by choosing the correct term from the word bank.

binary fission      endospore  
antibiotic      bioremediation  
virus      bacteria

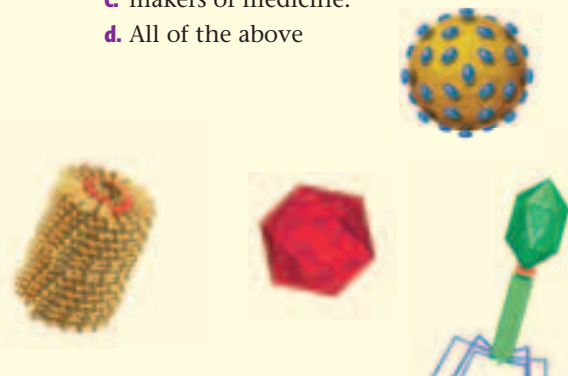
- 2 Most prokaryotes reproduce by \_\_\_\_.
- 3 Bacterial infections can be treated with \_\_\_\_.
- 4 A(n) \_\_\_\_ needs a host to reproduce.

### UNDERSTANDING KEY IDEAS

#### Multiple Choice

- 5 Bacteria are used for all of the following EXCEPT
  - a. making certain foods.
  - b. making antibiotics.
  - c. cleaning up oil spills.
  - d. preserving fruit.
- 6 In the lytic cycle, the host cell
  - a. is destroyed.
  - b. destroys the virus.
  - c. becomes a virus.
  - d. undergoes cell division.
- 7 A bacterial cell
  - a. is an endospore.
  - b. has a loop of DNA.
  - c. has a distinct nucleus.
  - d. is a eukaryote.

- 8 Bacteria
  - a. include methane makers.
  - b. include decomposers.
  - c. all have chlorophyll.
  - d. are rod-shaped.
- 9 Cyanobacteria
  - a. are consumers.
  - b. are parasites.
  - c. contain chlorophyll.
  - d. are decomposers.
- 10 Archaea
  - a. are special types of bacteria.
  - b. live only in places without oxygen.
  - c. are lactic acid-producing bacteria.
  - d. can live in hostile environments.
- 11 Viruses
  - a. are about the same size as bacteria.
  - b. have nuclei.
  - c. can reproduce only within a host cell.
  - d. do not infect plants.
- 12 Bacteria are important to the planet as
  - a. decomposers of dead organic matter.
  - b. processors of nitrogen.
  - c. makers of medicine.
  - d. All of the above



## Short Answer

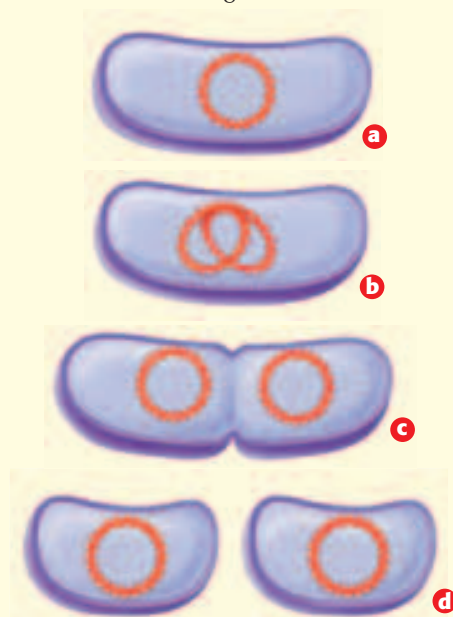
13. How are the functions of nitrogen-fixing bacteria and decomposers similar?
14. Which cycle takes more time, the lytic cycle or the lysogenic cycle?
15. Describe two ways in which viruses do not act like living things.
16. What is bioremediation?
17. Describe how doctors can treat a viral infection.

## Critical Thinking

18. **Concept Mapping** Use the following terms to create a concept map: *bacteria*, *bacilli*, *cocci*, *spirilla*, *consumers*, *producers*, and *cyanobacteria*.
19. **Predicting Consequences** Describe some of the problems you think bacteria might face if there were no humans.
20. **Applying Concepts** Many modern soaps contain chemicals that kill bacteria. Describe one good outcome and one bad outcome of the use of antibacterial soaps.
21. **Identifying Relationships** Some people have digestive problems after they take a course of antibiotics. Why do you think these problems happen?

## INTERPRETING GRAPHICS

The diagram below illustrates the stages of binary fission. Match each statement with the correct stage.



22. The DNA loops separate.
23. The DNA loop replicates.
24. The parent cell starts to expand.
25. The DNA attaches to the cell membrane.



13. Nitrogen-fixing bacteria and decomposers both perform functions that are critical for life on Earth.
14. the lysogenic cycle; In the lysogenic cycle, the virus injects its genetic material into the host but does not immediately begin to reproduce.
15. Viruses do not grow or eat as living things do.
16. Bioremediation is the process by which bacteria or other organisms turn toxic substances into harmless ones.
17. Sample answer: Doctors can treat some viral infections with antiviral medicines that stop viruses from reproducing.

## Critical Thinking

18. An answer to this exercise can be found at the end of this book.
19. Sample answer: Most bacteria would face no problems at all. The only bacteria that might have a problem are pathogenic bacteria that infect only humans.
20. Sample answer: Antibacterial soaps can prevent bacterial infection. But these soaps might also lead to bacteria changing and becoming harder to fight with antibiotics available today.
21. Sample answer: Antibiotics kill all bacteria, even the good bacteria that live in your digestive tract. Your digestive system does not work properly without healthy colonies of beneficial bacteria.

## CHAPTER RESOURCES

### Chapter Resource File

- Chapter Review **GENERAL**
- Chapter Test A **GENERAL**
- Chapter Test B **ADVANCED**
- Chapter Test C **SPECIAL NEEDS**
- Vocabulary Activity **GENERAL**

### Workbooks

- Study Guide
- Study Guide is also available in Spanish.

## Interpreting Graphics

22. stage c
23. stage b
24. stage a
25. stage b

## Standardized Test Preparation

### Teacher's Note

To provide practice under more realistic testing conditions, give students 20 minutes to answer all of the questions in this Standardized Test Preparation.

### MISCONCEPTION ALERT

Answers to the standardized test preparation can help you identify student misconceptions and misunderstandings.

### READING

#### Passage 1

1. A
2. F
3. D



### TEST DOCTOR

**Question 2:** Students who chose answers G and I may be confused because the passage states that 40% to 50% of infected humans die. If the percentage of people who die is between 40 and 50, the answer must be over 40% and under 50%. Therefore, the correct answer must be F.



## Standardized Test Preparation

### READING

Read each of the passages below. Then, answer the questions that follow each passage.

**Passage 1** Viruses that evolve in isolated areas and that can infect human beings are called emerging viruses. These new viruses are dangerous to public health. People become infected when they have contact with the normal hosts of these viruses. In the United States, the hantavirus is considered an emerging virus. First detected in the southwestern United States, the hantavirus occurs in wild rodents and can infect and kill humans. Roughly 40% to 50% of humans infected with the hantavirus die. Other emerging viruses include the Ebola (Africa), Lassa (Africa), and Machupo (South America) viruses.

1. In the passage, what does the word *emerging* mean?
  - A to become visible or known
  - B to fade away into the background
  - C to melt from two things into one
  - D to become urgent
2. Which of the following statements is a fact from the passage?
  - F Hantavirus causes death in more than 40% of its victims.
  - G Hantavirus causes death in more than 50% of its victims.
  - H Hantavirus causes death in fewer than 30% of its victims.
  - I Hantavirus causes death in fewer than 40% of its victims.
3. Which of the following is an emergent virus in South America?
  - A Ebola virus
  - B Lassa virus
  - C SARS virus
  - D Machupo virus

**Passage 2** Less than 100 years ago, people had no way to treat bacterial infections. But in 1928, a Scottish scientist named Alexander Fleming discovered the first antibiotic, or bacteria-killing drug. This first antibiotic was called *penicillin*. The discovery of antibiotics improved healthcare dramatically. However, scientists are now realizing that many bacteria are becoming resistant to existing antibiotics. Scientists are hoping that a particular type of virus called a bacteriophage (bak TIR ee uh FAHJ) might hold the key to fighting bacteria in the future. Bacteriophages destroy bacteria cells. Each kind of bacteriophage can infect only a particular species of bacteria.

1. In what year was penicillin discovered?
  - A 1905
  - B 1928
  - C 1969
  - D 1974
2. According to the passage, what might be the key to fighting bacteria in the future?
  - F antibiotics
  - G bacteriophages
  - H penicillin
  - I antibiotic-resistant bacteria
3. According to the passage, what can each kind of bacteriophage infect?
  - A viruses that cause disease
  - B only antibiotic-resistant bacteria
  - C all kinds of bacteria
  - D only a particular species of bacteria

#### Passage 2

1. B
2. G
3. D



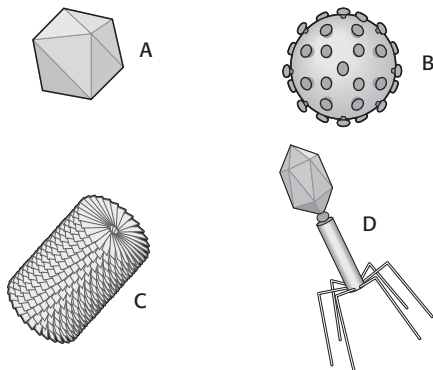
### TEST DOCTOR

**Question 3:** Students who chose answer A may mistakenly think that bacteriophages kill viruses, but bacteriophages are in fact viruses. Students who chose answer B may be confused because the passage mentions antibiotic-resistant bacteria as a problem and bacteriophages as a solution. However, bacteriophages do not kill only resistant bacteria. The correct answer is D, because each bacteriophage infects only a particular species of bacteria.



## INTERPRETING GRAPHICS

The images below show the four main shapes of viruses. Use these pictures to answer the questions that follow.



- Which viral shape attacks only bacteria?  
**A** virus A  
**B** virus B  
**C** virus C  
**D** virus D
- Which viral shape is the cylinder?  
**F** virus A  
**G** virus B  
**H** virus C  
**I** virus D
- Which viral shape would you expect to have the largest surface area-to-volume ratio?  
**A** virus A  
**B** virus B  
**C** virus C  
**D** virus D

## MATH

Read each question below, and choose the best answer.

- Reagan spent \$26 for four equally priced CDs. Which of the following equations could be used to find how much each CD costs?  
**A**  $4 \times \$26 = n$   
**B**  $n = \$26 - 4$   
**C**  $4 \times n = \$26$   
**D**  $n \times \$26 = 4$
- What is  $5 + (-8)$  equal to?  
**F** -13  
**G** -3  
**H** 3  
**I** 13
- What is  $-9 - 2$  equal to?  
**A** -11  
**B** -7  
**C** -4  
**D** 7
- What is the solution to  $45 \div 0.009$ ?  
**F** 5,000  
**G** 500  
**H** 50  
**I** 5
- What is  $-9 + 2$  equal to?  
**A** -11  
**B** -7  
**C** -4  
**D** 7
- Jennifer, Beth, and Sienna live 8 km, 2.2 km, and 7.4 km from the school. Which of the following is a reasonable estimate of the average distance these friends live from the school?  
**F** 6 km  
**G** 7.4 km  
**H** 9 km  
**I** 18 km

## INTERPRETING GRAPHICS

- D
- H
- D

## TEST DOCTOR

**Question 3:** A spherical shape has less surface area relative to volume than other shapes such as cones and pyramids. This shape helps spherical viruses and bacteria to keep from drying out. Students who chose B may have mistakenly thought that spheres have larger surface area relative to volume. Students who chose answers A or C may have felt less familiar with the shapes that make up the virus in answer D. However, answer D probably has the highest surface area relative to its volume.

## MATH

- C
- G
- A
- F
- B
- F

## TEST DOCTOR

**Question 6:** Students who chose answer G may be confused about what an average is and decide that the middle number, 7.4, is the answer. Students who chose answer I may have estimated the sum of the three distances and then not divided the sum by 3 to find an average. The correct answer, F, is found by adding the three distances and then dividing the sum by 3.

## CHAPTER RESOURCES

### Chapter Resource File



• Standardized Test Preparation **GENERAL**

### State Resources



For specific resources for your state, visit [go.hrw.com](http://go.hrw.com) and type in the keyword **HSMSTR**.

## Science, Technology, and Society

### Discussion GENERAL

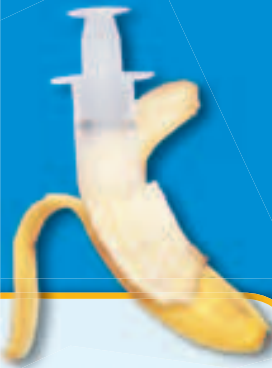
The milk of transgenic animals is also being tested as a potential edible vaccine. Scientists hope that goat's milk containing malaria-like proteins will prevent millions of malaria deaths. Ask students how they think scientists could do this. Then, tell students that scientists put genes for the proteins in the goat's genome. When the mammary cells express the proteins into the milk, the scientists can then milk the goats, isolate the malaria-like proteins, and use the proteins to make a vaccine.

## Scientific Discoveries

### Background

Influenza, or the flu, is a highly contagious disease that causes fever, chills, sore throats, coughing, and even death. The flu has been a fact of life since as early as 412 BCE. For many years, no one knew how this disease worked. In the 15th century, people believed that epidemics were influenced by stars and, because of this, they named the disease *influenza*. Only recently have scientists discovered that this disease is a virus. Scientists today continue to do research in order to understand how the flu virus attacks our bodies.

# Science in Action



## Science, Technology, and Society

### Edible Vaccines

Vaccines protect you from life-threatening diseases. But vaccinations are expensive, and the people who give them must go through extensive training. These and other factors often prevent people in developing countries from getting vaccinations. But help may be on the way. Scientists are developing edible vaccines. Imagine eating a banana and getting the same protection you would from several painful injections. These vaccines are made from DNA that encodes a protein in the disease-causing particles. This DNA can then be inserted into the banana's genes. Researchers are still working on safe and effective edible vaccines.

### Language Arts **Activity**

**WRITING SKILL** Write an advertisement for an edible vaccine. Be sure to describe the benefits of vaccinations.



## Scientific Discoveries

### Spanish Flu and the Flu Cycle

In 1918, a version of the influenza (the flu) virus killed millions of people worldwide. This disease, mistakenly called the Spanish Flu (it probably started in China), was one of the worst epidemics in history. Doctors and scientists realized that the large movement of people during the First World War probably made it easier for the Spanish Flu to spread. But the question of how this common disease could become so deadly remained unknown. One important factor is that the influenza virus is constantly changing. Many scientists now think that the influenza virus mutates into a more deadly form about every 30 years. There were flu epidemics in 1918, 1957, and 1968, which leads some scientists to believe that we are overdue for another flu epidemic.

### Social Studies **Activity**

**WRITING SKILL** Conduct an interview with an older member of your family. Ask them how the flu, smallpox, tuberculosis, or polio has affected their lives. Write a report that includes information on how doctors deal with the disease today.

### Answer to Language Arts Activity

Answers may vary. Advertisements should show an understanding of the benefits of edible vaccines, such as the cost savings and reduced training required for administering the vaccinations.

### Answer to Social Studies Activity

Answers may vary. Students should include information on how the disease in their report is dealt with today.

## People in Science

### Laytonville Middle School

**Composting Project** In 1973, Mary Appelhof tried an experiment. She knew that bacteria can help break down dead organic matter. In her basement, she set up a bin with worms and dumped her food scraps in there. Her basement didn't smell like garbage because her worms were eating the food scraps! Composting uses heat, bacteria, and, sometimes, worms to break down food wastes. Composting turns these wastes into fertilizer.

Binet Payne, a teacher at the Laytonville Middle School in California, decided to try Appelhof's composting system. Ms. Payne asked her students to separate their school cafeteria's trash into different categories: veggie wastes (worm food), protein foods (meat, milk, and cheese), bottles, cans, bags (to be recycled), and "yucky trash" (napkins and other nonrecyclables). The veggie waste was placed into the worm bins, and the protein foods were used to feed a local farm's chickens and pigs. In the first year, the Garden Project saved the school \$6,000, which otherwise would have been used to dump the garbage into a landfill.

### Math ACTiViTy

If the school saved \$6,000 the first year, how much money did the school save each day of the year?

*Composting can help reduce the amount of waste that is sent to a landfill.*



To learn more about these Science in Action topics, visit [go.hrw.com](http://go.hrw.com) and type in the keyword **HL5VIRF**.



Check out Current Science® articles related to this chapter by visiting [go.hrw.com](http://go.hrw.com). Just type in the keyword **HL5CS10**.

## People in Science

### Teaching Strategy-GENERAL

Explain to students that there are two types of decomposition: aerobic and anaerobic. In aerobic decomposition, organic material combines with oxygen to produce carbon dioxide, water, heat, and energy. In anaerobic decomposition, there is no oxygen present. Organic matter combines with water to produce carbon dioxide, methane, hydrogen sulfide, and energy. If you are composting and the pile starts to smell rotten, the smell is probably due to the hydrogen sulfide being made by anaerobic decomposition. This smell signals that the pile needs more oxygen. The easiest way to add oxygen is by turning the pile.

### ACTiViTy

GENERAL

Have students follow these steps to make their own compost bin: Drill 8 holes into the bottom of a 2 ft × 2 ft plastic bin (at least 8 in. deep). Add water to several pounds of shredded paper until it feels moist. Spread the bedding in the bottom of the bin, and cover it with a few handfuls of soil. Place some red worms in the bin. Add some veggie wastes, and leave the bin covered for a week. After a week, discuss what is happening in the bin. **Note:** If the compost will be used to help grow food, you should research whether there are any toxins in the kind of paper you plan to use as bedding for the bin.

### Answer to Math Activity

\$16.44 per day (\$6,000 ÷ 365 days)