

# Protists and Fungi

## 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. 268–273 <b>Chapter Opener</b>	<b>SE</b> Start-up Activity, p. 269 <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 Protists</b> <ul style="list-style-type: none"> <li>Describe the characteristics of protists.</li> <li>Describe four ways that protists get food.</li> <li>Describe three ways that protists reproduce.</li> </ul>	<b>TE</b> Activity Methods of Moving, p. 270 <b>GENERAL</b> <b>SE</b> School-to-Home Activity Food for Thought, p. 271 <b>GENERAL</b> <b>TE</b> Group Activity Making a Hypothesis, p. 271 <b>ADVANCED</b> <b>TE</b> Connection Activity Math, p. 272 <b>GENERAL</b> <b>SE</b> Science in Action Math, Social Studies, and Language Arts Activities, p. 296–297 <b>GENERAL</b> <b>SE</b> Model-Making Lab Making a Protist Mobile, p. 773 <b>GENERAL</b> <b>CRF</b> Datasheet for LabBook*	<b>OSP</b> Lesson Plans (also in print) <b>TR</b> Bellringer Transparency* <b>TR</b> L38 The Life Cycle of <i>P. vivax</i> * <b>CD</b> Science Tutor
<b>PACING • 45 min</b> pp. 274–281 <b>Section 2 Kinds of Protists</b> <ul style="list-style-type: none"> <li>Describe how protists can be organized into three groups based on their shared traits.</li> <li>List an example for each group of protists.</li> </ul>	<b>TE</b> Demonstration Algae as Food, p. 274 <b>GENERAL</b> <b>TE</b> Activity Organizing Algae Information, p. 275 <b>BASIC</b> <b>TE</b> Activity Concept Mapping, p. 276 <b>GENERAL</b> <b>TE</b> Activity Observing Live Amoebas, p. 277 <b>GENERAL</b> <b>SE</b> Connection to Geology Shell Deposits, p. 278 <b>GENERAL</b> <b>SE</b> Connection to Social Studies Malaria, p. 279 <b>GENERAL</b> <b>TE</b> Group Activity Make a Slime Mold, p. 280 <b>ADVANCED</b> <b>LB</b> Long-Term Projects & Research Ideas Algae for All! <b>ADVANCED</b>	<b>OSP</b> Lesson Plans (also in print) <b>TR</b> Bellringer Transparency* <b>TR</b> L39 <i>Euglena</i> , <i>Paramecium</i> * <b>TR</b> <b>LINK TO EARTH SCIENCE</b> E111 The Geologic Time Scale* <b>SE</b> Internet Activity, p. 280 <b>GENERAL</b> <b>CD</b> Science Tutor
<b>PACING • 90 min</b> pp. 282–289 <b>Section 3 Fungi</b> <ul style="list-style-type: none"> <li>Describe the characteristics of fungi.</li> <li>Distinguish between the four main groups of fungi.</li> <li>Explain how lichens affect their environment.</li> </ul>	<b>SE</b> Quick Lab Moldy Bread, p. 284 <b>GENERAL</b> <b>CRF</b> Datasheet for Quick Lab* <b>TE</b> Activity Making Models, p. 285 <b>GENERAL</b> <b>TE</b> Connection Activity Math, p. 285 <b>ADVANCED</b> <b>SE</b> Quick Lab Observe a Mushroom, p. 286 <b>GENERAL</b> <b>CRF</b> Datasheet for Quick Lab* <b>TE</b> Activity Fungus Reproduction, p. 286 <b>BASIC</b> <b>SE</b> Connection to Language Arts Beatrix Potter, p. 287 <b>GENERAL</b> <b>SE</b> Skills Practice Lab There's a Fungus Among Us!, p. 290 <b>GENERAL</b> <b>CRF</b> Datasheet for Chapter Lab* <b>LB</b> Whiz-Bang Demonstrations Unleash the Yeast! <b>GENERAL</b> <b>LB</b> Labs You Can Eat Knot Your Average Yeast Lab* <b>BASIC</b>	<b>OSP</b> Lesson Plans (also in print) <b>TR</b> Bellringer Transparency* <b>CRF</b> SciLinks Activity* <b>GENERAL</b> <b>VID</b> Lab Videos for Life Science <b>CD</b> Science Tutor

**PACING • 90 min**

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

- CRF** Vocabulary Activity\* **GENERAL**  
**SE** Chapter Review, pp. 292–293 **GENERAL**  
**CRF** Chapter Review\* ■ **GENERAL**  
**CRF** Chapter Tests A\* ■ **GENERAL**, B\* **ADVANCED**, C\* **SPECIAL NEEDS**  
**SE** Standardized Test Preparation, pp. 294–295 **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. 268 <b>GENERAL</b> <b>OSP</b> Science Puzzlers, Twisters & Teasers* <b>GENERAL</b>		National Science Education Standards UCP 2; SAI 1; LS 1b
<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. 270 <b>GENERAL</b> <b>TE</b> Reading Strategy Prediction Guide, p. 271 <b>BASIC</b> <b>TE</b> Support for English Language Learners, p. 271 <b>SE</b> Math Practice Pairs of Paramecia, p. 272 <b>GENERAL</b> <b>SS</b> Science Skills Organizing Your Research* <b>GENERAL</b> <b>MS</b> Math Skills for Science A Shortcut for Multiplying Large Numbers* <b>GENERAL</b> <b>CRF</b> Reinforcement Worksheet Protists on Parade* <b>BASIC</b>	<b>SE</b> Reading Checks, pp. 271, 272 <b>GENERAL</b> <b>TE</b> Reteaching, p. 272 <b>BASIC</b> <b>TE</b> Quiz, p. 272 <b>GENERAL</b> <b>TE</b> Alternative Assessment, p. 272 <b>GENERAL</b> <b>SE</b> Section Review,* p. 273 <b>GENERAL</b> <b>TE</b> Homework, p. 273 <b>GENERAL</b> <b>CRF</b> Section Quiz* <b>GENERAL</b>	UCP 5; SAI 2; LS 1b, 1c, 1f, 2a, 4b, 5a
<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. 274 <b>GENERAL</b> <b>TE</b> Reading Strategy Prediction Guide, p. 275 <b>BASIC</b> <b>TE</b> Support for English Language Learners, p. 276 <b>TE</b> Inclusion Strategies, p. 279	<b>SE</b> Reading Checks, pp. 275, 276, 278, 280 <b>GENERAL</b> <b>TE</b> Reteaching, p. 280 <b>BASIC</b> <b>TE</b> Quiz, p. 280 <b>GENERAL</b> <b>TE</b> Alternative Assessment, p. 280 <b>BASIC</b> <b>SE</b> Section Review,* p. 281 <b>GENERAL</b> <b>CRF</b> Section Quiz* <b>GENERAL</b>	UCP 5; LS 1a, 1b, 1f, 3a, 5a; <i>LabBook</i> : UCP 2
<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 Paired Summarizing, p. 282 <b>GENERAL</b> <b>TE</b> Reading Strategy Prediction Guide, p. 283 <b>GENERAL</b> <b>TE</b> Support for English Language Learners, p. 283 <b>TE</b> Inclusion Strategies, p. 288 <b>CRF</b> Reinforcement Worksheet An Ode to a Fungus* <b>BASIC</b> <b>CRF</b> Critical Thinking Protist Pop Culture* <b>ADVANCED</b>	<b>SE</b> Reading Checks, pp. 283, 284, 286, 288 <b>GENERAL</b> <b>TE</b> Reteaching, p. 288 <b>BASIC</b> <b>TE</b> Quiz, p. 288 <b>GENERAL</b> <b>TE</b> Alternative Assessment, p. 288 <b>GENERAL</b> <b>SE</b> Section Review,* p. 289 <b>GENERAL</b> <b>CRF</b> Section Quiz* <b>GENERAL</b>	UCP 5; SAI 1; SPSP 5; LS 1a, 1b, 1d, 1f, 2a, 4b, 5a; <i>Chapter Lab</i> : UCP 5; SAI 1; LS 1a



[www.scilinks.org](http://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](http://go.hrw.com). Just type in the keyword **HL5CS11T**.



**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.



## 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?  
 Explain.

**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, "Protest"?

Explain.

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

**SPECIAL NEEDS** PHYSICAL SCIENCE

and a chestnut have in common?

### VOCABULARY ACTIVITY

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

**Getting the Dirt on the Soil**  
 After you finish reading Chapter (Unique 106), 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 106).

**BASIC**

### CRITICAL THINKING

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

**A Solar Solution**  
 Dear Mr. Jones,

**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 11**  
**SCIENCE PUZZLERS, TWISTERS & TEASERS**  
**Protests and Fungi**

**Riddles**  
 1. Try to solve the following riddles based on what you have learned about protests and fungi.

a. I sometimes have structures that look like antennae, but I am not an alien.

I like to eat, but then again I don't have to.

I'm most comfortable among the dead.

What am I?

b. I can convert the sun's energy into food, but I am not a plant.

Even if you are not mad, I make you see red.

I can poison you without ever touching you.

What am I?

**GENERAL**

## Labs and Activities

### LONG-TERM PROJECTS & RESEARCH IDEAS

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_  
**PROJECT 11**  
**STUDENT WORKSHEET**  
**Algae for All!**

What do pond scum, rot fish, and the green stuff growing in your aquarium have in common? They all are types of **algae**. As a matter of fact, algae are valuable members of the biosphere. Unfortunately, algae don't always receive the recognition they deserve. Did you know that half the world's organic material produced by photosynthesis comes from algae? And humans eat algae more than you might think. We use algae to make medicines as well as to treat sewage. Many cultures eat seaweed and other algae regularly. And though they thrive in watery places like lakes and ponds, these hardy creatures can live almost anywhere—from the Antarctic to the Sahara Desert!

**Algae Blooms**  
 1. How do algae and diatoms mix? Design an experiment to determine the effects of detergent in waste water on algae and other pond algae, such as *Chlorella*. Report your experiment to test for the effects of detergents or acid rain. Present your findings in a scientific article.

**More Long-Term Projects**  
 2. Interview a dermatologist or pathologist about other human diseases that are caused by fungi or protozoa. Create a brochure for patients with a fungal or protozoan-related disease that explains the disease and its treatment.

3. You may not realize it, but you probably eat algae on a regular basis. No kidding! Carotenoids, vitamins, and agar are a few algae extracts commonly used in food products. Look for these extracts and other algae-related products on the labels of food and cosmetics containers. Identify and list products in your home that contain algae. Create a poster that highlights at least five of the products to your home that use or contain algae.

**Research Idea**  
 4. Sometimes an organ-transplant patient suffers from organ rejection, even though a new organ can save the patient's life. Why does the body do this? How can the drug cyclosporine, derived from a fungus, help the transplant operation to be more successful? Find out about cyclosporine and research how it works. Write a newspaper article about your findings.

**ADVANCED**

### WHIZ-BANG DEMONSTRATIONS

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_  
**DEMO 7**  
**TEACHER-LED DEMONSTRATION**  
**Unleash the Yeast!**

**Purpose**  
 Students observe as yeast convert food to energy and learn that fungi are heterotrophic.

**Time Required**  
 15–20 minutes

**Lab Ratings**  
 Safety: 1/5  
 Cleanliness: 1/5  
 Cost: 1/5

**Materials**  
 • 500 mL beakers (5)  
 • 100 mL of warm water  
 • 25 mL of active dry yeast  
 • 25 mL of sugar  
 • 25 mL of oil  
 • 25 mL of vinegar  
 • 25 mL of baking soda  
 • 25 mL of cornstarch

**Procedure**  
 1. Label the beakers 1–5. Add one-half package of yeast to each beaker.  
 2. Add 25 mL of warm water to each beaker.  
 3. Add 25 mL of sugar to beaker 1.  
 4. Add 25 mL of oil to beaker 2.  
 5. Add 25 mL of vinegar to beaker 3.  
 6. Add 25 mL of baking soda to beaker 4.  
 7. Add 25 mL of cornstarch to beaker 5.

**Discussion**  
 Use the following questions as a guide to encourage class discussion:  
 • Why did the balloons inflate? (As a by-product of the digestion process, the yeast produced enough gas to inflate the balloons. As the yeast digested the sugar, alcohol and carbon dioxide were created as waste products. These products caused the liquid to bubble and the balloons to inflate.)

**Critical Thinking** Yeast is a fungus, which is a different category than an animal or a plant. Is the yeast more like a plant or an animal in the way that it obtains its food? Explain. (The yeast has no chloroplasts and cannot produce its own food. Plants, on the other hand, produce their own food. Plants use sunlight to produce the energy they need to live. Organisms that produce their own food, such as plants, are called autotrophs.)

**GENERAL**

### LABS YOU CAN EAT

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_  
**LAB 5**  
**STUDENT WORKSHEET**  
**Knot Your Average Yeast Lab**

Have you ever wondered what makes dough rise? Follow it at not, though it may become a fungus—a tiny, living, one-celled organism called yeast. While doing, yeast are in a state of suspended animation, but when you add warm water and sugar, watch out! The yeast get active and go into a feeding frenzy. What's left behind is carbon dioxide and alcohol.

In this activity, you can watch yeast at work!

**Objective**  
 To observe the effects of yeast activity on pretest dough.

**Day 1: Activate These Yeast Cells!**  
 1. Label the beakers 1–4. Add one-half package of yeast to each beaker.  
 2. Add ingredients to each beaker according to the following directions:  
 Beaker 1: 125 mL warm water  
 Beaker 2: 125 mL warm water and 8 mL sugar  
 Beaker 3: 125 mL hot water and 8 mL sugar  
 Beaker 4: 125 mL hot water and 8 mL sugar

3. Using a separate stirring rod each time, gently stir the contents of each beaker. What happens?  
 4. Observe the contents of each beaker for a few seconds. What is happening in the beakers? Record and explain your observations in the chart on page 23.

5. What do your lab results tell you about the effect temperature has on the carbon-dioxide production of yeast?

**BASIC**

### DATASHEETS FOR QUICK LABS

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_  
**TEACHER RESOURCE PAGE**  
**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 7 as needed.

**DATASHEETS FOR CHAPTER LABS**

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_  
**TEACHER RESOURCE PAGE**  
**Skills Practice Lab**  
**Using Scientific Methods** SAMPLE

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

**DATASHEETS FOR LABBOOK**

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_  
**TEACHER RESOURCE PAGE**  
**Skills Practice Lab**  
**Does It All Add Up?** SAMPLE

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

## Review and Assessments

### SECTION QUIZ

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

**Section:**  
 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 released.

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.

4. A process that uses energy to break down organic compounds.

5. A process that uses energy to break down organic compounds.

**GENERAL**

### SECTION REVIEW

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

**Section:**  
**KEY TERMS**  
 1. What do heterotrophic and autotrophic mean?

2. How does a trace fossil differ from a petrified wood?

3. What is a fossil?

4. What is a fossil?

5. What is a 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 stimulus and a response.

**GENERAL**

### 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 slow down. d. they change direction.

3. Longshore currents transport sediment

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

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 slow down. d. they change direction.

3. Longshore currents transport sediment

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

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 slow down. d. they change direction.

3. Longshore currents transport sediment

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

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

**GENERAL**

**PERFORMANCE-BASED ASSESSMENT**

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

**OBJECTIVE**  
 Determine which factors cause some sugar solutions 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 shapes break down more rapidly than others?

**MATERIALS AND EQUIPMENT**  
 • 1 cup of sugar cubes  
 • 50 mL of water

**GENERAL**



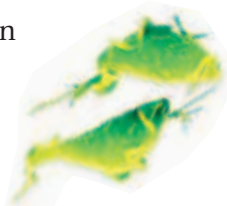
*This Chapter Enrichment provides relevant and interesting information to expand and enhance your presentation of the chapter material.*

## Section 1

### Protists

#### Protists, Protists, Everywhere

- Most protists are aquatic. Some live in marine environments; others live in fresh water or in the water that surrounds soil particles. Still other protists live in the body fluids of other organisms. Some even live in snow.



#### Is That a Fact!

- A harmless species of symbiotic amoebas called *Entamoeba gingivalis* lives in the mouths of many people and feeds on loose cells and organic debris.

#### The Need to Conjugate

- Laboratory experiments have shown that some species of *Paramecium* must conjugate periodically to survive. If these paramecia are not allowed to conjugate, they have the capacity for only a limited number of asexual divisions (about 350) before they die.

## Section 2

### Kinds of Protists

#### Products from Algae

- The cell walls of red algae contain a substance that gives the algae a slippery texture. Agar, which is derived from this substance, has the consistency of gelatin and is used worldwide as a culture medium for growing bacteria, fungi, and plant tissue.
- Giant kelp and other brown algae are the source of algin, which has hundreds of uses. For example, it is used as a thickening and stabilizing agent in ice cream, milkshakes, pie fillings, and weight-control drinks; as an additive in paper and a coating on frozen food packages; as a smoothing agent in lotions and creams; and as an ingredient in latex paints and adhesives.

#### Is That a Fact!

- During the Irish potato famine of 1846, people ate a red alga called *dulse* as a substitute for potatoes.

### Slime Molds

- There are two types of slime molds: cellular slime molds (about 70 species in the phylum Acrasiomycota) and plasmodial or acellular slime molds (about 800 species in the phylum Mycetozoa).
- Plasmodial slime molds are named for their slimy, often large and colorful plasmodia. A plasmodium is the feeding phase of the slime mold, and it engulfs bacteria, yeast, and bits of organic matter in its path. A plasmodium can flow around obstacles and will even flow through the meshwork of a piece of cloth.

#### Is That a Fact!

- Many students who have kept fish in an aquarium have seen *Saprolegnia*, the common water mold that forms a fuzzy white mass as it grows over the surface of a dead or an injured fish.



### Diatoms

- The word *diatom* comes from the Greek word *diatomos*, which means "cut in two." The meaning refers to the glassy, two-part shells (called *frustules*) that enclose these single-celled organisms.
- The frustules of diatoms have complex and strikingly beautiful markings that are different for each species and are therefore important in diatom identification.
- One liter of sea water may contain almost a million diatoms.



## Section 3

### Fungi

#### Fungi Functions

- Fungi are extremely important as decomposers; they break down complex organic material to simple organic compounds and inorganic molecules. Through this process, fungi make carbon, nitrogen, phosphorus, and other essential elements available to living things.
- Fungi are also essential in the making of bread, cheeses, wine, beer, and soy sauce; in the production of many antibiotics; and as research organisms for biochemists, cytologists, microbiologists, and mycologists.
- Most plant roots have mutualistic symbiotic associations with fungi, which are called *mycorrhizae*. The mycorrhizae often greatly enhance plant mineral nutrient uptake.
- Fungi are the major cause of plant diseases. At least 5,000 kinds of fungi attack crops, garden plants, and wild plants. Some fungi also cause disease, such as ringworm, in animals. A toxic fungus from the genus *Stachybotrys* has made some houses unlivable for humans.



#### Sac Fungi

- There are more than 30,000 known species of sac fungi (class Ascomycota), about 500 of which are single-celled yeasts.
- Morels and truffles are multicellular sac fungi. For hundreds of years, the only way to enjoy truffles, which grow underground on the roots of oak and hazelnut trees, was to unearth wild ones with the help of specially trained pigs and dogs. Today, truffles can be cultivated commercially, but doing so is very difficult.



#### A Predatory Fungus

- One of the imperfect fungi (*Arthrobotrys dactyloides*) preys on tiny roundworms (nematodes) in soil. The filaments of the fungi produce minute loops that swell rapidly when nematodes try to crawl through them. The loops hold the nematodes tightly while hyphae grow into the nematodes' bodies and kill them.

#### Lichens

- Lichens are a symbiotic association between a fungus—in most cases a sac fungus, or ascomycete—and either a photosynthetic alga or a cyanobacterium. The term *lichen* is often defined without mentioning cyanobacteria, the name now used for blue-green algae.
- In severe growing conditions, lichens grow extremely slowly. Even small lichens may be hundreds or even thousands of years old.



#### Is That a Fact!

- ◆ Lichens are an important food for caribou. During winter on the tundra, other foods are not available and caribou eat almost exclusively lichens.

SciLINKS®

NSTA

Developed and maintained by the  
National Science Teachers Association

SciLinks is maintained by the National Science Teachers Association to provide you and your students with interesting, up-to-date links that will enrich your classroom presentation of the chapter.

Visit [www.scilinks.org](http://www.scilinks.org) and enter the SciLinks code for more information about the topic listed.

Topic: **Protists**  
SciLinks code: **HSM1245**

Topic: **Fungi**  
SciLinks code: **HSM0628**

Topic: **Algae**  
SciLinks code: **HSM0042**

Topic: **Lichens**  
SciLinks code: **HSM0871**

Topic: **Protozoans**  
SciLinks code: **HSM1247**

## Overview

Tell students that this chapter will help them learn about protists and fungi. The chapter describes how protists and fungi get food and reproduce. It also describes several different kinds of protists and fungi.

## Assessing Prior Knowledge

Students should be familiar with the following topics:

- characteristics of living things
- classification
- cells

## Identifying Misconceptions

As students learn the material in this chapter, some of them may be confused about what characteristics unite the organisms in the kingdom Protista. You may want to stress that this group is unique in that the organisms in kingdom Protista are united more by their differences from other groups than by their similarities with each other. Many of the organisms in kingdom Protista are only distantly related to each other, and scientists do not agree on how to classify the members of this kingdom.

# Protists and Fungi

## The Big Idea

Protists and fungi are eukaryotes.

### SECTION

1	Protists .....	270
2	Kinds of Protists .....	274
3	Fungi .....	282

### About the PHOTO

These glowing disks may look like spaceships, but they are mushrooms! Some fungi—and some protists—glow with bioluminescence (BIE oh LOO muh NES uhns), just as fireflies do. Bioluminescence is the production of light from chemical reactions in an organism. The function of bioluminescence in fungi is not known. Some scientists think that the glow attracts insects that help spread the fungi's spores. Other scientists think that the light is just a way to release energy.

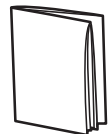
## PRE-READING ACTIVITY



### FOLDNOTES

**Booklet** Before you read the chapter, create the FoldNote entitled “Booklet”

described in the **Study Skills** section of the Appendix. Label each page of the booklet with a main idea from the chapter. As you read the chapter, write what you learn about each main idea on the appropriate page of the booklet.



## 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

#### Section 1 Protists

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

#### Section 2 Kinds of Protists

UCP 5; LS 1a, 1b, 1f, 3a, 5a; LabBook: UCP 2

### Section 3 Fungi

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

#### Chapter Lab

UCP 5; SAI 1; LS 1a

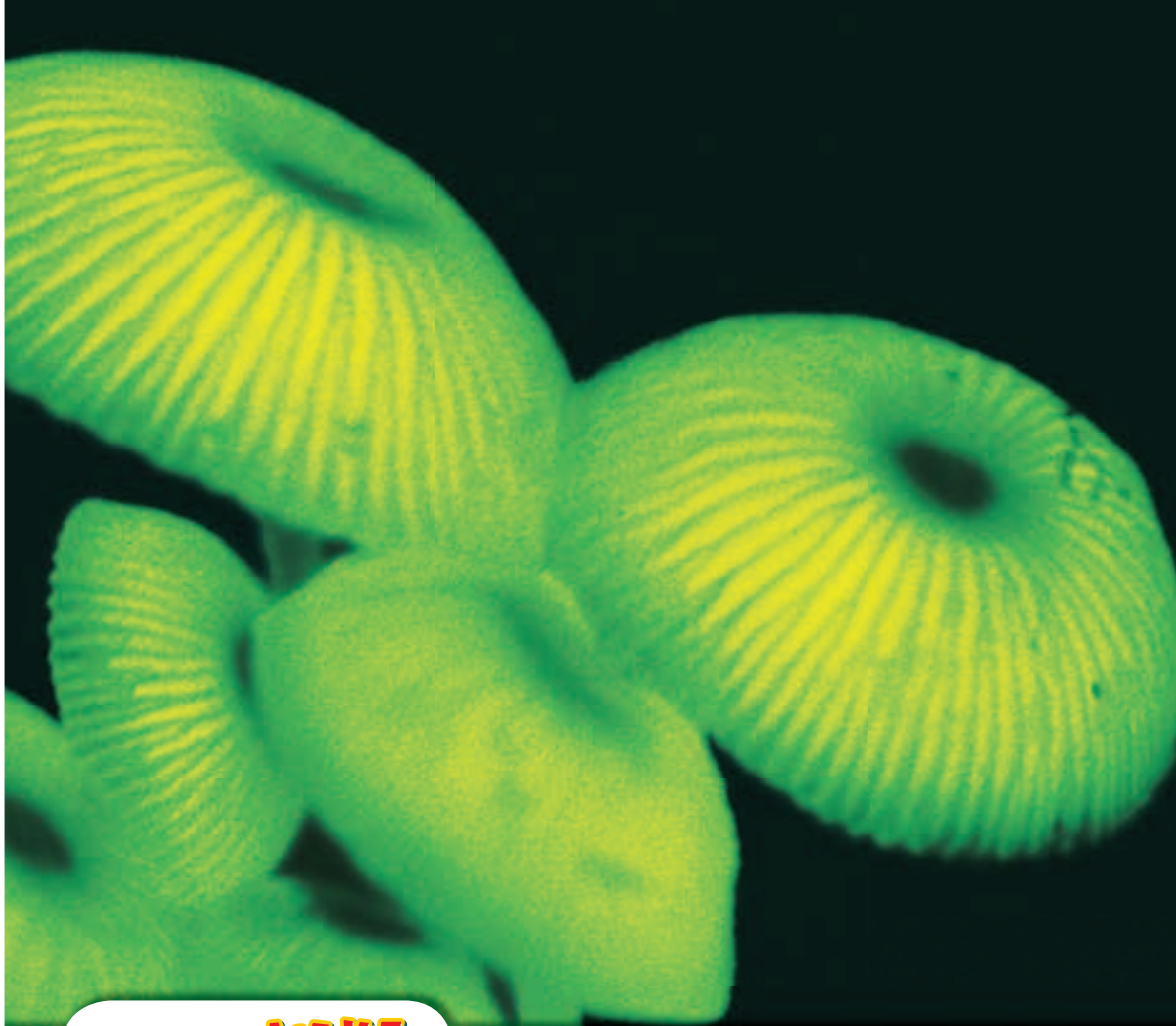
#### Chapter Review

SAI 1; LS 1a, 2a

#### Science in Action

SAI 2; ST 2; SPSP 5; HNS 2; LS 1f





## START-UP Activity

### A Microscopic World

In this activity, you will find some common protists in pond water or in a solution called a *hay infusion*.

#### Procedure

1. Use a **plastic eyedropper** to place **one drop of pond water or hay infusion** onto a **microscope slide**.
2. Add a **drop of ProtoSlo™** to the slide.
3. Add a **plastic coverslip** by putting one edge on the slide and then slowly lowering the coverslip over the drop to prevent air bubbles.
4. Observe the slide under low power of a **microscope**.

5. Find an organism in the liquid on the slide.
6. Observe the organism under high power to get a closer look.
7. Sketch the organism as you see it under high power. Then, return the microscope to low power, and find other organisms to sketch. Return the microscope to high power, and sketch the new organisms.

#### Analysis

1. How many kinds of organisms do you see?
2. Are the organisms alive? Support your answer with evidence.
3. How many cells does each organism appear to have?

## START-UP Activity

### MATERIALS

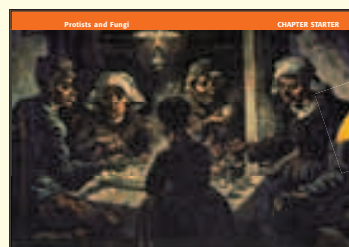
#### FOR EACH STUDENT

- microscope
- microscope slide
- plastic coverslip
- plastic dropper
- pond water or hay infusion
- ProtoSlo™

**Safety Caution:** Tell students not to taste the solution. Care should be taken handling microscope slides and coverslips. Check for known mold or fungi allergies among students before conducting this lab. Have an eyewash available, and instruct students to wipe up all spills immediately.

### Answers

1. Answers may vary. Pond water may contain protist producers, such as members of the genera *Spirogyra* and *Volvox*, and protist heterotrophs, such as members of the genera *Stentor*, *Vorticella*, *Euglena*, and *Paramecium* and amoebas. Students may also see nematode worms and small, fast-moving, multicellular animals called *rotifers*.
2. Sample answer: The organisms are moving, which suggests that they are alive. Also, green pigments suggest that algae are going through photosynthesis.
3. Answers may vary, but most of these microscopic organisms, if not all, are single-celled organisms.



#### This Really Happened!

The year is 1845, and the country is Ireland. The weather is cold and rainy, and the situation is desperate. Disease has swept through the potato fields. In just a few weeks, it destroyed almost the entire crop.

The Irish depend on potatoes for food. Every day, hundreds of people die of starvation. With no other hope for survival, tens of thousands are fleeing their homes. But what can they do?

Water molds are protists. This particular water mold changed the course of Irish history. It also changed the American population. Do you have Irish ancestry? If so, a water mold may have brought your family to this country.

But don't get the wrong idea. Not all protists are harmful. Some are very helpful. You'll learn about protists in this chapter.

#### Chapter Starter Transparency

Use this transparency to help students begin thinking about the relationships between protists and humans.

### 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

#### Workbooks

- Science Puzzlers, Twisters & Teasers**
  - Protists and Fungi **GENERAL**



## Focus

## Overview

This section introduces students to protists. Students will learn that protists share few characteristics but that they are all eukaryotic. Students will also learn that protists get food as producers or heterotrophs and that protists reproduce asexually or sexually.

## Bellringer

Ask students if they have heard of protists before reading this chapter. Students should make a list of examples of protists. Then, have students read the lists aloud and discuss why protists are not well known.

## Motivate

## Activity

GENERAL

**Methods of Moving** Ask students to imagine that an organism needs to move itself without using arms, fins, wings, or legs. Ask students, “How would the organism move? What environments could the organism live in?” Have students write their answers in their **science journal**. Encourage students to illustrate their answers whenever possible. (Accept all reasonable responses. Tell students that many protists live in water and move by using flagella and cilia.) **LS Verbal**

## What You Will Learn

- Describe the characteristics of protists.
- Describe four ways that protists get food.
- Describe three ways that protists reproduce.

## Vocabulary

protist                      parasite  
heterotroph              host

## READING STRATEGY

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

**protist** an organism that belongs to the kingdom Protista

## Protists

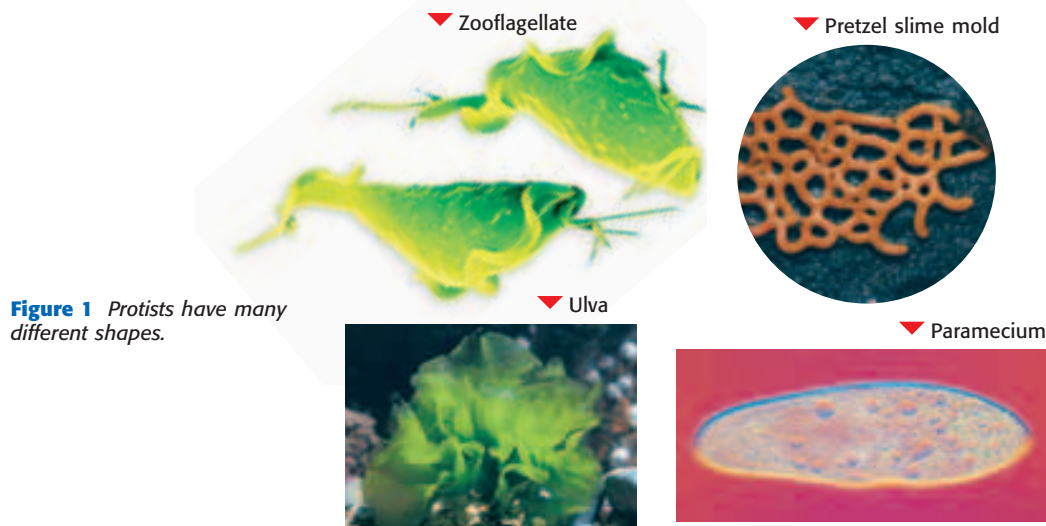
Some are so tiny that they cannot be seen without a microscope. Others grow many meters long. Some are poisonous. And some provide food for people.

What are they? The organisms described above are protists. A **protist** is a member of the kingdom Protista. Protists differ from other living things in many ways. Look at **Figure 1** to see a variety of protists.

## General Characteristics

Protists are very diverse and have few traits in common. Most protists are single-celled organisms, but some are made of many cells, and others live in colonies. Some protists produce their own food, and some eat other organisms or decaying matter. Some protists can control their own movement, and others cannot. However, protists do share a few characteristics. For example, all protists are *eukaryotic* (yoo KAR ee AHT ik), which means that their cells each have a nucleus.

Members of the kingdom Protista are related more by how they differ from members of other kingdoms than by how they are similar to other protists. Protists are less complex than other eukaryotic organisms are. For example, unlike fungi, plants, and animals, protists do not have specialized tissues. Because protists are so diverse, some scientists think that kingdom Protista should be broken up into several kingdoms. Scientists are still revising the classification of protists.



**Figure 1** Protists have many different shapes.

## CHAPTER RESOURCES

## Chapter Resource File

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

## Technology

- Transparencies
- Bellringer

## Workbooks

- Interactive Textbook **Struggling Readers**

## Protists and Food

Protists get food in many ways. Some protists can make their own food. Other protists eat other organisms, parts or products of other organisms, or the remains of other organisms. Some protists use more than one method of getting food.

### Producing Food

Some protists are *producers*. Like green plants, these protists make their own food. Protist producers have special structures called *chloroplasts* (KLAWR uh PLASTS) in their cells. These structures capture energy from the sun. Protists use this energy to produce food in a process called *photosynthesis* (FOHT oh SIN thuh sis). Plants use this same process to make their own food.

**✓ Reading Check** How do protist producers get their food? (See the Appendix for answers to Reading Checks.)

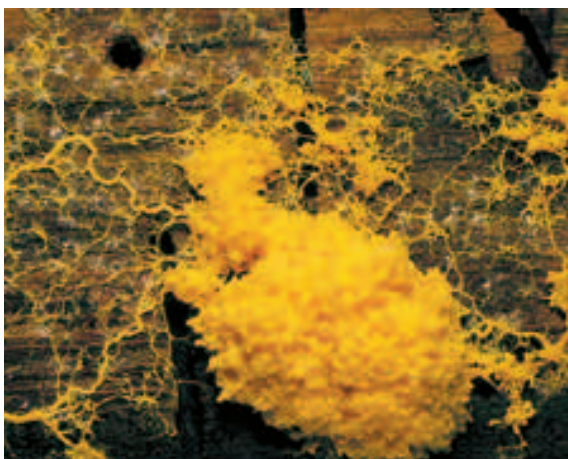
### Finding Food

Some protists must get food from their environment. These protists are heterotrophs (HET uhr oh TROHES). **Heterotrophs** are organisms that cannot make their own food. These organisms eat other organisms, parts or products of other organisms, or the remains of other organisms.

Many protist heterotrophs eat small living organisms, such as bacteria, yeast, or other protists. The way that these heterotrophs get food is similar to how many animals get food. Some protist heterotrophs are decomposers. *Decomposers* get energy by breaking down dead organic matter. Some protists get energy in more than one way. For example, slime molds, such as the one in **Figure 2**, get energy by engulfing both small organisms and particles of organic matter.

Some protist heterotrophs are parasites. A **parasite** invades another organism to get the nutrients that it needs. An organism that a parasite invades is called a **host**. Parasites cause harm to their host. Parasitic protists may invade fungi, plants, or animals. During the mid-1800s, a parasitic protist wiped out most of the potatoes in Ireland. Without potatoes to eat, many people died of starvation. Today, people know how to protect crops from many such protists.

**Figure 2** Slime molds get energy from small organisms and particles of organic matter.



## SCHOOL to HOME

### Food for Thought

With your family, review how producers, consumers, decomposers, and parasites get energy. Think of organisms that live near your home and that get their food in these different ways. Then, make a poster to display your examples. Be sure that the poster describes each way of getting food.

## ACTiViTy

**heterotroph** an organism that gets food by eating other organisms or their byproducts and that cannot make organic compounds from inorganic materials

**parasite** an organism that feeds on an organism of another species (the host) and that usually harms the host; the host never benefits from the presence of the parasite

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

## Teach



## READING STRATEGY

BASIC

**Prediction Guide** Before students read about how protists get food, ask them to brainstorm ways in which organisms get food. (Answers may include photosynthesis, consuming plants or animals, decomposing, and parasitism.) Tell students that protists are very diverse and that there is probably a protist that uses every method of getting food listed by the class. Ask students to look for the methods they brainstormed as they read about how protists get food. **LS Verbal**

## Group ACTiViTy — ADVANCED

**Making a Hypothesis** Amoebas sometimes ignore food that is close to them and move toward food that is farther away. Scientists are not sure why amoebas behave in this way. Ask students to work in groups to come up with a hypothesis about this behavior. Have groups design experiments that could test their hypotheses. **LS Interpersonal**

## SUPPORT FOR

### English Language Learners

**Across Kingdoms** Identifying examples of heterotrophs, parasites, and hosts from the animal kingdom will help students understand the concepts in the protista kingdom. Ask students to use vocabulary terms from this page to explain the relationships between these pairs of animals: dog/flea, wolf/rabbit. If students are unfamiliar with the animals, display pictures. (dog is host to parasite flea because the flea eats the dog's blood; wolf is a heterotroph because it cannot make its own food and eats the rabbit instead) **LS Verbal**

## WEIRD SCIENCE

At the 1933 Chicago World's Fair, an exhibit of "hair growing on wood" was displayed in the Believe It or Not pavilion. Although the "hair" amazed many fair-goers, it was actually the clustered fruiting bodies of a slime mold.

### Answer to Reading Check

Protist producers make their own food through photosynthesis.



## Close

### Reteaching

BASIC

**Sunshine** Help students get used to the idea that plants are not the only organisms that use photosynthesis by telling them that some bacteria use photosynthesis. This may help them remember that protist producers use photosynthesis. **LS Logical**

### Quiz

GENERAL

1. How do protist producers differ from plants? (Plants have specialized tissues that have specific functions, but protist producers do not have specialized tissues.)
2. When might protists switch from asexual to sexual reproduction? (Sample answer: Some protists switch methods each generation, and other protists use sexual reproduction only when conditions are stressful.)

### Alternative Assessment

GENERAL



#### Making a Pop-up Book

Ask students to make a pop-up book in which they devote a chapter to each of three groups of protists. Encourage students to be creative and write text for their protist books. **LS Verbal/Kinesthetic**

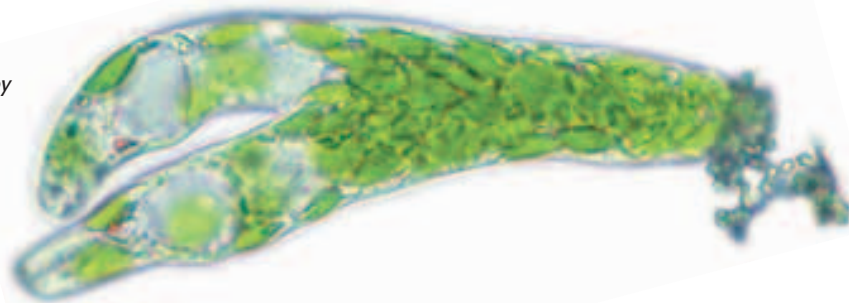
#### Answer to Reading Check

binary fission and multiple fission

#### Answer to Math Practice

24 protists (3 pairs results in 12 protists. 6 pairs results in 24 protists.)

**Figure 3** Members of the genus *Euglena* reproduce by dividing lengthwise during fission.



### Producing More Protists

Like all living things, protists reproduce. Protists reproduce in several ways. Some protists reproduce asexually, and some reproduce sexually. Some protists even reproduce asexually at one stage in their life cycle and sexually at another stage.

#### Asexual Reproduction

Most protists reproduce asexually. In asexual reproduction, the offspring come from just one parent. These offspring are identical to the parent. **Figure 3** shows a member of the genus *Euglena* reproducing asexually by fission. In *binary fission*, a single-celled protist divides into two cells. In some cases, single-celled protists use *multiple fission* to make more than two offspring from one parent. Each new cell is a single-celled protist.

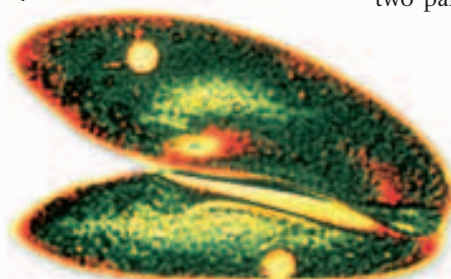
**✓ Reading Check** What are two ways that protists can reproduce asexually by fission?

#### Sexual Reproduction

Some protists can reproduce sexually. Sexual reproduction requires two parents. Members of the genus *Paramecium* (PAR uh MEE see uhm) sometimes reproduce sexually by a process called *conjugation*. During conjugation, two individuals join together and exchange genetic material by using a small, second nucleus. Then, they divide to produce four protists that have new combinations of genetic material. **Figure 4** shows two paramecia in the process of conjugation.

Many protists can reproduce asexually and sexually. In some protist producers, the kind of reproduction alternates by generation. For example, a parent will reproduce asexually, and its offspring will reproduce sexually. Other protists reproduce asexually until environmental conditions become stressful, such as when there is little food or water. When conditions are stressful, these protists will use sexual reproduction until conditions improve.

**Figure 4** Members of the genus *Paramecium* can reproduce by conjugation, a type of sexual reproduction.



### CONNECTION ACTIVITY

Math

GENERAL

**Malaria Math** Many protists reproduce asexually by fission, or dividing in two. Students are probably familiar with this form of division, which can result in a population growing exponentially over time; that is, 1 cell divides to produce 2 cells, which in turn divide to produce 4 cells, which in turn produces 8 cells, and so on. *Plasmodium vivax* and some other parasitic, spore-forming protozoa can divide

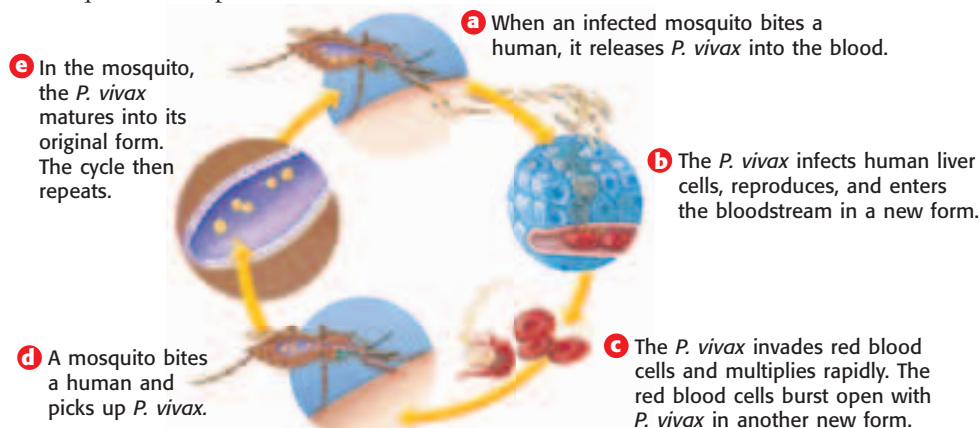
asexually by a process known as *schizogony*, or multiple fission. For example, a single spore, or a sporozoite of a *P. vivax* organism can produce 40,000 offspring. Researchers have determined that when a mosquito that is infected with *P. vivax* inserts its proboscis into a human blood vessel, the mosquito injects about a thousand spores. Have students calculate how many *P. vivax* spores could be present in a person's body after just one division by multiple fission. (1,000 spores  $\times$  40,000 offspring = 40,000,000 spores) **LS Logical**



## Reproductive Cycles

Some protists have complex reproductive cycles. These protists may change forms many times. **Figure 5** shows the life cycle of *Plasmodium vivax* (plaz MOH dee uhm VIE vaks), the protist that causes the disease malaria. *P. vivax* depends on both humans and mosquitoes to reproduce.

**Figure 5** *P. vivax* infects both humans and mosquitoes as it reproduces.



## SECTION Review

### Summary

- Protists are a diverse group of single-celled and many-celled organisms.
- Protists are grouped in their own kingdom because they differ from other organisms in many ways.
- Protists get food by producing it or by getting it from their environment.
- Some protists reproduce asexually, some reproduce sexually, and some reproduce both asexually and sexually.

### Using Key Terms

- Use the following terms in the same sentence: *parasite* and *host*.
- In your own words, write a definition for each of the following terms: *protist* and *heterotroph*.

### Understanding Key Ideas

- What is one way that protists differ from plants and animals?
  - Protists are eukaryotic.
  - All protists have many cells.
  - Protists do not have specialized tissues.
  - Protists are not eukaryotic.
- Name a characteristic shared by all protists.
- Name three ways that protists can differ from each other.
- Describe four ways that protists get food.
- Describe three ways that protists reproduce.

### Math Skills

- If seven individuals of the genus *Euglena* reproduce at one time, how many individuals result?

### Critical Thinking

- Identifying Relationships** How is conjugation similar to fission?
- Applying Concepts** The spread of malaria depends on both human and mosquito hosts. Use this fact to think of a way to stop the spread of malaria.

**SciLinks** **NSTA**

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: Protists  
SciLinks code: HSM1245

## Homework

GENERAL



**Research** Encourage students to research and report on malaria and the work currently being done to develop malaria vaccines. **Verbal**

## CHAPTER RESOURCES

### Chapter Resource File

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

### Technology

- Transparencies**
- L38 The Life Cycle of *P. vivax*

### Workbooks

- Interactive Textbook**
- Math Skills for Science**
- A Shortcut for Multiplying Large Numbers **GENERAL**

## Answers to Section Review

- Sample answer: An organism that is invaded by a parasite is called a *host*.
- Sample answer: A protist is a eukaryotic organism that is a member of the kingdom Protista. A heterotroph is an organism that gets food by eating other organisms or organic matter.
- c
- All protists are eukaryotic.
- Sample answer: Protists can differ in whether they are single-celled or multicellular, how they get food (as producers or as heterotrophs), how they move (with pseudopodia, flagella, or cilia), and how they reproduce (sexually, asexually, or both at different stages of life).
- Protists get food by producing it, by eating other organisms, by consuming dead organic matter, or by invading other organisms as parasites.
- Protists can reproduce asexually by fission, sexually by conjugation, and in complex reproductive cycles.
- 14 individual protists
- Sample answer: In both conjugation and fission, the number of protists resulting from reproduction is double the number that reproduced.
- Sample answer: If populations of mosquitoes infected by malaria were controlled, malaria could not spread between infected people because the steps of the *P. vivax* reproductive cycle that depend on the mosquito could not happen.

## Focus

## Overview

This section describes what different kinds of protists look like, where they live, and how they move. Protists are organized into three groups: protist producers, heterotrophic protists that can move, and heterotrophic protists that cannot move.

## Bellringer

Ask students where they think algae live. **(Students may think of algae that live in the ocean.)** Tell them that algae also live in fresh water, moist soil, melting snow, and other environments.

## Motivate

## Demonstration — GENERAL

**Algae as Food** Display the following on a table: ice cream, salad dressing, jelly beans, chocolate milk, instant pudding, and dry gravy mix. Tell students that two substances taken from algae—alginate and carrageenan—are common ingredients in many foods. Alginate comes from brown algae, while carrageenan comes from a red alga. Both are used as thickeners, stabilizers, and emulsifiers. Have students read the ingredients on the packages. **LS Visual**

## What You Will Learn

- Describe how protists can be organized into three groups based on their shared traits.
- List an example for each group of protists.

## Vocabulary

algae  
phytoplankton

## READING STRATEGY

**Reading Organizer** As you read this section, make a table comparing protist producers, heterotrophs that can move, and heterotrophs that cannot move.

**algae** eukaryotic organisms that convert the sun's energy into food through photosynthesis but that do not have roots, stems, or leaves (singular, *alga*)

**phytoplankton** the microscopic, photosynthetic organisms that float near the surface of marine or fresh water

**Figure 1** Some kinds of algae, such as this giant kelp, can grow to be many meters in length.

## Kinds of Protists

Would you believe that there is an organism that lives in the forest and looks like a pile of scrambled eggs? This organism exists, and it's a protist.

Slimy masses of protists can look like spilled food. Smears of protists on the walls of a fish tank may look like dirt. Few of the many kinds of protists look alike.

These unique organisms are hard to classify. Scientists are always learning more about protist relationships. So, organizing protists into groups is not easy. One way that protists are grouped is based on shared traits. Using this method, scientists can place protists into three groups: producers, heterotrophs that can move, and heterotrophs that can't move. These groups do not show how protists are related to each other. But these groups do help us understand how protists can differ.

## Protist Producers

Many protists are producers. Like plants, protist producers use the sun's energy to make food through photosynthesis. These protist producers are known as **algae** (AL JEE). All algae (singular, *alga*) have the green pigment chlorophyll, which is used for making food. But most algae also have other pigments that give them a color. Almost all algae live in water.

Some algae are made of many cells, as shown in **Figure 1**. Many-celled algae generally live in shallow water along the shore. You may know these algae as *seaweeds*. Some of these algae can grow to many meters in length.

Free-floating single-celled algae are called **phytoplankton** (FIET oh PLANGK tuhn). These algae cannot be seen without a microscope. They usually float near the water's surface. Phytoplankton provide food for most other organisms in the water. They also produce much of the world's oxygen.



## CHAPTER RESOURCES

## Chapter Resource File

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

## Technology

- Transparencies
- Bellringer

## Workbooks

- Interactive Textbook **Struggling Readers**

## Teach



### READING STRATEGY

BASIC

**Prediction Guide** Before students read about algae, ask them, “Knowing that algae carry out photosynthesis, what substance would you expect to find in their cells?” (the green pigment chlorophyll) **LS Logical**



### Cultural Awareness

GENERAL

**Seaweed Medicines** Native Hawaiians have historically used a species of brown alga from the genus *Sargassum* to heal cuts caused by corals. The algae were chopped up and applied to cuts as a poultice. Other seaweeds contain compounds that may have medicinal value as well. About 20 different seaweeds are used in preparations for treating diseases, including intestinal parasite infections and cancer. Have interested students research specific examples of medicinal uses for seaweed. **LS Verbal**

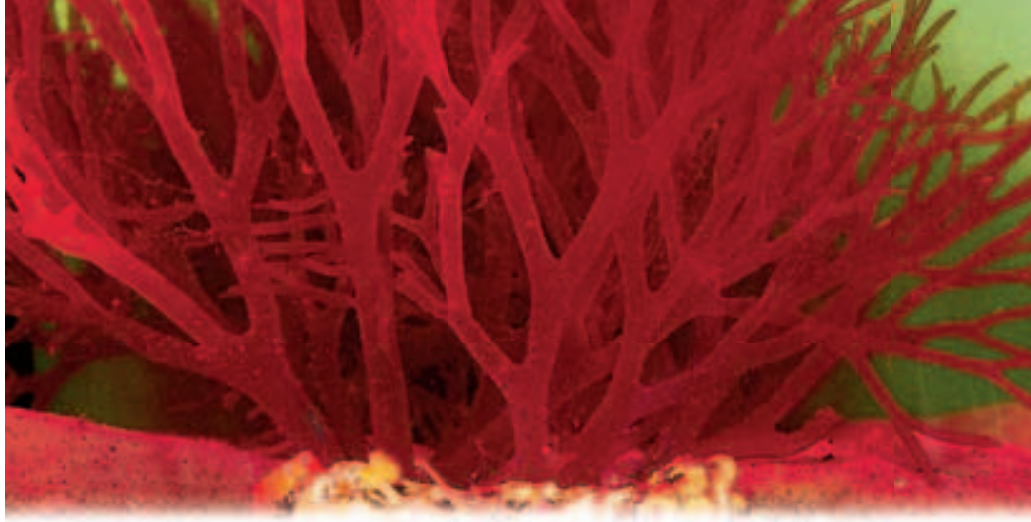
## ACTIVITY

BASIC

**Organizing Algae Information** To help students organize information about the three types of algae described on this page, have students create a table containing three columns, one for each type of alga. The table should have three rows: one describing the size of the alga, one describing where the alga can be found, and one describing how the alga gets its food. Then, have students reread this page and record information about the different kinds of algae in the appropriate spaces on their table.

**LS Visual**

English Language Learners



### Red Algae

Most of the world's seaweeds are red algae. Most red algae live in tropical oceans, attached to rocks or to other algae. Red algae are usually less than 1 m in length. Their cells contain chlorophyll, but a red pigment gives them their color. Their red pigment allows them to absorb the light that filters deep into the clear water of the Tropics. Red algae can grow as deep as 260 m below the surface of the water. An example of a red alga can be seen in **Figure 2**.

**✓ Reading Check** If red algae have chlorophyll in their cells, why aren't they green? (See the Appendix for answers to Reading Checks.)

### Green Algae

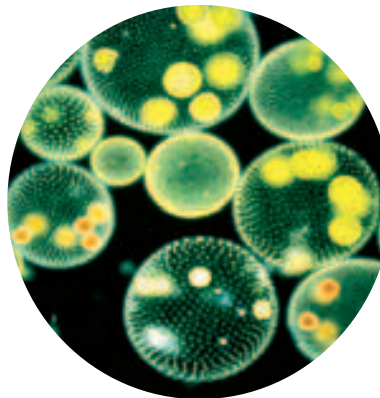
The green algae are the most diverse group of protist producers. They are green because chlorophyll is the main pigment in their cells. Most live in water or moist soil. But others live in melting snow, on tree trunks, and inside other organisms.

Many green algae are single-celled organisms. Others are made of many cells. These many-celled species may grow to be 8 m long. Individual cells of some species of green algae live in groups called *colonies*. **Figure 3** shows colonies of *Volvox*.

### Brown Algae

Most of the seaweeds found in cool climates are brown algae. They attach to rocks or form large floating beds in ocean waters. Brown algae have chlorophyll and a yellow-brown pigment. Many are very large. Some grow 60 m—as long as about 20 cars—in just one season! Only the tops of these gigantic algae are exposed to sunlight. These parts of the algae make food through photosynthesis. This food is transported to parts of the algae that are too deep in the water to receive sunlight.

**Figure 2** This *Sebdenia* (seb DEE nee uh) is a red alga.



**Figure 3** *Volvox* is a green alga that grows in round colonies.

### Is That a Fact!

Giant kelp, a type of brown alga, is anchored to the ocean bottom. It has air bladders that help keep it floating upward, toward the water's surface, where the sunlight is the strongest.

### Answer to Reading Check

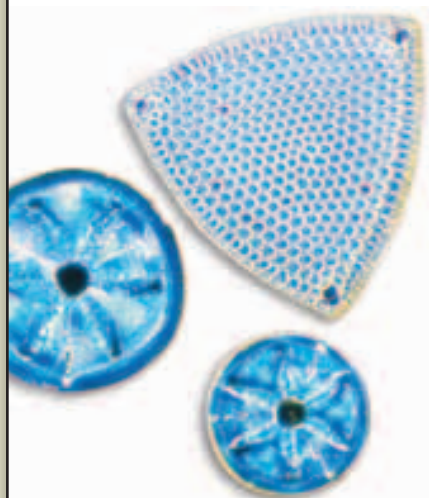
Red algae also have a red pigment in their cells that gives the algae a red color.



## CONNECTION ACTiVity

Art ADVANCED

**Art with Algae** Anna Atkins (1799–1871) was an amateur botanist. Atkins specialized in making photographic blueprints called *cyanotypes*, or sunprints. Over a 10-year period, Atkins created hundreds of cyanotypes of algae from the British Isles. Her book, *British Algae: Cyanotype Impressions*, was published in 1843 and is thought to be the first book illustrated with photographic images. Interested students may wish to create their own cyanotypes of algae to accompany their reports. Students may use leaves, fern fronds, or other plant parts if algae are not available. Cyanotype paper can be obtained from biological supply houses. **Visual**



**Figure 4** Although most diatoms are free floating, some cling to plants, shellfish, sea turtles, and whales.

### Diatoms

Diatoms (DIE e TAHMZ) are single celled. They are found in both salt water and fresh water. Diatoms get their energy from photosynthesis. They make up a large percentage of phytoplankton. **Figure 4** shows some diatoms' many unusual shapes. The cell walls of diatoms contain a glasslike substance called *silica*. The cells of diatoms are enclosed in a two-part shell.

### Dinoflagellates

Most dinoflagellates (DIE noh FLAJ uh lits) are single celled. Most live in salt water, but a few species live in fresh water. Some dinoflagellates even live in snow. Dinoflagellates have two whiplike strands called *flagella* (singular, *flagellum*). The beating of these flagella causes the cells to spin through the water. Most dinoflagellates get their energy from photosynthesis, but a few are consumers, decomposers, or parasites.

**✓ Reading Check** Name three places where dinoflagellates live.

### Euglenoids

Euglenoids (yoo GLEE NOYDZ) are single-celled protists. Most euglenoids live in fresh water. They use their flagella to move through the water. Many euglenoids are producers and so make their own food. But when there is not enough light to make food, these euglenoids can get food as heterotrophs. Other euglenoids do not contain chlorophyll and cannot make food. These euglenoids are full-time consumers or decomposers. Because euglenoids can get food in several ways, they do not fit well into any one protist group. **Figure 5** shows the structure of a euglenoid.

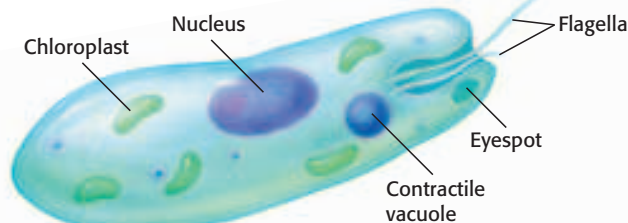
**Figure 5** The Structure of Euglenoids

Photosynthesis takes place in **chloroplasts**. These structures contain the green pigment chlorophyll.

Most euglenoids have two **flagella**, one long and one short. Euglenoids use flagella to move through water.

Euglenoids can't see, but they have **eyespot**s that sense light.

A special structure called a **contractile vacuole** holds excess water and removes it from the cell.



## ACTiVity

GENERAL

**Writing** **Concept Mapping** Have students construct a concept map using the following terms: *brown algae*, *algae*, *phytoplankton*, *protists*, *red algae*, *green algae*, *diatoms*, *dinoflagellates*, and *producers*. **Visual/Verbal**

**Answer to Reading Check**  
salt water, fresh water, and snow

### CHAPTER RESOURCES

#### Technology



**Transparencies**

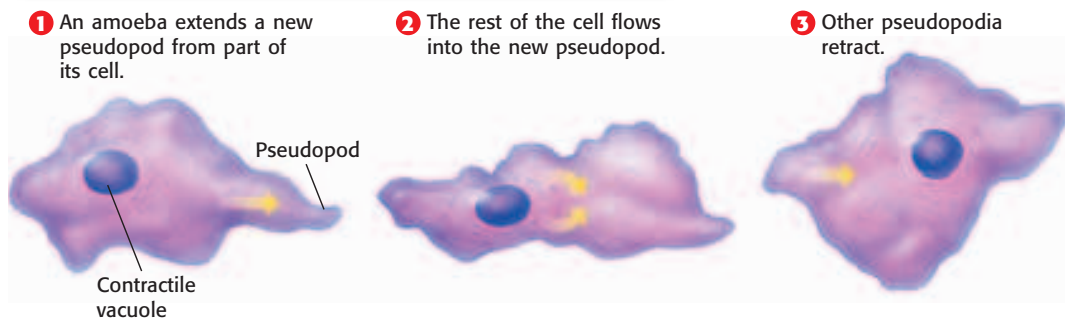
• L39 *Euglena*, *Paramecium*

### SUPPORT FOR

#### English Language Learners

**Poster Project** Have groups of 4 students create posters representing one type of protist: producers, heterotrophs that can move, and heterotrophs that can't move. Posters should show the members of the protist type and how they obtain food. Check posters, and have students correct content or language errors. Make clear that all students must learn about all types of protists. Groups should act as class "experts" for their types of protist. **Visual/Verbal**

**Figure 6 Amoebic Movement**



## Heterotrophs That Can Move

Some heterotrophic protists have special traits that allow them to move. Other heterotrophic protists cannot move on their own. Those that can move are usually single-celled consumers or parasites. These mobile protists are sometimes called *protozoans* (PROHT oh ZOH uhnz).

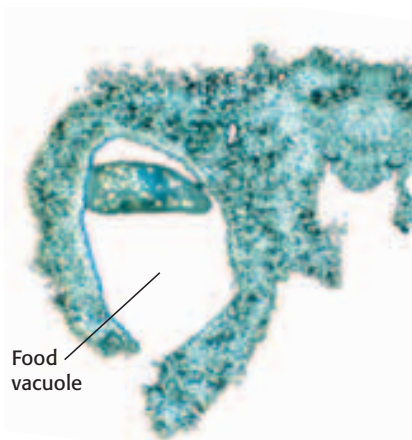
### Amoebas

Amoebas (uh MEE buhs) and similar amoeba-like protists are soft, jellylike protozoans. They are found in both fresh and salt water, in soil, and as parasites in animals. Although amoebas look shapeless, they are highly structured cells. Amoebas have contractile vacuoles to get rid of excess water. Many amoebas eat bacteria and small protists. But some amoebas are parasites that get food by invading other organisms. Certain parasitic amoebas live in human intestines and cause amoebic dysentery (uh MEE bik DIS uhnh TER ee). This painful disease causes internal bleeding.

### Amoebic Movement

Amoebas and amoeba-like protists move with pseudopodia (soo doh POH dee uh). *Pseudopodia* means “false feet.” To move, an amoeba stretches a pseudopod out from the cell. The cell then flows into the pseudopod. **Figure 6** shows how an amoeba uses pseudopodia to move.

Amoebas and amoeba-like protists use pseudopodia to catch food, too. When an amoeba senses a food source, it moves toward the food. The amoeba surrounds the food with its pseudopodia. This action forms a *food vacuole*. Enzymes move into the vacuole to digest the food, and the digested food passes into the amoeba. **Figure 7** shows an amoeba catching food. To get rid of wastes, an amoeba reverses the process. A waste-filled vacuole is moved to the edge of the cell and is released.



**Figure 7** An amoeba engulfs its prey with its pseudopodia.

## Using the Figure—GENERAL



**Amoebas** Tell students that **Figure 6** shows how an amoeba moves. Explain to students that an amoeba moves by first stretching out a pseudopod and allowing the rest of its cytoplasm to flow into the extended pseudopod. Once this movement is completed, the amoeba retracts its other pseudopod. Ask students to draw in their **science journal** all three stages of an amoeba moving.

**Visual**

**English Language Learners**

## ACTIVITY

GENERAL

### Observing Live Amoebas

Obtain live amoebas from a biological supply house. Have students work in pairs to place an amoeba on a slide with a little water and to observe it under a microscope. Have students observe how the amoeba moves. Students should also look for contractile vacuoles in their specimens. **Kinesthetic**

## CONNECTION to Language Arts—GENERAL

**Word Origins** Tell students that the word *protozoan* comes from the roots *protos*, which means “first,” and *zoion*, which means “animal.” Ask students to guess why those roots make up the word *protozoan*, which was once used to describe mobile heterotrophic protists. **Verbal**



**Q: Knock, Knock!**

**A: Who's there?**

**Q: Euglena.**

**A: Euglena who?**

**Q: Euglena your room, or you're grounded!**



People may have more in common with amoebas than they think. Researchers have discovered that very similar contractile proteins are used in both amoeboid movement and the movement of animal muscles. The cytoplasm of an amoeba contains thick and thin filaments that are almost identical to the thick myosin filaments and the thin actin filaments found in the striated muscle of humans.

## Teach, continued

### Discussion GENERAL

**Protists and Pyramids** Ask students the following questions:

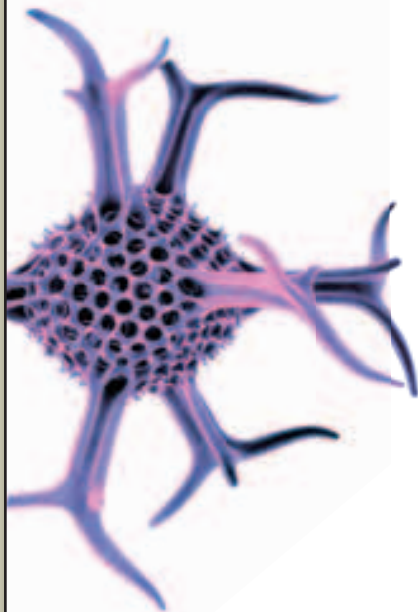
- What are the great pyramids of Egypt made of? (Accept all reasonable responses.)
- How is it possible that the pyramids are made, in part, of protist shells? (Accept all reasonable responses.)

Tell students that tiny, single-celled protists called *foraminiferans* make shells. When the foraminiferans die, the shells fall to the ocean floor. Over millions of years, the shells collect and mix with other minerals in the ocean water. Under the pressure of the ocean water, these components form the type of limestone that was used to make the great pyramids of Egypt. **LS Verbal**

### CONNECTION to Earth Science GENERAL

**Foraminiferans** For millions of years, different species of foraminiferans flourished and then died out, leaving distinctive layers in sea-floor deposits. Some of those deposits are now exposed as thick outcroppings of limestone. These fossils provide clues about the age of rock layers and the relationship between limestone deposits in different parts of the world. Use the teaching transparency titled “The Geologic Time Scale” to discuss the geologic time scale.

**LS Visual**



**Figure 8** Radiolarians are amoeba-like protists that have shells.

#### CONNECTION TO Geology

**Shell Deposits** Foraminiferans have existed for more than 600 million years. During this time, shells of dead foraminiferans have been sinking to the bottom of the ocean. Millions of years ago, foraminiferan shells formed a thick layer of sediment of limestone and chalk deposits. The chalk deposits in England that are known as the White Cliffs of Dover formed in this way. Use geology books to find examples of sedimentary rocks formed from protist shells. Make a poster that explains the process by which shells become sedimentary rock.

**ACTIVITY**

### Shelled Amoeba-Like Protists

Not all amoeba-like protists look shapeless. Some have an outer shell. *Radiolarian* (RAY dee oh LER ee uhn) shells look like glass ornaments, as shown in **Figure 8**. *Foraminiferans* (fuh RAM uh NIF uhr uhnz) have snail-like shells. These protists move by poking pseudopodia out of pores in the shells.

**✓ Reading Check** Name two shelled, amoeba-like protists.

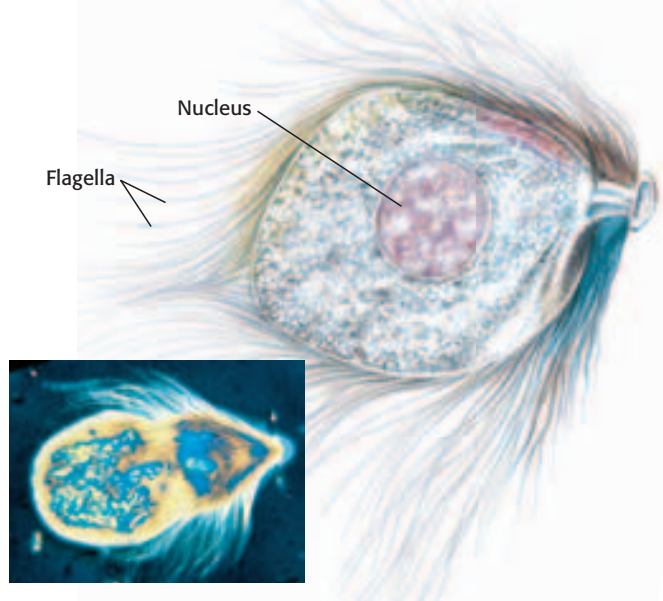
### Zooflagellates

Zooflagellates (ZOH uh FLAJ uh LAYTS) are protists that wave flagella back and forth to move. Some zooflagellates live in water. Others live in the bodies of other organisms.

Some zooflagellates are parasites that cause disease. The parasite *Giardia lamblia* (jee AWR dee uh LAM blee uh) can live in the digestive tract of many vertebrates. One form of *G. lamblia* lives part of its life in water. People who drink water infected with *G. lamblia* can get severe stomach cramps.

Some zooflagellates live in mutualism with other organisms. In *mutualism*, one organism lives closely with another organism. Each organism helps the other live. The zooflagellate in **Figure 9** lives in the gut of termites. This zooflagellate digests the cell walls of the wood that the termites eat. Both organisms benefit from the arrangement. The protist helps the termite digest wood. The termite gives the protist food and a place to live.

**Figure 9** The Structure of Flagellates



### CHAPTER RESOURCES

#### Technology



#### Transparencies

- **LINK TO EARTH SCIENCE** E111 The Geologic Time Scale

**Answer to Reading Check**  
radiolarians and foraminiferans



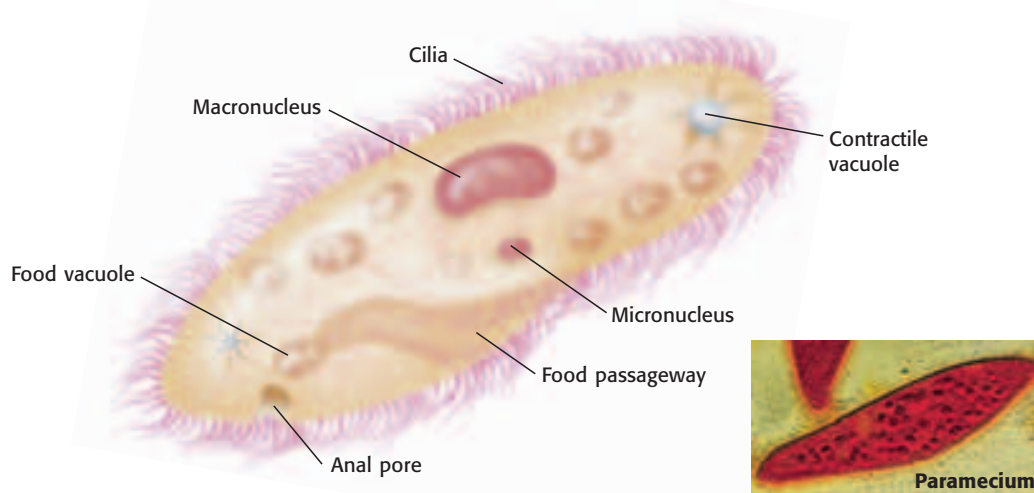
**Figure 10** The Structure of a Paramecium

Members of the genus *Paramecium* eat by using cilia to sweep food into a **food passageway**.

Food enters a **food vacuole**, where enzymes digest the food.

Food waste is removed from the cell through the **anal pore**.

A **contractile vacuole** pumps out excess water.



### Ciliates

Ciliates (SIL ee its) are complex protists. They have hundreds of tiny, hairlike structures known as *cilia*. The cilia move a protist forward by beating back and forth. Cilia can beat up to 60 times a second! Ciliates also use their cilia for feeding. The cilia sweep food toward the protist's food passageway. The best-known genus of ciliates is *Paramecium*, shown in **Figure 10**.

The cell of a paramecium has two kinds of nuclei. A large nucleus called a *macronucleus* controls the functions of the cell. A smaller nucleus, the *micronucleus*, passes genes to another paramecium during sexual reproduction.

### Heterotrophs That Can't Move

Not all protist heterotrophs have features that help them move. Some of these protists are parasites that do not move about. Others can move only at certain phases in their life cycle.

### Spore-Forming Protists

Many spore-forming protists are parasites. They absorb nutrients from their hosts. They have no cilia or flagella, and they cannot move on their own. Spore-forming protists have complicated life cycles that usually include two or more hosts. For example, the spore-forming protist that causes malaria uses both mosquitoes and humans as hosts.

### CONNECTION TO Social Studies

**Malaria** *Plasmodium vivax* is a spore-forming protist that causes malaria. People get malaria in tropical areas when they are bitten by mosquitoes carrying *P. vivax*. Malaria can be treated with drugs, but many people do not have access to these drugs. Millions of people die from malaria each year. Research malaria rates in different parts of the world, and give a presentation of your findings to the class.

### ACTIVITY

### Is That a Fact!

Deposits of foraminiferan shells on the sea floor are thousands of meters thick and cover millions of square kilometers. The sand of some beaches is also mostly made from the remains of foraminiferans. There are nearly 50,000 of these foraminiferan shells in 1 g of sand.

### CONNECTION ACTIVITY Social Studies

ADVANCED

**Researching Malaria** Malaria is an enormous world health problem. According to the World Health Organization, 500 million people contract malaria each year and 2.7 million people die from it each year. Have students conduct library or Internet research on the nature of the disease and modern efforts to combat it. **LS Verbal**

## Research

ADVANCED



**Animalcules** Anton van Leeuwenhoek (1632–1723) called the tiny, active organisms he viewed under his handmade microscopes *animalcules*. The ciliated protozoans undoubtedly are the most animal-like members of the kingdom Protista. Have students research a ciliate protozoan of their choice. Encourage students to make posters of their ciliate. Posters should include a large, detailed drawing of the ciliate, information about where it lives, what it eats, and how it moves, and other interesting information about its biology.

**LS Visual**

### INCLUSION Strategies

- **Hearing Impaired**
- **Developmentally Delayed**
- **Learning Disabled**

Students can better understand and remember new information when they relate it to familiar information. Ask students to look at the pictures of protists throughout this section and identify familiar items that look like the different kinds of protists. Some possibilities include giant kelp: wide noodles; *Sebdenia*: a branching plant; colonies of *Volvox*: rubber balls; paramecium: a removable shoe liner; and slime mold sporangia: cherry tomatoes.

**LS Visual**

English Language Learners

## Close

### Reteaching

BASIC

**Phytoplankton** To help students remember what phytoplankton are, tell them that the word *phytoplankton* comes from the roots *phyto*, which means “plant,” and *planktos*, which means “wandering.” Remind students that phytoplankton are protist producers. **LS Verbal**

### Quiz

GENERAL

1. Why are euglenoids difficult to classify? (Sample answer: Many euglenoids can be producers or heterotrophs.)
2. Name three protists that are producers. (red, brown, and green algae; diatoms; and many euglenoids)

### Alternative Assessment

BASIC



**Pretty Protists** Ask students to find pictures of magnified protists on the Internet or at a library. Students should choose five pretty or interesting organisms and draw those protists on a poster that describes each organism. **LS Visual**

**Answer to Reading Check**  
as decomposers or as parasites

**Figure 11** Parasitic water molds attack various organisms, including fish.



### Internet Activity

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

### Water Molds

Water molds are also heterotrophic protists that can't move. Most water molds are small, single-celled organisms. Water molds live in water, moist soil, or other organisms. Some of them are decomposers and thus eat dead matter. But many are parasites. Their hosts can be living plants, animals, algae, or fungi. A parasitic water mold is shown in **Figure 11**.

**✓ Reading Check** Name two ways that water molds get food.

### Slime Molds

Slime molds are heterotrophic protists that can move only at certain phases of their life cycle. They look like thin, colorful, shapeless globs of slime. Slime molds live in cool, moist places in the woods. They use pseudopodia to move and to eat bacteria and yeast. They also decompose small bits of rotting organic matter by surrounding small pieces of the matter and then digesting them.

Some slime molds live as a giant cell that has many nuclei and a single cytoplasm at one stage of life. As long as food and water are available, the cell will continue to grow. One cell may be more than 1 m across! Other slime molds live as single-celled individuals that can come together as a group when food or water is hard to find.

When environmental conditions are stressful, slime molds grow stalklike structures with rounded knobs at the top, as shown in **Figure 12**. The knobs contain spores. *Spores* are small reproductive cells covered by a thick cell wall. The spores can survive for a long time without water or nutrients. As spores, slime molds cannot move. When conditions improve, the spores will develop into new slime molds.

**Figure 12** The spore-containing knobs of a slime mold are called sporangia (spoh RAN jee uh).



### Group Activity

ADVANCED

**Make a Slime Mold** For this activity, students should wear safety goggles, an apron, and protective gloves. They should not put any of the materials in their mouths. Food coloring is nontoxic but can stain skin and clothing. Students can make a substance that behaves much like a slime mold. Have students work in groups of four or five. Each group should have a 25 × 25 cm (9 × 9 in.) pan, cornstarch, food coloring, a small container of water, a measuring cup, and a tablespoon. Instruct the students to

place 240 mL (1 cup) of cornstarch in the pan. Then, have them add 15 mL (1 Tbsp) of water at a time to the cornstarch until the mixture has the consistency of a slime that flows slowly. Then, have them mix a few drops of food coloring into the mixture, and allow students to explore moving the slime around in the pan. They can put small objects, such as paper clips, in the path of the slime and let the substance surround the objects.

**LS Kinesthetic**

English Language Learners

## SECTION Review

### Summary

- Protists can be organized into the following groups: producers, heterotrophs that can move, and heterotrophs that cannot move.
- Protist producers make their own food through photosynthesis. They are known as *algae*, and most live in water. Free-floating single-celled algae are phytoplankton.
- Red algae, green algae, brown algae, diatoms, dinoflagellates, and some euglenoids are producers.
- Heterotrophic protists cannot make their own food. They are consumers, decomposers, or parasites. Those that can move are sometimes called *protozoans*.
- Amoeba-like protists, shelled amoeba-like protists, flagellates, and ciliates are heterotrophs that can move.
- Spore-forming protists, water molds, and slime molds are protists that cannot move or can move only in certain phases of their life cycle.

### Using Key Terms

1. Use the following terms in the same sentence: *phytoplankton* and *algae*.

### Understanding Key Ideas

2. Which of the following kinds of protists are producers?
  - a. diatoms
  - b. amoebas
  - c. slime molds
  - d. ciliates
3. How do many amoeba-like protists eat?
  - a. They secrete digestive juices onto food.
  - b. They produce food from sunlight.
  - c. They engulf food with pseudopodia.
  - d. They use cilia to sweep food toward them.
4. Give an example of one protist from each of the three groups of protists.
5. Explain why it makes sense to group protists based on shared traits rather than by how they are related to each other.

### Critical Thinking

6. **Making Comparisons** How do protist producers, heterotrophs that can move, and heterotrophs that can't move differ?

7. **Making Inferences** You learned how shelled amoeba-like protists move. How do you think they get food into their shells in order to eat?

### Interpreting Graphics

Use the photo below to answer the questions that follow.



8. How does this protist move?
9. Identify what kind of protist is shown. To do so, first make a list of the kinds of protists that this organism could not be.

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: *Algae; Protozoans*

SciLinks code: HSM0042; HSM1247

### CHAPTER RESOURCES

#### Chapter Resource File



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

### Answers to Section Review

1. Sample answer: Phytoplankton are single-celled free-floating algae.
2. a
3. c
4. Sample answer: protist producer: diatom; heterotrophic protist that can move: radiolarian; heterotrophic protist that can't move: water mold
5. Scientists are not sure how protists are related to each other. Protists are a very diverse group of organisms. So, grouping them by their shared traits is a helpful way to organize protists.
6. The three groups of protists differ from each other in the ways that they get food and the ways that they move. Protist producers make food by photosynthesis. A few of them have flagella and can move. Heterotrophs get food by eating other organisms or organic matter. The two groups of heterotrophs differ in whether they can move. One group can move throughout the entire life cycle, and the other group can move only at certain parts of the life cycle or not at all.
7. Sample answer: Shelled amoeba-like protists can use their pseudopodia to eat. They can poke the pseudopodia out of the pores in their shells and engulf food outside the shell.
8. Sample answer: This protist has flagella, so we can assume it moves with its flagella.
9. The protist cannot be an amoeba-like protist because it does not have pseudopodia. It can't be a ciliate because it has no cilia. It can't be a euglenoid or a dinoflagellate, because it has more than two flagella. It can't be a protist producer, because it has no chloroplasts. Based on the photo, it must be a zooflagellate.



## Focus

## Overview

In this section, students will learn about fungi—eukaryotic consumers that obtain their food by absorbing nutrients from other organisms. Students will be introduced to the four main groups of fungi: threadlike fungi, sac fungi, club fungi, and imperfect fungi. Finally, students will learn about lichens.

## Bellringer

Ask students to answer the following questions:

- What are mushrooms?
- What is the function of a mushroom's cap? (The umbrella-shaped mushrooms that students may be most familiar with are club fungi. The above-ground part of the mushroom produces spores.)

## Motivate

Discussion GENERAL

**Fungi** Ask students to describe a world without fungi. (Accept all reasonable responses. Explain that without fungi, there would be no leavened bread, penicillin, blue cheese, or mushroom pizza. Also, many plant species would grow poorly without help from mycorrhizae. And because fungi are decomposers, dead organic matter might collect without fungi.) **LS Verbal**

## What You Will Learn

- Describe the characteristics of fungi.
- Distinguish between the four main groups of fungi.
- Explain how lichens affect their environment.

## Vocabulary

fungus	spore
hypha	mold
mycelium	lichen

## READING STRATEGY

**Paired Summarizing** Read this section silently. In pairs, take turns summarizing the material. Stop to discuss ideas that seem confusing.

**fungus** an organism whose cells have nuclei, rigid cell walls, and no chlorophyll and that belongs to the kingdom Fungi

**Figure 1** Fungi vary greatly in their appearance.

▼ Straight coral fungus



▲ Bird's nest fungus

▼ Witch's hat fungus



## Fungi

How are cheese, bread, and soy sauce related to fungi? A fungus can help make each of these foods.

Fungi (singular, *fungus*) are everywhere. The mushrooms on pizza are a type of fungus. The yeast used to make bread is a fungus. And if you've ever had athlete's foot, you can thank a fungus for that, too.

## Characteristics of Fungi

**Fungi** are eukaryotic heterotrophs that have rigid cell walls and no chlorophyll. They are so different from other organisms that they are placed in their own kingdom. As you can see in **Figure 1**, fungi come in a variety of shapes, sizes, and colors.

## Food for Fungi

Fungi are heterotrophs, but they cannot catch or surround food. Fungi must live on or near their food supply. Most fungi are consumers. These fungi get nutrients by secreting digestive juices onto a food source and then absorbing the dissolved food. Many fungi are decomposers, which feed on dead plant or animal matter. Other fungi are parasites.

Some fungi live in mutualism with other organisms. For example, many types of fungi grow on or in the roots of a plant. The plant provides nutrients to the fungus. The fungus helps the root absorb minerals and protects the plant from some disease-causing organisms. This relationship between a plant and a fungus is called a *mycorrhiza* (MIE koh RIE zuh).

## CHAPTER RESOURCES

## Chapter Resource File

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

## Technology

- Transparencies
- Bellringer

## Workbooks

- Interactive Textbook **Struggling Readers**

## Is That a Fact!

There are about 350 species of yeasts. The most economically important species of yeasts is *Saccharomyces cerevisiae*, which has been used by humans in the production of bread, beer, and wine for thousands of years.



**Prediction Guide** Before students read the rest of this section, ask them if each of the following statements is true or false. Students will learn the answers as they read the section.

- Unlike protists, fungi can reproduce only asexually. (false)
- Morels and truffles are highly prized fungi. (true)
- Lichens are a combination of a fungus and an alga. (true)

**LS Verbal**

## Discussion

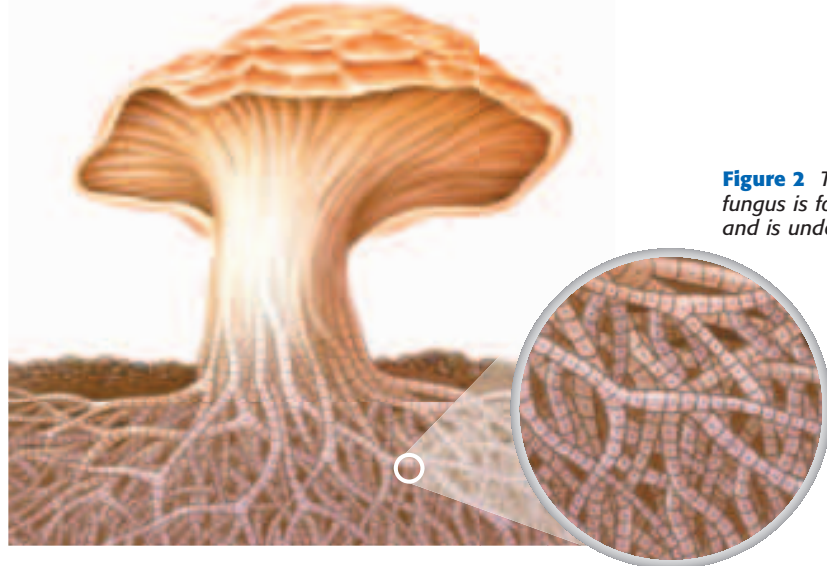
GENERAL

**Allergies and Molds** Ask students if they or people that they know are allergic to molds. As a class, encourage students to discuss why mold allergies are so common. Then, have students discuss what types of environments or substances mold-sensitive people might want to avoid and why. (Sample answer: One reason mold allergies are common is that molds and mold spores are so common. Mold-sensitive individuals might want to avoid caves, damp basements, damp soil, leaf litter, and other decaying organic matter because molds flourish in such places and materials.)

**LS Verbal/Auditory**

## Answer to Reading Check

hyphae breaking apart so that each piece becomes a new fungus or fungi producing spores



**Figure 2** The mycelium of a fungus is formed by hyphae and is underground.

### Hidden from View

All fungi are made of eukaryotic cells, which have nuclei. Some fungi are single celled, but most fungi are made of many cells. These many-celled fungi are made up of chains of cells called hyphae (HIE fee). **Hyphae** (singular, *hypha*) are threadlike fungal filaments. These filaments are made of cells that have openings in their cell walls. These openings allow cytoplasm to move freely between the cells.

Most of the hyphae that make up a fungus grow together to form a twisted mass called the **mycelium** (mie SEE lee uhm). The mycelium makes up the major part of the fungus. However, this mass is hidden from view underneath the ground. **Figure 2** shows the hyphae of a fungus.

### Making More Fungi

Reproduction in fungi may be either asexual or sexual. Asexual reproduction in fungi occurs in two ways. In one type of asexual reproduction, the hyphae break apart, and each new piece becomes a new fungus. Asexual reproduction can also take place by the production of spores. **Spores** are small reproductive cells that are protected by a thick cell wall. Spores are light and easily spread by wind. When the growing conditions where a spore lands are right, the spore will grow into a new fungus.

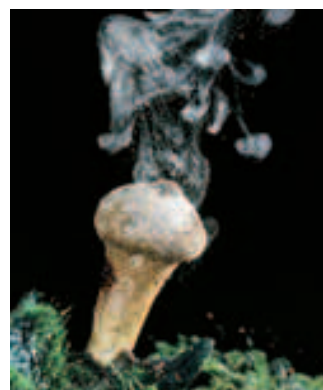
Sexual reproduction in fungi happens when special structures form to make sex cells. The sex cells join to produce sexual spores that grow into a new fungus. **Figure 3** shows a fungus releasing sexual spores into the air.

**✓ Reading Check** What are two ways that fungi can reproduce asexually? (See the Appendix for answers to Reading Checks.)

**hypha** a nonreproductive filament of a fungus

**mycelium** the mass of fungal filaments, or hyphae, that forms the body of a fungus

**spore** a reproductive cell or multicellular structure that is resistant to stressful environmental conditions and that can develop into an adult without fusing with another cell



**Figure 3** This puffball is releasing sexual spores that can produce new fungi.

## SUPPORT FOR

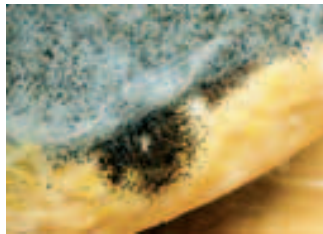
### English Language Learners

**Fungi** Because there are so many different types of fungi, their common characteristics will need to be emphasized so that students remember they are all in one kingdom. Have students look at the photos of fungi throughout this section and list elements they have in common. Elicit these shared elements from students, and write them on the board to check for accuracy. When the list of characteristics is complete and accurate, ask students to

copy it into their science journals as a key to deciding whether or not something belongs in the fungi kingdom. **LS Visual/Verbal**



**Tempeh** Centuries ago, Indonesians found that the bread mold of the genus *Rhizopus* can be used to make a food called *tempeh*. Soybeans that have been stripped of their skins and boiled are inoculated with this mold and left to sit for 24 hours. A mycelium grows around the soybeans, holding them together in a mass and producing enzymes that increase the level of B vitamins in the mixture. Tempeh is very nutritious and is prepared daily in many Indonesian homes, just as bread is in many other countries. Tempeh can be fried, baked, steamed, or roasted. Ask interested students to find a recipe that uses tempeh. **Verbal**



**Figure 4** Black bread mold is a soft, cottony mass that grows on bread and fruit.

**mold** a fungus that looks like wool or cotton

## QUICK LAB

### Moldy Bread

1. Dampen a slice of bread with a few drops of water, and then seal it in a plastic bag for 1 week.
2. Draw a picture of the bread in the plastic bag.
3. Predict what you think will happen during the week. Will the bread get moldy?
4. After the week has passed, check on the bread in the plastic bag. Compare it with your original drawing. What happened? Were your predictions correct?
5. With a partner, discuss where you think mold spores come from and how they grow.

## QUICK LAB

### MATERIALS

#### FOR EACH GROUP

- bag, plastic, sealable
- bread, 1 slice
- water

### Answers

4. After a week, the bread should have become moldy.
5. Answers may vary. The mold spores likely came from the air and grew using the nutrients in the bread and water.

## Kinds of Fungi

Fungi are classified based on their shape and the way that they reproduce. There are four main groups of fungi. Most species of fungi fit into one of these groups. These groups are threadlike fungi, sac fungi, club fungi, and imperfect fungi.

### Threadlike Fungi

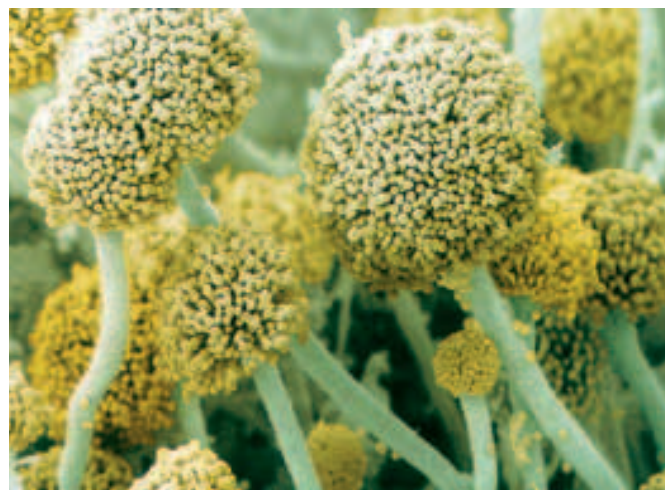
Have you ever seen fuzzy mold growing on bread? A **mold** is a shapeless, fuzzy fungus. **Figure 4** shows a black bread mold. This particular mold belongs to a group of fungi called *threadlike fungi*. Most of the fungi in this group live in the soil and are decomposers. However, some threadlike fungi are parasites.

Threadlike fungi can reproduce asexually. Parts of the hyphae grow into the air and form round spore cases at the tips. These spore cases are called *sporangia* (spoh RAN jee uh). **Figure 5** shows some magnified sporangia. When the sporangia break open, many tiny spores are released into the air. New fungi will develop from these spores if they land in an area with good growing conditions.

Threadlike fungi can also reproduce sexually. Threadlike fungi reproduce sexually when a hypha from one individual joins with a hypha from another individual. The hyphae grow into specialized sporangia that can survive times of cold or little water. When conditions improve, these specialized sporangia release spores that can grow into new fungi.

**Reading Check** Describe two ways that threadlike fungi can reproduce.

**Figure 5** Each of the round sporangia contains thousands of spores.



## WEIRD SCIENCE

The mold of the genus *Pilobolus* grows on animal manure. This mold produces little sacs of spores on top of stalked structures that swell. As the spores mature, pressure builds up in the swollen structures until the sacs are shot up to 8 m into the air! The spore sacs stick to grass and leaves. When animals eat the plants, the spores pass through their digestive track and end up in their dung, where the spores germinate.

### Answer to Reading Check

asexually by releasing spores from sporangia or sexually by different individuals growing together into specialized sporangia





## Making Models

Encourage students to research a species of sac or club fungus in an encyclopedia, in books on fungi, or on the Internet. Provide students with colored modeling clay, and have them create lifelike models of the fungi they have investigated. Make a class display of the fungus models.

**LS** Kinesthetic

English Language Learners

## CONNECTION ActiViTy

Math

ADVANCED

**Cooking Calculations** Truffles are called the black diamonds of French cooking. Tell students that in western France, an unusually dry summer produced a smaller-than-usual harvest. Prices of first-quality truffles rose from \$535 per kilogram to \$625 per kilogram. Ask students, “What percentage increase in the price of truffles does this price difference represent?”  
 $(\$625 - \$535 = \$90; \$90 \div 535 \times 100 = 16.8\% \text{ increase})$

Tell students to imagine that they are chefs and are required to make a new dish with a recipe that calls for 1 lb of truffles. Ask students, “How many kilograms of this high-priced fungus will you need to buy, and what will it cost at the new price?”

$(1 \text{ kg} = 2.2 \text{ lb. Students will need } 0.45 \text{ kg for this recipe. The cost would be } \$625 \times 0.45 = \$281.25.)$

**LS** Logical



**Figure 6** Morels are only part of a larger fungus. They are the sexual reproductive part of a fungus that lives under the soil.

## Sac Fungi

Sac fungi are the largest group of fungi. Sac fungi include yeasts, powdery mildews, truffles, and morels. Some morels are shown in **Figure 6**.

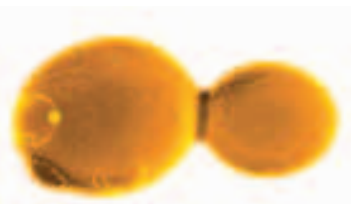
Sac fungi can reproduce both asexually and sexually during their life cycles. Most of the time, they use asexual reproduction. When they reproduce sexually, they form a sac called an *ascus*. This sac gives the sac fungi their name. Sexually produced spores develop within the ascus.

Most sac fungi are made of many cells. However, *yeasts* are single-celled sac fungi. When yeasts reproduce asexually, they use a process called *budding*. In budding, a new cell pinches off from an existing cell. **Figure 7** shows a yeast that is budding. Yeasts are the only fungi that reproduce by budding.

Some sac fungi are very useful to humans. For example, yeasts are used in making bread and alcohol. Yeasts use sugar as food and produce carbon dioxide gas and alcohol as waste. Trapped bubbles of carbon dioxide cause bread dough to rise. This process is what makes bread light and fluffy. Other sac fungi are sources of antibiotics and vitamins. And some sac fungi, such as truffles and morels, are prized as human foods.

Not all sac fungi are helpful. In fact, many sac fungi are parasites. Some cause plant diseases, such as chestnut blight and Dutch elm disease. The effects of Dutch elm disease are shown in **Figure 8**.

**Figure 8** Dutch elm disease is a fungal disease that has killed millions of elm trees.



**Figure 7** Yeasts reproduce by budding. A round scar forms where a bud breaks off from a parent cell.



## Is That a Fact!

Some yeasts produce an enzyme called *invertase*. This enzyme is used by commercial candy makers to soften or liquefy the centers of chocolate candies after the coating has been applied. The invertase takes several weeks to liquefy the centers, so it can be added before the candy is coated with chocolate.

## Quick Lab

## MATERIALS

## FOR EACH STUDENT

- knife, plastic
- magnifying lens
- mushroom

**Safety Caution:** Remind students to review all safety cautions and icons before beginning this lab activity. You may want to ask students to wear protective gloves, especially students with allergies to fungi.

## Answer

4. Students should be able to find and label the stalk, cap, and gills. Spores and hyphae may or may not be visible.

## Activity

## BASIC



## Fungus Reproduction

Have students write out the following words: *threadlike fungi*, *sac fungi*, *club fungi*, *ascus*, *gills*, and *sporangia*. Then, have students match the type of fungus with its appropriate reproductive structure. Finally, have students use each correctly matched pair in a sentence. (*threadlike fungi*, *sporangia*; *sac fungi*, *ascus*; *club fungi*, *gills*)

LS Verbal

## Answer to Reading Check

the spore-forming structures, called *basidia*



**Figure 9** A ring of mushrooms can appear overnight. In European folk legends, these were known as “fairy rings.”

## Quick Lab

## Observe a Mushroom

1. Identify the stalk, cap, and gills on a **mushroom** that your teacher has provided.
2. Carefully twist or cut off the cap, and cut it open with a **plastic knife**. Use a **magnifying lens** to observe the gills. Look for spores.
3. Use the magnifying lens to observe the other parts of the mushroom. The mycelium begins at the bottom of the stalk. Try to find individual hyphae.
4. Sketch the mushroom, and label the parts.

## Club Fungi

The umbrella-shaped mushrooms are the most familiar fungi. Mushrooms belong to a group of fungi called *club fungi*. This group gets its name from structures that the fungi grow during reproduction. Club fungi reproduce sexually. During reproduction, they grow special hyphae that form clublike structures. These structures are called *basidia* (buh SID ee uh), the Greek word for “clubs.” Sexual spores develop on the basidia.

When you think of a mushroom, you probably picture only the spore-producing, above-ground part of the organism. But most of the organism is underground. The mass of hyphae from which mushrooms are produced may grow 35 m across. That’s about as long as 18 adults lying head to toe! Mushrooms usually grow at the edges of the mass of hyphae. As a result, mushrooms often appear in circles, as shown in **Figure 9**.

The most familiar mushrooms are known as *gill fungi*. The basidia of these mushrooms develop in structures called *gills*, under the mushroom cap. Some varieties are grown commercially and sold in supermarkets. However, not all gill fungi are edible. For example, the white destroying angel is a very poisonous fungus. Simply a taste of this mushroom can be fatal. See if you can pick out the poisonous fungus in **Figure 10**.

**✓ Reading Check** What part of a club fungus grows above the ground?



**Figure 10** Many poisonous mushrooms look just like edible ones. Never eat a mushroom from the wild unless a professional identifies it in person.

## WEIRD SCIENCE

Mushrooms consist mostly of water (about 90%). But some fungi are nutritious. The shiitake mushroom has been grown for centuries in Japan and China. In ancient China, people believed that eating shiitake mushrooms promoted good health. They were right—shiitake

mushrooms are rich in iron, phosphorus, calcium, and vitamins B, D, and C. Shiitake mushrooms also have twice the protein content of most other commercially grown mushrooms.





**Figure 11** Bracket fungi look like shelves on trees. The underside of the bracket contains spores.

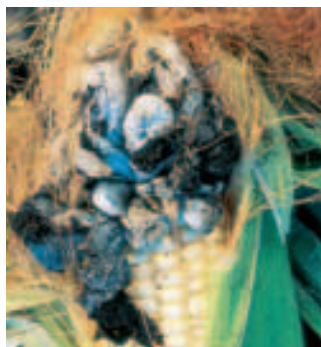
### Nonmushroom Club Fungi

Mushrooms are not the only club fungi. Bracket fungi, puffballs, smuts, and rusts are also club fungi. Bracket fungi grow outward from wood and form small shelves or brackets, as shown in **Figure 11**. Smuts and rusts are common plant parasites. They often attack crops such as corn and wheat. The corn in **Figure 12** has been infected with a smut.

### Imperfect Fungi

The *imperfect fungi* group includes all of the species of fungi that do not quite fit in the other groups. These fungi do not reproduce sexually. Most are parasites that cause diseases in plants and animals. One common human disease caused by these fungi is athlete's foot, a skin disease. Another fungus from this group produces a poison called *aflatoxin* (AF luh TAHKS in), which can cause cancer.

Some imperfect fungi are useful. *Penicillium*, shown in **Figure 13**, is the source of the antibiotic penicillin. Other imperfect fungi are also used to produce medicines. Some imperfect fungi are used to produce cheeses, soy sauce, and the citric acid used in cola drinks.



**Figure 12** This corn is infected with a club fungus called smut.



**Figure 13** The fungus *Penicillium* produces a substance that kills certain bacteria.

### CONNECTION TO Language Arts

**Beatrix Potter** Beatrix Potter (1866–1943) is best known for writing children's stories, such as *The Tale of Peter Rabbit* and *The Tale of Two Bad Mice*. Potter lived and worked in England and had a scholarly interest in fungi. She was a shy person, and she was not taken seriously by fungi scholars of her time. But today, she is widely respected as a mycologist (a scientist who studies fungi). She wrote many valuable papers about fungi and made detailed drawings of more than 270 fungi. Research Potter's life, and present a report to your class.

**Activity**

### WEIRD SCIENCE

A fungus that covered an area of 4 km<sup>2</sup> (2.5 mi<sup>2</sup>) and weighed nearly 1,000 tons was found near Seattle, Washington. The fungus is estimated to be up to 1,000 years old.

### Is That a Fact!

If you are allergic to penicillin, you will probably be allergic to Camembert and Roquefort cheeses, too. These cheeses get their flavor from molds of the genus *Penicillium*.

### CONNECTION to Real World

GENERAL

**Fungal Medicines** Cyclosporin is a chemical compound that was discovered in an imperfect fungus in the 1980s. Cyclosporin suppresses immune reactions that lead to the rejection of transplanted organs. This fungal drug has led to much greater success in organ transplants. Interested students should research other fungal medicines. **Verbal**

### Using the Figure—GENERAL

**Dirty Fungi?** Tell students that the word *smut*, which describes a non-mushroom club fungus, comes from the same root word that led to the words *mud* and *moss*. In fact, another definition for the word *smut* is the following: a mark made by something dirty; a spoiled spot. Ask students to look at the photo of a smut in **Figure 12** and write a few sentences about possible reasons why the name of this fungus relates to dirt. **Verbal**

### MISCONCEPTION ALERT

**Lawn Care** Students may think that they can rid a lawn or a garden of mushrooms by pulling the mushrooms out like they pull out weeds or by chopping the mushrooms up with a hoe. Tell students that because the largest part of a club fungus lives underground, this approach will not work. In fact, chopping up mushrooms with a hoe may help release and spread fungal spores, which could grow into additional mycelia.



## Close

### Reteaching

BASIC

**Drawing Fungi** Ask students to draw an example of each of the four kinds of fungi. Then, ask students why some fungi are hard to draw. (Many fungi do not have a defined shape.) Remind them that much of a club fungus is underground. **LS Visual**

### Quiz

GENERAL

1. Why should you never eat wild mushrooms that haven't been identified by an expert? (Many poisonous mushrooms closely resemble mushrooms that are safe to eat.)
2. From what kind of a fungus is the antibiotic penicillin derived? (an imperfect fungus from the genus *Penicillium*)
3. Where are lichens found? (on bare rocks, soil, tree trunks, and mountain peaks in environments ranging from dry deserts to cold, polar regions)

### Alternative Assessment

GENERAL

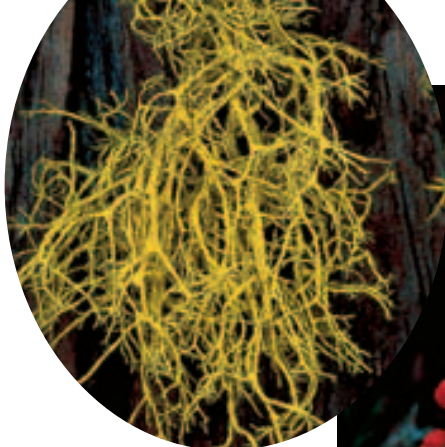
**Describing Fungi** Have students write a story in which they find several fungi on a walk through a temperate forest. Students should identify each fungus' group and its role in the forest ecosystem.

**LS Verbal**



### Answer to Reading Check

Lichens make acids that break down rocks, which causes cracks.

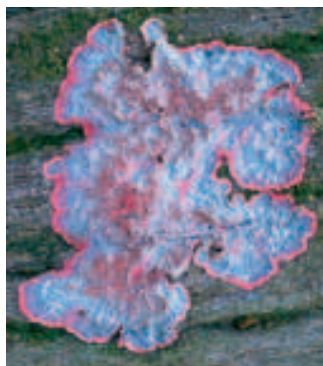


▲ Wolf lichen

British soldier lichen ▶



▼ Christmas lichen



**Figure 14** These are some of the many types of lichens.

**lichen** a mass of fungal and algal cells that grow together in a symbiotic relationship and that are usually found on rocks or trees

### Lichens

A **lichen** (LIE kuhn) is a combination of a fungus and an alga that grow together. The alga actually lives inside the protective walls of the fungus. The resulting organism is different from either organism growing alone. The lichen is a result of a mutualistic relationship. But the merging of the two organisms to form a lichen is so complete that scientists give lichens their own scientific names. **Figure 14** shows some examples of lichens.

Unlike fungi, lichens are producers. The algae in the lichens produce food through photosynthesis. And unlike algae, lichens can keep from drying out. The protective walls of the fungi keep water inside the lichens. Lichens are found in almost every type of land environment. They can even grow in dry environments, such as deserts, and cold environments, such as the Arctic.

Because lichens need only air, light, and minerals to grow, they can grow on rocks. As lichens grow, the changes that they make to their surroundings allow other organisms to live there, too. For example, lichens make acids that break down rocks and cause cracks. When bits of rock and dead lichens fill the cracks, soil is made. Other organisms then grow in this soil.

Lichens absorb water and minerals from the air. As a result, lichens are easily affected by air pollution. So, the presence or absence of lichens can be a good measure of air quality in an area.

**Reading Check** How can lichens affect rocks?

### INCLUSION Strategies

- Attention Deficit Disorder
- Behavior Control Issues
- Hearing Impaired

Many students are more successful when some movement is built into a class period. Give students a chance to move around while they explore the meaning of *intertwined* as it is used to describe how lichens grow. Ask half of the students to select one textbook and the other half to select another textbook. Use several copies of each text book for the following

exercise. Have students place a mixture of the two textbooks flat on the floor in a random arrangement. Then, ask them to consider the mass of textbooks as one object made of many small ones. Discuss how the arrangement of the two kinds of textbooks making up a separate object is similar to the arrangement of the alga and fungus making up a separate organism, a lichen.

**LS Kinesthetic**

English Language Learners

## SECTION Review

### Summary

- Fungi can be consumers, decomposers, or parasites, or they can live in mutualistic relationships with other organisms.
- Most fungi are made up of chains of cells called *hyphae*. Many hyphae join together to form a mycelium.
- The four main groups of fungi are threadlike fungi, sac fungi, club fungi, and imperfect fungi.
- Threadlike fungi are primarily decomposers that form sporangia containing spores.
- During sexual reproduction, sac fungi form little sacs in which sexual spores develop.
- Club fungi form structures called *basidia* during sexual reproduction.
- The imperfect fungi include all of the species that do not quite fit in the other groups. Many are parasites that reproduce only by asexual reproduction.
- A lichen is a combination of a specific fungus and a specific alga. The lichen is different from either organism growing alone.

### Using Key Terms

- In your own words, write a definition for each of the following terms: *spore* and *mold*.

For each pair of terms, explain how the meanings of the terms differ.

- fungus* and *lichen*
- hyphae* and *mycelium*

### Understanding Key Ideas

- Which of the following statements about fungi is true?
  - All fungi are eukaryotic.
  - All fungi are decomposers.
  - All fungi reproduce by sexual reproduction.
  - All fungi are producers.
- What are the four main groups of fungi? Give a characteristic of each group.
- How are fungi able to withstand periods of cold or drought?

### Critical Thinking

- Analyzing Processes** Many fungi are decomposers. Imagine what would happen to the natural world if decomposers no longer existed. Write a description of how a lack of decomposers might affect the processes of nature.
- Identifying Relationships** Explain how two organisms make up a lichen.

### Interpreting Graphics

Use the photo below to answer the questions that follow.



- To which group of fungi does this organism belong? How can you be sure?
- What part of the organism is shown in this photo? What part is not shown? Explain.

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)

Topics: Fungi; Lichens

SciLinks codes: HSM0628; HSM0871

## 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
- Critical Thinking **ADVANCED**

### Answers to Section Review

- Sample answer: A spore is a reproductive cell that is protected by a thick wall. A mold is a shapeless, fuzzy fungus.
- Sample answer: Fungi are decomposers that break down dead organic material. A lichen is a fungus and an alga living in a close symbiotic relationship. The lichen gets food through the alga's photosynthesis.
- Sample answer: Hyphae are threadlike filaments. A large mass of hyphae make up the body of a fungus, which is the mycelium.
- a
- Sample answer: Threadlike fungi have hyphae that end in sporangia. Sac fungi have spores in a sac called an *ascus*. Club fungi produce clublike structures called *basidia*. Imperfect fungi do not reproduce sexually.
- Sample answer: During periods of extreme cold, heat, or drought, some fungi form spores or sporangia, which can survive difficult environmental conditions.
- Sample answer: If fungi and other decomposers ceased to exist, the dead matter would not break down. The forest floors would be littered with dead matter that would never decompose.
- Sample answer: Lichens are a combination of a fungus and an alga. Each organism benefits from the other, and the relationship is so close that the lichen is considered to be a unique organism.
- Sample answer: This organism is a club fungus. You could be sure by looking for club-shaped basidia on gills under the cap.
- Sample answer: We can see the basidia, which is the reproductive structure of the fungus. We cannot see the mycelium, which makes up the bulk of the organism, because the mycelium is underground.

## There's a Fungus Among Us!

### Teacher's Notes



#### Time Required

15 minutes of one class period and one 45-minute class period the next day



#### Lab Ratings



Teacher Prep  

Student Set-Up  

Concept Level  

Clean Up  

#### Preparation Notes

Do not use mushrooms gathered from the wild. Suitable mushrooms can be found in the produce section of a grocery store. Have protective gloves available for students who wish to wear them. This lab works well with groups of 2 to 4 students per mushroom. If you do not have an incubator, place the Petri dishes in a warm place, out of drafts and direct sunlight.

#### Safety Caution

Remind students to review all safety cautions and icons before beginning this lab activity. Before beginning this lab, check for any mushroom allergies among students. Caution students not to eat any of the mushrooms.



#### OBJECTIVES

**Examine** the parts of a mushroom.

**Describe** your observations of the mushroom.

#### MATERIALS

- gloves, protective
- incubator
- microscope or magnifying lens
- mushroom
- paper, white (2 sheets)
- Petri dish with fruit-juice agar plate
- tape, masking
- tape, transparent
- tweezers

#### SAFETY



## There's a Fungus Among Us!

Fungi share many characteristics with plants. For example, most fungi live on land and cannot move from place to place. But fungi have several unique features that suggest that they are not closely related to any other kingdom of organisms. In this activity, you will observe some of the unique structures of a mushroom, a member of the kingdom Fungi.

#### Procedure

- 1 Put on your safety goggles and gloves. Get a mushroom from your teacher. Carefully pull the cap of the mushroom from the stem.
- 2 Using tweezers, remove one of the gills from the underside of the cap. Place the gill on a sheet of white paper.
- 3 Place the mushroom cap gill-side down on the other sheet of paper. Use masking tape to keep the mushroom cap in place. Place the paper aside for at least 24 hours.
- 4 Use tweezers to take several 1 cm pieces from the stem, and place these pieces in your Petri dish. Record the appearance of the plate by drawing the plate in a notebook. Cover the Petri dish, and incubate it overnight.
- 5 Use tweezers to gently pull the remaining mushroom stem apart lengthwise. The individual fibers or strings that you see are the hyphae, which form the structure of the fungus. Place a thin strand on the same piece of paper on which you placed the gill that you removed from the cap.
- 6 Use a magnifying lens or microscope to observe the gill and the stem hyphae.
- 7 After at least 24 hours, record any changes that occurred in the Petri dish.
- 8 Carefully remove the mushroom cap from the paper. Place a piece of transparent tape over the print left behind on the paper. Record your observations.



#### 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.



**Jason Marsh**  
Montevideo High and  
Country School  
Montevideo, Minnesota

#### CHAPTER RESOURCES

##### Chapter Resource File

- Datasheet for Chapter Lab
- Lab Notes and Answers

##### Technology

- Classroom Videos
- Lab Video



- Making a Protist Mobile





### Analyze the Results

- 1 Describing Events** Describe the structures that you saw on the gill and hyphae.
- 2 Explaining Events** What makes up the print that was left on the white paper?
- 3 Examining Data** Describe the structures on the mushroom gill. Explain how these structures are connected to the print.
- 4 Analyzing Data** Compare your original drawing of the Petri dish to your observations of the dish after leaving it for 24 hours.

### Draw Conclusions

- 5 Evaluating Results** Explain how the changes that occurred in your Petri dish are related to methods of fungal reproduction.

### Applying Your Data

Fungi such as mushrooms and yeast are used in cooking and baking in many parts of the world. Bread is a staple food in many cultures. There are thousands of kinds of bread. Conduct library and Internet research on how yeast makes bread rise. Find a bread recipe, and show how the recipe involves the care and feeding of yeast. Ask an adult to help you bake a loaf of bread to share with your class during your presentation.

### Analyze the Results

- 1.** Sample answer: Gills look like knife blades. Hyphae are string-like.
- 2.** The print on the white paper is a spore print produced by basidiospores being released from the gills.
- 3.** The structures on the mushroom gill contain the nuclei that will develop into spores like the ones that were released as the spore print.
- 4.** After 24 hours, students may see mycelia growth on the Petri dish. (It may take a little longer.)

### Draw Conclusions

- 5.** The mycelia grow to form the main body of the mushroom and develop from germinating spores.

### Applying Your Data

As the yeast fungus metabolizes sugars through cellular respiration, it produces carbon dioxide gas that makes the bread rise. Most bread recipes will include food for the yeast and conditions that encourage yeast growth (moisture and warmth).



### CHAPTER RESOURCES

#### Workbooks



##### Whiz-Bang Demonstrations

- Unleash the Yeast! **GENERAL**



##### Labs You Can Eat

- Knot Your Average Yeast Lab **BASIC**



##### Long-Term Projects & Research Ideas

- Algae for All! **ADVANCED**

## Chapter Review

### Assignment Guide

SECTION	QUESTIONS
1	5, 14, 17, 19
2	6–8, 11, 13, 15–16, 18, 23
3	1, 3–4, 9–10, 12, 20–22, 24–28
1 and 2	2

## ANSWERS

### Using Key Terms

1. Sample answer: The mycelium is the mass of hyphae that makes up the body of a fungus. A lichen is an organism that is made up of a fungus and an alga living intertwined. A heterotroph is an organism that cannot make its own food.
2. Sample answer: Algae, including free-floating phytoplankton, are protists that produce food from the sun's energy.
3. Sample answer: Molds, like all threadlike fungi, reproduce by releasing spores into the air.
4. Sample answer: A fungus is an organism that is made up of hyphae. A hypha is a threadlike filament that grows together with many other hyphae to form the mycelium.
5. A parasite is an organism that invades the body of another living organism to get food from it. A host is the organism that is invaded by a parasite.

## Chapter Review

### USING KEY TERMS

- 1 In your own words, write a definition for each of the following terms: *mycelium*, *lichen*, and *heterotroph*.
- 2 Use the following terms in the same sentence: *protists*, *algae*, and *phytoplankton*.
- 3 Use the following terms in the same sentence: *spore* and *mold*.

For each pair of terms, explain how the meanings of the terms differ.

- 4 *fungus* and *hypha*
- 5 *parasite* and *host*

### UNDERSTANDING KEY IDEAS

#### Multiple Choice

- 6 Protist producers include
  - a. euglenoids and ciliates.
  - b. lichens and zooflagellates.
  - c. spore-forming protists and smuts.
  - d. dinoflagellates and diatoms.
- 7 Protists can be
  - a. parasites or decomposers.
  - b. made of chains of cells called *hyphae*.
  - c. divided into four major groups.
  - d. only parasites.
- 8 A euglenoid has
  - a. a micronucleus.
  - b. pseudopodia.
  - c. two flagella.
  - d. cilia.

- 9 Which statement about fungi is true?
  - a. Fungi are producers.
  - b. Fungi cannot eat or engulf food.
  - c. Fungi are found only in the soil.
  - d. Fungi are primarily single celled.
- 10 A lichen is made up of
  - a. a fungus and a funguslike protist that live together.
  - b. an alga and a fungus that live together.
  - c. two kinds of fungi that live together.
  - d. an alga and a funguslike protist that live together.
- 11 Heterotrophic protists that can move
  - a. are also known as *protozoans*.
  - b. include amoebas and paramecia.
  - c. may be either free living or parasitic.
  - d. All of the above

#### Short Answer

- 12 How are fungi helpful to humans?
- 13 What is the function of cilia in a paramecium?
- 14 How are fungi different from protists that get food as decomposers?
- 15 How are slime molds and amoebas similar?
- 16 What is a contractile vacuole?
- 17 Compare how *Paramecium*, *Plasmodium vivax*, and *Euglena* reproduce.

### Understanding Key Ideas

6. d
7. a
8. c
9. b
10. b
11. d
12. Some fungi recycle nutrients as decomposers, provide food for humans, or are used to make medicines.
13. Members of the genus *Paramecium* use cilia to move and to get food.
14. Sample answer: Fungi cannot move, but protists that get food as decomposers, such as slime molds, can move in certain phases of life.
15. Both slime molds and amoebas are protists, and both move (slime molds move during certain phases of life) and feed by using pseudopodia.
16. a structure that holds excess water and removes water from a protist cell
17. *Paramecium* uses conjugation, *P. vivax* uses a complex cycle, and *Euglena* uses fission.

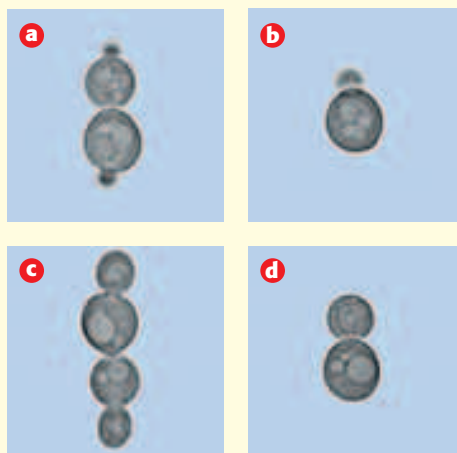
- 18 Compare how phytoplankton, amoebas, and *Giardia lamblia* get food.
- 19 Explain how protists differ from other organisms.
- 20 Give an example of where you might find each of the following fungi: threadlike fungi, sac fungi, club fungi, and imperfect fungi.

### CRITICAL THINKING

- 21 **Concept Mapping** Use the following terms to create a concept map: *yeast*, *basidia*, *threadlike fungi*, *mushrooms*, *fungi*, *bread mold*, *ascus*, and *club fungi*.
- 22 **Applying Concepts** Why do you think bread turns moldy less quickly when it is kept in a refrigerator than when it is kept at room temperature?
- 23 **Making Inferences** Some protozoans, such as radiolarians and foraminiferans, have shells around their bodies. How might these shells be helpful to the protists that live in them?
- 24 **Predicting Consequences** Suppose a forest where many threadlike fungi live goes through a very dry summer and fall and then a very cold winter. How could this extreme weather affect the reproductive patterns of these fungi?

### INTERPRETING GRAPHICS

Use the pictures of fungi below to answer the questions that follow.



- 25 What kind of fungus is shown here?
- 26 What cellular process is shown in these pictures?
- 27 Which picture was taken first? Which was taken last? Arrange the pictures in order.
- 28 Which is the original parent cell? How do you know?



18. Amoebas use pseudopodia to engulf food, phytoplankton produce their own food, and *G. lamblia* is a parasite that feeds on a host.
19. Protists do not have specialized tissues, so they are different from fungi, plants, and animals. And unlike bacteria, protists are eukaryotic.
20. Sample answer: threadlike fungi: old bread; sac fungi: under the soil; club fungi: in the supermarket; imperfect fungi: in an animal as a parasite

### Critical Thinking

21. An answer to this exercise can be found at the end of this book.
22. Bread mold is a threadlike fungus. These fungi grow best in warm, moist conditions. The refrigerator's cool temperature keeps the fungi from growing.
23. Sample answer: These protozoans are probably protected from danger by their shells because the shells are hard and their bodies are soft.
24. These fungi may respond to the difficult environmental conditions by changing from asexual reproduction to sexual reproduction. They would likely form sporangia that would release spores when the environmental conditions improved.

### Interpreting Graphics

25. yeast, which is a sac fungus
26. budding
27. b; c; b, d, a, c
28. The large cell in picture b is the original cell because it is the first to bud.

### 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.



## 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. I
3. C



**Question 2:** The correct answer is A. This fact is revealed in the second sentence. Students may choose answer G because the first sentence implies that the people near the cave do not pay attention to the dripping slime. However, the sentence does not state that they ignore the slime globs. Students may choose answer F if they exaggerate the point that these slime globs are made up of organisms. While the passage states that billions of organisms live in the caves, the passage says nothing about many different kinds of organisms living there.



## Standardized Test Preparation

### READING

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

**Passage 1** For centuries, people living near Cueva de Villa Luz (the Cave of the Lighted House) in Mexico have walked past slimy globs that drip from the cave's ceiling without thinking much about them. When scientists decided to analyze these slime balls, they discovered that the formations are home to billions of microscopic organisms! Scientists nicknamed these colonies "snot-tites" because the colonies resemble mucus. Actually, the "snot-tites" are a mixture of fungi and bacteria.

1. In the passage, what does *resemble* mean?  
**A** to look like  
**B** to feel like  
**C** to smell like  
**D** to sound like
2. Which of the following statements is a fact according to the passage?  
**F** Many kinds of organisms live in Cueva de Villa Luz.  
**G** The people of Mexico ignore the snot-tites.  
**H** Scientists found no explanation for the slime balls that are in Cueva de Villa Luz.  
**I** Cueva de Villa Luz's ceiling is dripping with microscopic organisms.
3. The microscopic organisms discovered by scientists  
**A** are fungi.  
**B** are bacteria.  
**C** are a mixture of fungi and bacteria.  
**D** are a mixture of protists and fungi.

**Passage 2** Between 1845 and 1852, Ireland lost one-third of its population. In 1846, a disease swept through the potato fields of Ireland. In just a few weeks, it destroyed almost the entire crop of potatoes. Because the Irish depended on potatoes for food, people were dying of starvation each day. About 2 million people fled the country to find a place to live where they could find enough food. The cause of all of these deaths and this devastation was a simple organism. The disease was caused by a water mold, which is a kind of protist.

1. What caused the population of Ireland to decline between 1845 and 1852?  
**A** a fungus  
**B** a water mold  
**C** a potato  
**D** poisonous potatoes
2. According to the passage, why did the population of Ireland decline?  
**F** A disease swept through the people of Ireland.  
**G** Some people died of starvation, and others fled the country.  
**H** A simple organism infected the people of Ireland.  
**I** When people ate potatoes, they became sick.
3. Which of the following statements is a fact according to the passage?  
**A** People in Ireland have always depended on potatoes for food.  
**B** Protists are parasitic and cause disease.  
**C** About 2 million people fled Ireland between 1845 and 1852.  
**D** Food is more readily available in the United States than it is in Ireland.

#### Passage 2

1. B
2. G
3. C

**Question 2:** The correct answer is G. The fourth and fifth sentences reveal that some people died of starvation and others fled the country because of the potato famine. Students may choose answer F or H if they misread the passage and think the water mold infects people instead of potatoes. They may choose answer I if they assume that the water mold was passed from potatoes to people when people ate potatoes. Instead, the water mold caused problems because it killed the potatoes and then left people without enough to eat.

## INTERPRETING GRAPHICS

The table below shows the number of species in different phyla of protists. Use this table to answer the questions that follow.

Protist Phyla	
Phylum	Number of Species
Rhizopoda	300
Foraminifera	300
Chlorophyta	7,000
Rhodophyta	4,000
Phaeophyta	1,500
Bacillariophyta	11,500
Dinoflagellata	2,100
Euglenophyta	1,000
Kinetoplastida	3,000
Ciliophora	8,000
Acrasiomycota	70
Myxomycota	800
Oomycota	580
Apicomplexa	3,900

- Which phylum has the largest number of species?  
**A** Rhizopoda  
**B** Bacillariophyta  
**C** Ciliophora  
**D** Euglenophyta
- Which phylum has the smallest number of species?  
**F** Acrasiomycota  
**G** Rhizopoda  
**H** Chlorophyta  
**I** Bacillariophyta
- If the total number of species of protists is 43,000, what percentage of species are in the phylum Bacillariophyta?  
**A** 0.27%  
**B** 3.7%  
**C** 27%  
**D** 374%

- If the total number of species of protists is 43,000, what percentage of species are in the phylum Rhizopoda?  
**F** 0.7%  
**G** 1.4%  
**H** 7%  
**I** 143%

## MATH

Read each question below, and choose the best answer.

- Beth had \$300 in her savings account when she started her summer job as an assistant to a commercial mushroom grower. If she put \$25 into her savings account each month, which equation could be used to find  $n$ , the number of months it took Beth to increase her savings to \$1,000?  
**A**  $1,000 = 300 + n$   
**B**  $1,000 = 25n$   
**C**  $1,000 = 25n + 300$   
**D**  $1,000 = 300n + 25$
- If you want to determine whether a polygon-shaped protist has the shape of a pentagon, which of the following pieces of information do you need to know?  
**F** the area  
**G** the length of the diagonal  
**H** the number of sides  
**I** the number of faces
- Marcus had an average score of 90% on two biology tests about protists. If his first test score was 96%, which score did he receive on the second test?  
**A** 45%  
**B** 84%  
**C** 90%  
**D** 102%

## INTERPRETING GRAPHICS

- B
- F
- C
- F



**Question 3:** The correct answer is C and is found by noting that there are approximately 11,500 species in the phylum Bacillariophyta and by dividing this number by the total species, 43,000 species, to get the figure 27%. Students may choose answer A if they forget how to change a decimal answer to a percentage. They may choose B or D if they forget how to find a percentage and divide 43,000 by the number of species of Bacillariophyta.

## MATH

- C
- H
- B



**Question 1:** Because Beth begins with \$300 in her account, the answer will have to include that as a starting point. She will add \$25 to the original \$300 each month for  $n$  months until the total is \$1,000. So, the answer equation must set 1,000 equal to 300 plus 25 times  $n$  months, as shown in answer C. Students may choose answer B if they forget to account for the original \$300. They may choose answer D if they confuse the original money with the money earned each month. They may choose answer A if they forget to account for how much money is added each month.

## 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

### Activity

ADVANCED

Have students research the ingredients of some of the foods and other products in their home pantry to determine if the foods contain algae derivatives, such as carageenan, alginate, or beta carotene. (Sample answers: carageenan: brownie mix, chocolate milk, coffee creamer, cottage cheese, evaporated milk, frozen yogurt, ice cream, infant formula, pet food, pudding, relishes, sauces, gravies, sour cream, toothpaste, whipped cream, yogurt; alginate: brownie mix, frozen foods and desserts, relishes, salad dressing, sauces, gravies; beta carotene: cheese, coffee creamer, egg substitute, frozen foods and dessert, ice cream, margarine, mayonnaise, vitamins, and salad dressing.)

## Weird Science

### Teaching Strategy

GENERAL

Bioluminescent dinoflagellates are available for sale on the Internet. You can use a microscope to observe their movements and characteristics. And you can observe a protist's entire life cycle in less than a week.

# Science in Action



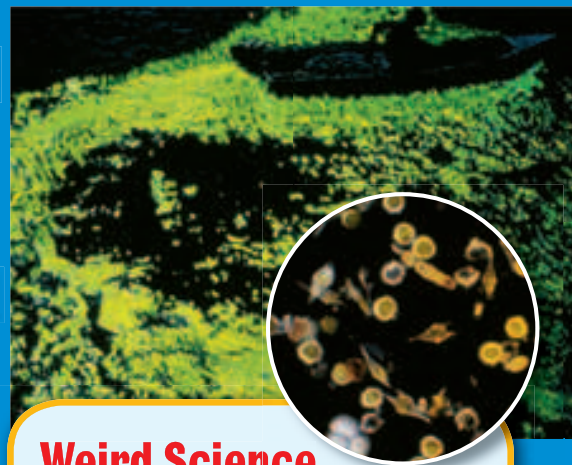
## Science, Technology, and Society

### Algae Ice Cream

If someone offered you a bowl of algae ice cream, would you eat it? Would you eat algae pudding? These foods may not sound appetizing, but algae are a central ingredient in these foods. You eat many kinds of algae every day. Parts of brown algae help thicken ice cream and other dairy products. Red algae help keep breads and pastries from drying out. They are also used in chocolate, milk, eggnog, ice cream, sherbet, instant pudding, and frosting. Green algae contain a pigment that is used as yellow and orange food coloring. Algae are all around you!

### Social Studies Activity

Food products are not the only products that use protist producers. In groups, research how people take advantage of the shiny shells of diatoms. Then, present your findings to the class.



## Weird Science

### Glowing Protists

As your kayak drifts silently through the night, it leaves a trail of swirling green light in the water behind it. You jump in the water to swim, and your hands turn into glowing underwater comets, which leave sparkling trails that slowly fade away. This may sound like a dream, but it happens every night for swimmers at Mosquito Bay on the island of Vieques in Puerto Rico. The source of this green glow is a protist. The waters of this bay contain millions of dinoflagellates that glow when the water around them is disturbed.

The species of dinoflagellates in Mosquito Bay is *Pyrodinium bahamense*, which means "whirling fire." These spherical single-celled protists are covered by armored plates. Each individual has two flagella that spin it through the water. The light is produced by a chemical reaction that is similar to the reaction in fireflies.

### Math Activity

Living in every gallon of water in Mosquito Bay are 750,000 dinoflagellates. Suppose you took a gallon of water from this bay and dumped it into a bathtub full of 6 gal of fresh water that didn't contain any dinoflagellates. Then, you mixed up the water and turned out the lights to see if the bathtub would glow in the dark. How many dinoflagellates would be in each gallon of water in the bathtub after you mixed up the water?

### Answers to Social Studies Activity

Student presentations may vary, but students should find that diatoms are used in products such as toothpaste and reflective road paints. Their hard, glassy shells add texture and shine to these products. They may also be used in insecticides because their sharp edges can damage insects.

### Answers to Math Activity

The concentration of dinoflagellates in the bathtub's water would be 750,000 dinoflagellates in 7 gallons of water. So, the number of dinoflagellates in each gallon of water would be about 107,143 protists.



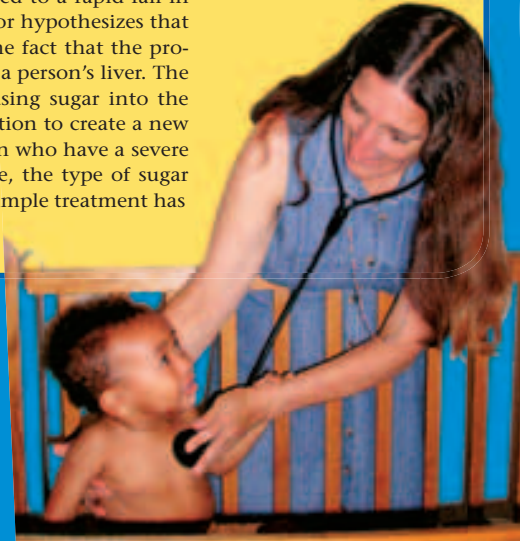
## People in Science

### Terrie Taylor

**Fighting Malaria** Malaria claims about 2 million victims each year. A person gets malaria when the blood is infected by protists from the genus *Plasmodium*. Dr. Terrie Taylor of Michigan State University's College of Osteopathic Medicine has devoted her life to malaria research. Since 1987, Dr. Taylor has spent six months of every year in Malawi, a small African country in which malaria is widespread.

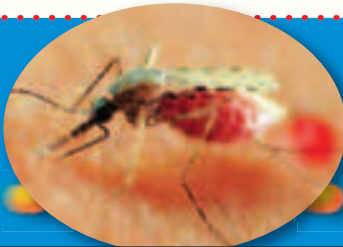
When Dr. Taylor first traveled to Malawi, she did not have a particular interest in malaria. However, she quickly started to realize that the majority of her patients were infected with the deadly disease. The patients who were suffering the most were children. For every 100 children infected with malaria and treated by Dr. Taylor, between 20 and 25 would die from a malaria-induced coma. When a malaria coma starts, the patient becomes confused and sleepy. The patient then falls into a coma, which may lead to death. Dr. Taylor worked with other doctors at the hospital to develop a coma scale so that doctors could have a standardized way to assess patients moving toward coma. This scale is now used around the world.

Dr. Taylor wanted to find out why malaria victims fell into a coma. She took blood samples from malaria patients. She realized that severe malaria often led to a rapid fall in the patient's blood-sugar level. Dr. Taylor hypothesizes that the drop in blood sugar is related to the fact that the protists that cause malaria primarily infect a person's liver. The liver is the organ responsible for releasing sugar into the blood. Dr. Taylor has used this information to create a new treatment. Whenever she treats children who have a severe case of malaria, she gives them glucose, the type of sugar that is found in the bloodstream. This simple treatment has already saved hundreds of lives!



### Language Arts Activity

The word *malaria* is a combination of two words. *Mala* means "bad," and *aria* means "air." Why do you think that people would use these words to describe the disease? Note that people did not realize that malaria was transmitted to people by mosquitoes until about 1899.



To learn more about these Science in Action topics, visit [go.hrw.com](http://go.hrw.com) and type in the keyword **HL5PROF**.



Check out Current Science® articles related to this chapter by visiting [go.hrw.com](http://go.hrw.com). Just type in the keyword **HL5CS11**.

## People in Science

### Activity

GENERAL

Malaria is not very common in North America, but there are many other diseases caused by protists or fungi that are common in North America. Have students find out what protist or fungal diseases are prevalent in your area. Have students produce a chart showing the different diseases that they learn about. Ask students to state the most common ways a person can become infected with the disease, what treatments exist for the disease, and how common the disease is.

### Background

Malaria is difficult to diagnose because the symptoms vary greatly between individuals and can resemble the symptoms of other diseases. The only way to make an accurate diagnosis is to examine the patient's red blood cells for signs of infection by protists from the genus *Plasmodium*. Recently, tests have been developed that allow for the detection of the parasite's genetic material in the bloodstream. These new tests can verify a malaria infection several days faster than previous tests.

### Answers to Language Arts Activity

Sample answer: Before people understood what caused malaria, they may have noticed that people became sick after spending time outdoors (where mosquitoes were present). Because people lacked a better explanation, they may have thought that the disease was caused by breathing bad air while they were outside.