Refer to pages 4T-5T of the Teacher Guide for an explanation of the National Science Education Standards correlations.

Section	Objectives	Activities/Features
Section 19.1 **The World of Protists** National Science Education Standards UCP.1, UCP.2, UCP.5; A.1, A.2; C.1, C.4, C.5, C.6; F.1, F.4, F.5 (1 session, 1 block)	1. **Identify** the characteristics of Kingdom Protista. 2. **Compare and contrast** the four groups of protozoans.	**MiniLab 19-1:** Observing Ciliate Motion, p. 522 **Inside Story:** A Paramecium, p. 523 **Problem-Solving Lab 19-1,** p. 524
Section 19.2 **Algae: Plantlike Protists** National Science Education Standards UCP.1, UCP.2, UCP.5; A.1, A.2; C.1, C.4, C.5, C.6; F.1, F.4, F.5 (2 sessions, 1 block)	3. **Compare and contrast** the variety of plantlike protists. 4. **Explain** the process of alternation of generations in algae.	**MiniLab 19-2:** Going on an Algae Hunt, p. 527 **Problem-Solving Lab 19-2,** p. 530 **Design Your Own BioLab:** How do *Paramecium* and *Euglena* respond to light? p. 538
Section 19.3 **Slime Molds, Water Molds, and Downy Mildews** National Science Education Standards UCP.1, UCP.2, UCP.4, UCP.5; A.1, A.2; C.1, C.3-5, C.6; F.1, F.4, F.5; G.1-3 (2 sessions, 1/2 block)	5. **Contrast** the cellular differences and life cycles of the two types of slime molds. 6. **Discuss** the economic importance of the downy mildews and water molds.	**Problem-Solving Lab 19-3,** p. 534 **Social Studies Connection:** The Irish Potato Famine, p. 540

Need Materials? Contact Carolina Biological Supply Company at 1-800-334-5551 or at **http://www.carolina.com**

MATERIALS LIST

BioLab

p. 538 microscope, microscope slides, coverslips, dropper, metric ruler, index cards, scissors, toothpicks, methyl cellulose solution, *Euglena* culture, *Paramecium* culture

MiniLabs

p. 522 *Paramecium* culture, wheat seeds, microscope, microscope slide, coverslip, dropper

p. 527 microscope, microscope slide, coverslip, dropper, pond water, paper, pencil

Alternative Lab

p. 534 microscope, sterile agar plate, oat cereal flakes, plasmodium stage of *Physarum polycephalum*

Key to Teaching Strategies

- **L1** Level 1 activities should be appropriate for students with learning difficulties.
- **L2** Level 2 activities should be within the ability range of all students.
- **L3** Level 3 activities are designed for above-average students.
- **ELL** ELL activities should be within the ability range of English Language Learners.
- **COOP LEARN** Cooperative Learning activities are designed for small group work.
- **P** These strategies represent student products that can be placed into a best-work portfolio.
- (block icon) These strategies are useful in a block scheduling format.

Teacher Classroom Resources

Section	Reproducible Masters	Transparencies
Section 19.1 **The World of Protists**	Reinforcement and Study Guide, p. 83 L2 Critical Thinking/Problem Solving, p. 19 L3 BioLab and MiniLab Worksheets, p. 89 L2 Laboratory Manual, pp. 133-136 L2 Content Mastery, pp. 93-94, 96 L1	Section Focus Transparency 45 L1 ELL Basic Concepts Transparency 30 L2 ELL Reteaching Skills Transparency 29 L1 ELL Reteaching Skills Transparency 30 L1 ELL
Section 19.2 **Algae: Plantlike Protists**	Reinforcement and Study Guide, pp. 84-85 L2 BioLab and MiniLab Worksheets, p. 90 L2 Laboratory Manual, pp. 137-140 L2 Tech Prep Applications, pp. 27-28 L2 Content Mastery, pp. 93, 95-96 L1	Section Focus Transparency 46 L1 ELL Basic Concepts Transparency 28 L2 ELL Basic Concepts Transparency 30 L2 ELL
Section 19.3 **Slime Molds, Water Molds, and Downy Mildews**	Reinforcement and Study Guide, p. 86 L2 Concept Mapping, p. 19 L3 ELL BioLab and MiniLab Worksheets, pp. 91-92 L2 Content Mastery, pp. 93, 95-96 L1	Section Focus Transparency 47 L1 ELL Basic Concepts Transparency 29 L2 ELL Basic Concepts Transparency 30 L2 ELL

Assessment Resources

Chapter Assessment, pp. 109-114
MindJogger Videoquizzes
Performance Assessment in the Biology Classroom
Alternate Assessment in the Science Classroom
Computer Test Bank
BDOL Interactive CD-ROM, Chapter 19 quiz

Additional Resources

Spanish Resources ELL
English/Spanish Audiocassettes ELL
Cooperative Learning in the Science Classroom COOP LEARN
Lesson Plans/Block Scheduling

NATIONAL GEOGRAPHIC Teacher's Corner

Products Available From Glencoe
To order the following products, call Glencoe at 1-800-334-7344:
CD-ROM
NGS PictureShow: The Cell

Products Available From National Geographic Society
To order the following products, call National Geographic Society at 1-800-368-2728:
Video
Protists: Threshold of Life

Index to National Geographic Magazine
The following articles may be used for research relating to this chapter:
"Slime Mold: The Fungus That Walks," by Lee Douglas, July 1981.

GLENCOE TECHNOLOGY

The following multimedia resources are available from Glencoe.

Biology: The Dynamics of Life

CD-ROM ELL
Exploration: *The World of Protists*
BioQuest: *Biodiversity Park*
Video: *Protists*
Video: *Kelp Forests*
Video: *Slime Mold*

Videodisc Program
Protists
Kelp Forests
Slime Mold

Getting Started Demo

Naturalist Have students observe slides containing a variety of living amoebas, ciliates, and flagellates. Ask them to compare and contrast the organisms. Students should observe that the organisms are unicellular and move differently.

Theme Development

The theme of **unity within diversity** is evident throughout the chapter in discussions of the characteristics of protists. The theme of **homeostasis** is prominent in discussions of how the different protists carry out their life functions.

0:00 Out of Time?

If time does not permit teaching the entire chapter, use the BioDigest at the end of the unit as an overview.

Internet Address Book

interNET CONNECTION Note Internet addresses that you find useful in the space below for quick reference.

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Chapter 19 Protists

What You'll Learn

- You will differentiate among the major groups of protists.
- You will recognize the ecological niches of protists.
- You will identify some human diseases and the protists responsible for them.

Why It's Important

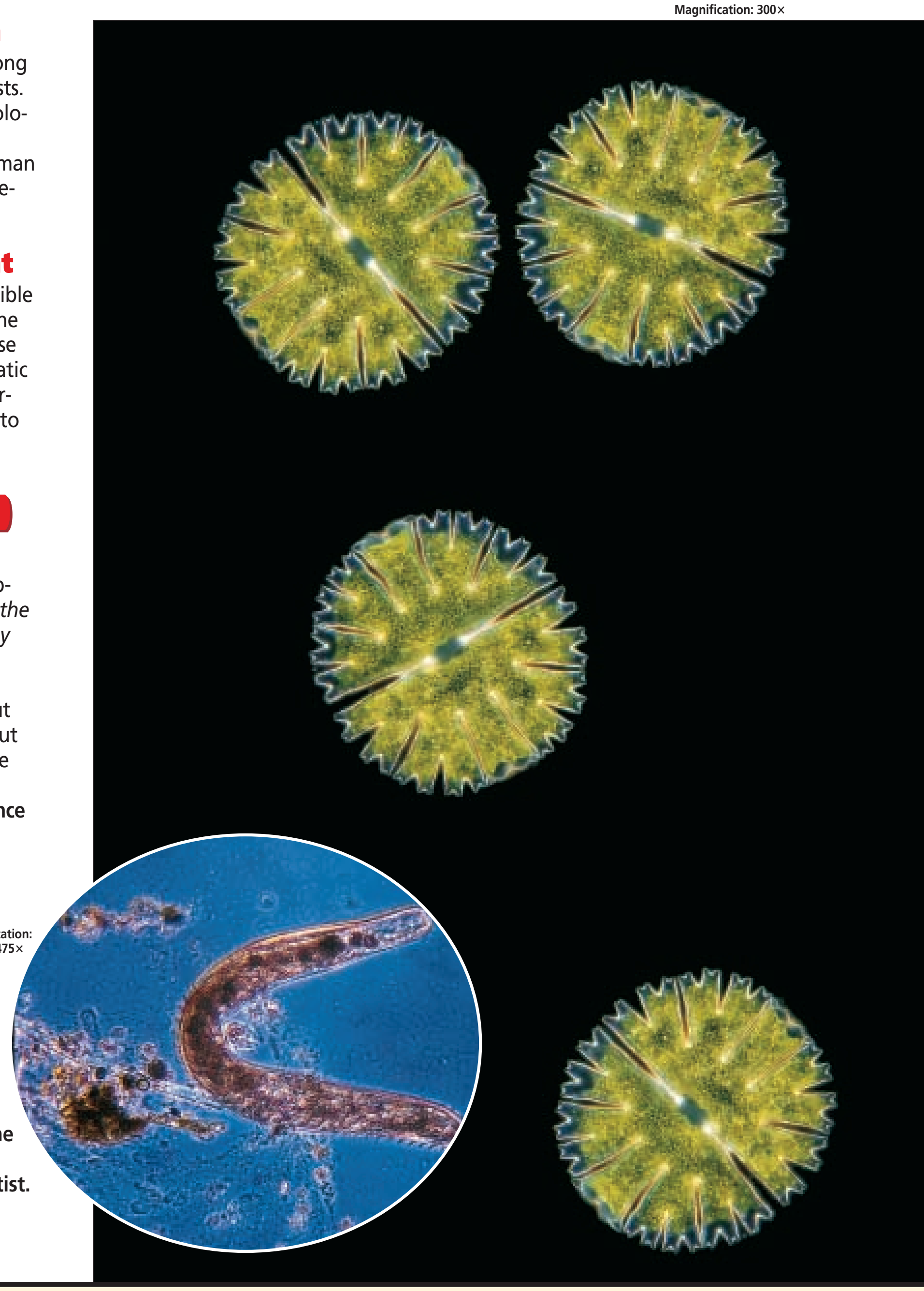
Because protists are responsible for much of the oxygen in the atmosphere, and are the base for most food chains in aquatic environments, most other organisms depend on protists to exist.

Getting Started

Observing Protists

View a slide of protists to observe their variety. *How are the protists similar? How do they differ?*

interNET CONNECTION To find out more about the protists, visit the Glencoe Science Web Site. www.glencoe.com/sec/science



Desmids are plantlike protists that produce much of the oxygen you breathe. The *Spirostomum ambiguum* (inset) is an animal-like protist.

Section 19.1 The World of Protists

In just a few drops of pond water, you can find an amazing collection of protists. Some protists will be moving, perhaps searching for food. Others will be using photosynthesis to make food. Still others will be decomposing organic matter in the pond water. In this section, you will read about the great diversity of protists, and why, in spite of this diversity, biologists group them together in Kingdom Protista.

A *Stylonchia* searching for food

Section Preview

Objectives

Identify the characteristics of Kingdom Protista.

Compare and contrast the four groups of protozoans.

Vocabulary

protozoan
algae
pseudopodia
asexual reproduction
flagellate
ciliate
sporozoan
spore

What Is a Protist?

Kingdom Protista contains the most diverse organisms of all the kingdoms. Protists may be unicellular or multicellular, microscopic or very large, and heterotrophic or autotrophic. In fact, there is no such organism as a typical protist. When you look at different protists, you may wonder how they could be grouped together. The characteristic that all protists share is that, unlike bacteria, they are all eukaryotes, which means that most of their metabolic processes occur inside their membrane-bound organelles.

Although there are no typical protists, some resemble animals in their method of nutrition. The animal-like protists are called **protozoa** (proht uh ZOH uh) (singular, protozoan). Unlike animals, though, all protozoans are unicellular. Other protists are plantlike autotrophs, using photosynthesis to make their food. Plantlike protists are called **algae** (AL jee) (singular, alga). Unlike plants, algae do not have organs such as roots, stems, and leaves. Still other protists are more like fungi because they decompose dead organisms. However, unlike fungi, funguslike protists are able to move at some point in their life and do not have chitin in their cell walls.

It might surprise you to learn how much protists affect other organisms. Some protists cause diseases, such as malaria and sleeping sickness, that

Word Origin

protozoa
From the Greek words *protos*, meaning "first," and *zoa*, meaning "animals." Protozoa are animal-like protists.

Prepare

Key Concepts

This section first presents the general characteristics of protists. Then, it discusses protozoans and details the characteristics of a representative organism from each of the four protozoan phyla.

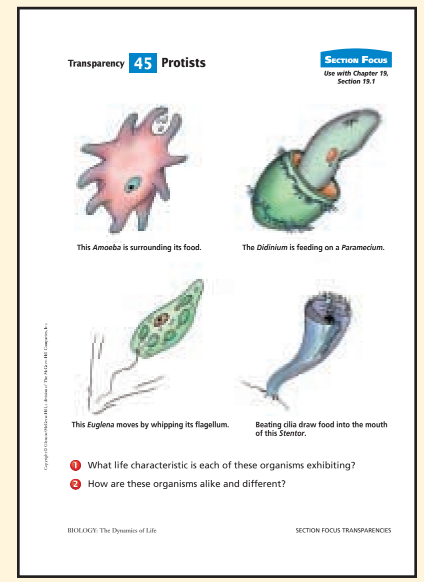
Planning

- Gather cotton and toothbrush bristles for MiniLab 19-1.

1 Focus

Bellringer

Before presenting the lesson, display **Section Focus Transparency 45** on the overhead projector and have students answer the accompanying questions. L1 ELL



Multiple Learning Styles

Look for the following logos for strategies that emphasize different learning modalities.

Kinesthetic Meeting Individual Needs, pp. 520, 522, 528, 531; Project, p. 527; Activity, p. 528

Visual-Spatial Activity, p. 520; Quick Demo, pp. 521, 536; Project, p. 521; Check for Understanding, p. 524; Tech Prep, p. 523; Reinforcement, p. 528; Extension, p. 536

Intrapersonal Portfolio, p. 520

Linguistic Biology Journal, pp. 524, 536; Portfolio, p. 529; Meeting Individual Needs, p. 533

Logical-Mathematical Activity, p. 525

Naturalist Getting Started Demo, p. 518; Biology Journal, p. 526; Check for Understanding, p. 536; Reteach, p. 536

Assessment Planner

Portfolio Assessment
- **Portfolio, TWE,** pp. 520, 529
- **Assessment, TWE,** pp. 521, 531
- **MiniLab, TWE,** p. 522
- **Problem-Solving Lab, TWE,** p. 530
- **BioLab, TWE,** pp. 538-539

Performance Assessment
- **MiniLab, SE,** pp. 522, 527
- **Problem-Solving Lab, TWE,** pp. 524, 534
- **MiniLab, TWE,** p. 527
- **Alternative Lab, TWE,** pp. 534-535
- **Assessment, TWE,** p. 535
- **BioLab, SE,** pp. 538-539

Knowledge Assessment
- **Assessment, TWE,** pp. 525, 532, 537
- **Alternative Lab, TWE,** pp. 534-535
- **Section Assessment, SE,** pp. 525, 532, 537
- **Chapter Assessment, SE,** pp. 541-543

Skill Assessment
- **Assessment, TWE,** p. 528

Resource Manager

Section Focus Transparency 45 and Master L1 ELL

2 Teach

Activity

Visual-Spatial After students have read about the characteristics of protists, have them diagram a generalized protist cell. They should draw their diagrams to scale and label the cell organelles. Then have students draw and label a bacterial cell for comparison. Although this activity will be difficult, it should initiate a useful discussion about the characteristics of protists. L3 ELL

Tying to Previous Knowledge

Ask students to compare and contrast the terms in the word pairs that follow: eukaryotes and prokaryotes, heterotrophs and autotrophs, and motile and nonmotile. *Eukaryotes have membrane-bound organelles; the prokaryotes lack membrane-bound organelles. Heterotrophs take in food from the environment; autotrophs produce their own food. A motile organism can move; a nonmotile organism cannot move.* L2 ELL

NATIONAL GEOGRAPHIC

VIDEODISC
STV: The Cell
Amoeba Changing Shape

Amoeba With Pseudopodia

WORD Origin

pseudopodia
From the Greek words *pseudo*, meaning "false," and *podos*, meaning "foot." An amoeba uses psuedopodia to obtain food.

result in millions of human deaths throughout the world every year. Unicellular algae produce much of the oxygen in Earth's atmosphere and are the basis of aquatic food chains. Slime molds and water molds decompose a significant amount of organic material, making the nutrients available to living organisms. Protozoans, algae, and funguslike protists play important roles on Earth. Look at *Figure 19.1* to see some protists.

What Is a Protozoan?

If you sat by a pond, you might notice clumps of dead leaves at the water's edge. Under a microscope, a piece of those wet decaying leaves reveals a small world, probably inhabited by animal-like protists. Although a diverse group, all protozoans are unicellular heterotrophs that feed on other organisms or dead organic matter. They usually reproduce asexually, and some also reproduce sexually.

Diversity of Protozoans

Many protozoans are grouped according to the way they move. Some protozoans use cilia or flagella to move. Others move and feed by sending out cytoplasm-containing extensions of their plasma membranes. These extensions are called **pseudopodia** (sewd uh POHD ee uh). Other protozoans are grouped together because they are parasites. There are four main groups of protozoans: the amoebas (uh MEE buz), the flagellates, the ciliates, and the sporozoans (spor uh ZOH unz).

Amoebas: Shapeless protists

The phylum Rhizopoda includes hundreds of species of amoebas and amoebalike organisms. Amoebas have no cell wall and form pseudopodia to move and feed. As a pseudopod forms, the shape of the cell changes and the amoeba moves. Amoebas form pseudopodia around their food, as you can see in *Figure 19.2.*

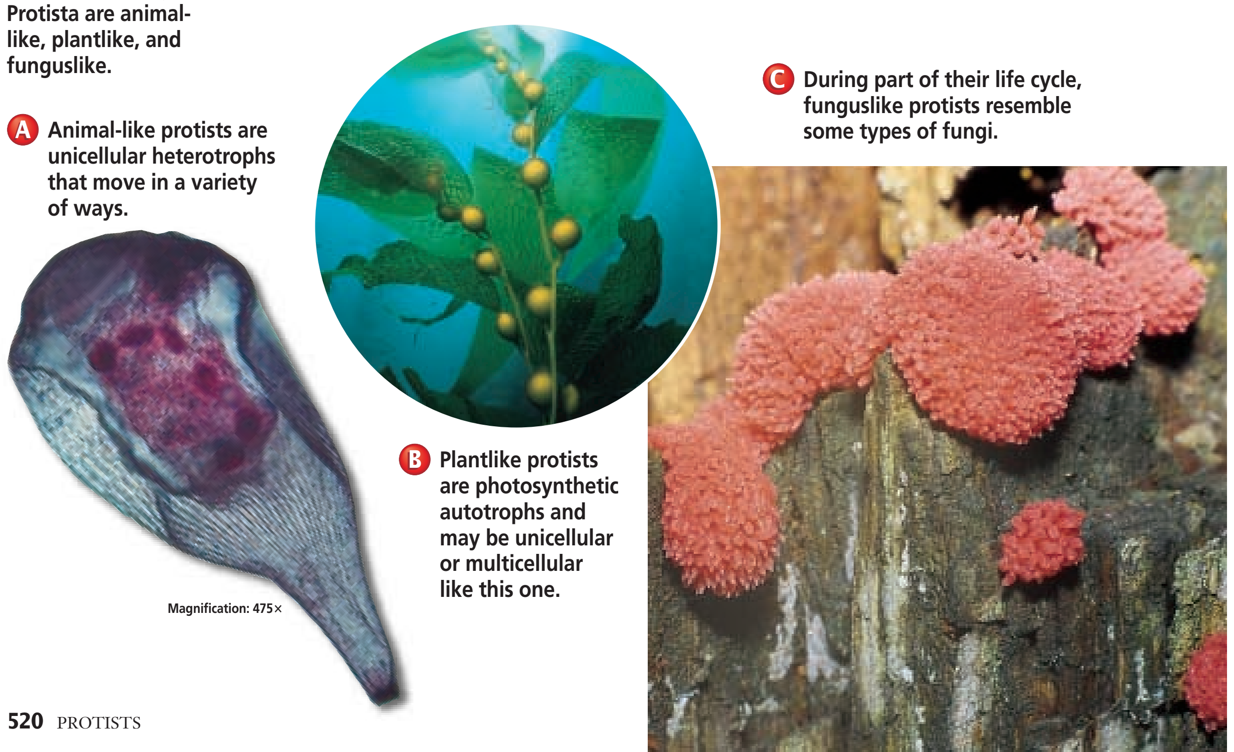


Figure 19.1
Members of Kingdom Protista are animal-like, plantlike, and funguslike.

A Animal-like protists are unicellular heterotrophs that move in a variety of ways.

B Plantlike protists are photosynthetic autotrophs and may be unicellular or multicellular like this one.

C During part of their life cycle, funguslike protists resemble some types of fungi.

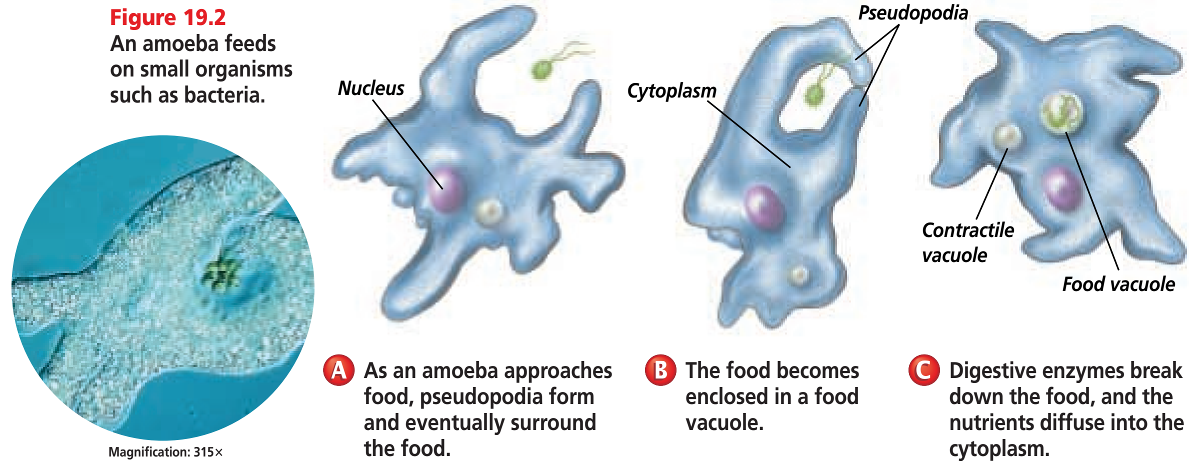


Figure 19.2
An amoeba feeds on small organisms such as bacteria.

A As an amoeba approaches food, pseudopodia form and eventually surround the food.

B The food becomes enclosed in a food vacuole.

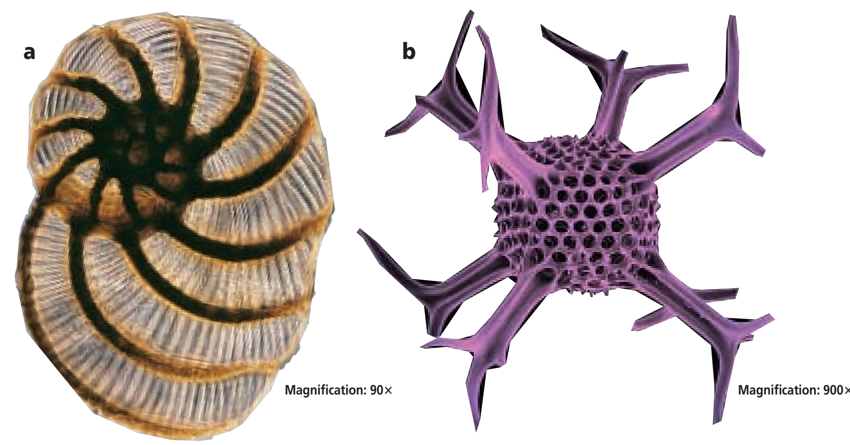
C Digestive enzymes break down the food, and the nutrients diffuse into the cytoplasm.

Although most amoebas live in saltwater, there are freshwater ones that live in the ooze of ponds, in wet patches of moss, and even in moist soil. Because amoebas live in moist places, nutrients dissolved in the water around them can diffuse directly through their cell membranes. However, because freshwater amoebas live in hypotonic environments, they constantly take in water. Their contractile vacuoles collect and pump out excess water.

Two groupings of mostly marine amoebas, the foraminiferan and radiolarian shown in *Figure 19.3,* have shells. Foraminiferans, which are abundant on the sea floor, have hard shells made of calcium carbonate. Fossil forms of these protists help geologists determine the ages of some rocks and sediments. Unlike foraminiferans, radiolarians have shells made of silica. Under a microscope, you can see the complexity of these shells. In addition, radiolarians are an important part of marine plankton—an assortment of microscopic organisms that float in the ocean's photic zone and form the base of marine food chains.

Most amoebas commonly reproduce by **asexual reproduction,** in which a single parent produces one or

Figure 19.3
Foraminiferans (a) and radiolarians (b) are amoebas that extend pseudopodia through tiny holes in their shells. Pseudopodia act like sticky nets that trap food.



Quick Demo

Visual-Spatial Have students observe prepared slides of amoebas, foraminiferans, and radiolarians and draw a labeled diagram of each organism they see, indicating the magnification at which they view each organism. Then ask them to describe the function of each labeled structure. L2 ELL

Assessment

Portfolio Ask students to make a table that summarizes the differences between amoebas, foraminiferans, and radiolarians. L2 P

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Exploration: *The World of Protists,* Disc 3
BioQuest: *Biodiversity Park* Disc 3, 4
Video: *Protists,* Disc 3

MEETING INDIVIDUAL NEEDS

Visually Impaired

Kinesthetic Ask students to build tactile models to demonstrate the difference between cilia and flagella. Velcro can model cilia, and pieces of string taped to a ball can simulate flagella. L1 ELL

Portfolio

A Moving Analogy

Intrapersonal Have the students describe or draw some everyday items that are analogous in structure, appearance, or function to protozoan structures, such as cilia, flagella, and pseudopodia. L1 P

PROJECT

Comparing the Speeds of Protists

Visual-Spatial Pair up students. Have one student in each pair observe a slide containing a variety of living protists under the low-power magnification. While the observer watches a protozoan move across the diameter of the field of view, the partner should use a stopwatch to time the event as the observer describes it. Instruct students to divide the number of seconds the protist takes to travel across the field of view by the field of view size (usually 1.5 mm). The result is speed in millimeters per second. Have students repeat the process for each different protist they see and make a table of their results. L2 COOP LEARN

MiniLab 19-1

Purpose

Students will discover how *Paramecium* responds when it contacts a solid object.

Process Skills

observe and infer, draw a conclusion

Teaching Strategies

- Using methyl cellulose to slow the protists interferes with *Paramecium's* normal response.
- Toothbrush bristles or small pieces of cotton may be used to block the path of *Paramecium.*
- Remind students to use caution when working with microscopes, slides, and coverslips.
- Have students wash their hands after handling cultures.

Expected Results

Paramecium typically reverses the direction in which its cilia are beating and backs away from a solid object that it contacts.

Analysis

1. It backs up, then proceeds forward in a new direction.
2. briefly
3. The cell turned on its long axis, and it folded.

Assessment

Portfolio Have students draw what occurs when *Paramecium* encounters solid objects and write captions for the events. Use the Performance Task Assessment List for Scientific Drawing in **PASC,** p. 55. L2 P

Resource Manager

BioLab and MiniLab Worksheets, p. 89 L2
Reteaching Skills Transparency 29 and Master L1 ELL

MiniLab 19-1 Observing and Inferring

Observing Ciliate Motion The cilia on the surface of a paramecium move so that the cell normally swims through the water with one end directed forward. But when this end bumps into an obstacle, the paramecium responds by changing direction.

Observing Paramecium

Procedure

1. Observe a *Paramecium* culture that has had boiled, crushed wheat seeds in it for several days.
2. Carefully place a drop of water containing wheat seed particles on a microscope slide. Gently add a coverslip.
3. Using low power, locate a paramecium near some wheat seed particles. **CAUTION:** ***Use caution when working with a microscope, glass slides, and coverslips.***
4. Watch the paramecium as it swims around among the particles. Record your observations of the organism's responses each time it contacts a particle.

Analysis

1. Describe what a paramecium does when it encounters an obstacle.
2. How long does the paramecium's response last?
3. Describe any changes in the shape of the paramecium as it moved among the particles.

more identical offspring by dividing into two cells. When environmental conditions become unfavorable, some types of amoebas form cysts that can survive extreme conditions.

Flagellates: Protozoans with flagella

The phylum Zoomastigina consists of protists called **flagellates,** which have one or more flagella. Flagellated protists move by whipping their flagella from side to side.

Some flagellates are parasites that cause diseases in animals, such as African sleeping sickness in humans. Other flagellates are helpful. For example, termites like those you see in ***Figure 19.4*** survive on a diet of wood. Without the help of a certain species of flagellate that lives in the guts of termites, some termites could not survive on such a diet. In a mutualistic relationship, flagellates convert cellulose from wood into a carbohydrate that both they and their termite hosts can use.

Ciliates: Protozoans with cilia

The roughly 8000 members of the protist phylum Ciliophora, known as **ciliates,** use the cilia that cover their bodies to move. Use the *MiniLab* on this page to observe a typical ciliate's motion. Ciliates live in every kind of aquatic habitat—from ponds and streams to oceans and sulfur springs. What does a typical ciliate look like? To find out, look at the *Inside Story* on the next page.

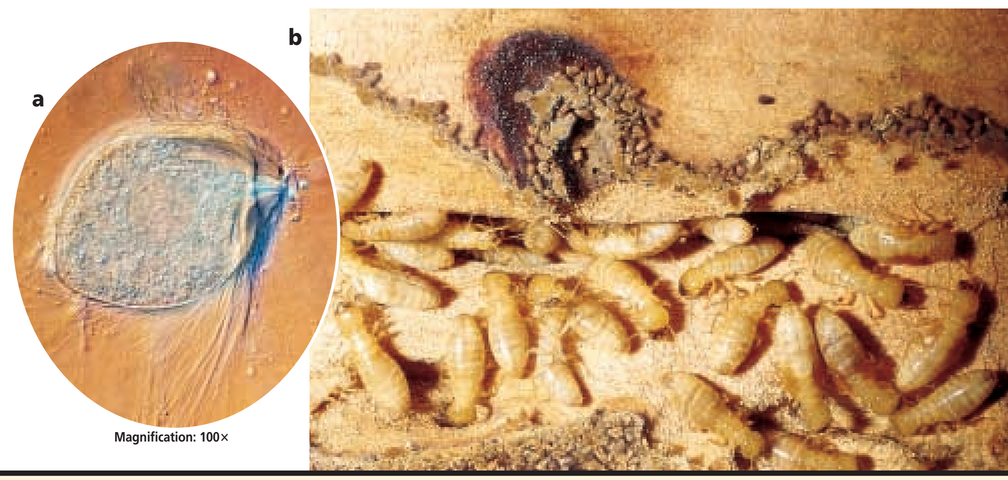


Figure 19.4
The flagellated protozoans (a) that live in the guts of termites (b) produce enzymes that digest wood, making nutrients available to their hosts.

Meeting Individual Needs

Gifted

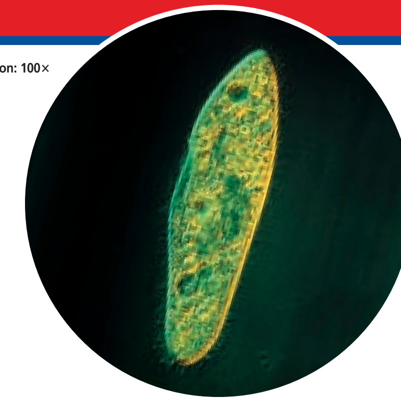
Kinesthetic Ask students to place a termite on a glass slide, grasp its head with a forceps, and gently pull to separate the head and intestines from the body. Have students add a few drops of Ringer's solution or water to the termite intestines, add a coverslip, and press gently on the coverslip to squash the intestines. Remind them to handle glass microscope slides and coverslips carefully and to use special care when viewing slides under high power. Then, ask students to observe the slide under low- and high-power magnification, looking for the termite's intestinal flagellates. Ask them to diagram and label the flagellates they see and place their drawings in their portfolios. L3 ELL

INSIDE STORY

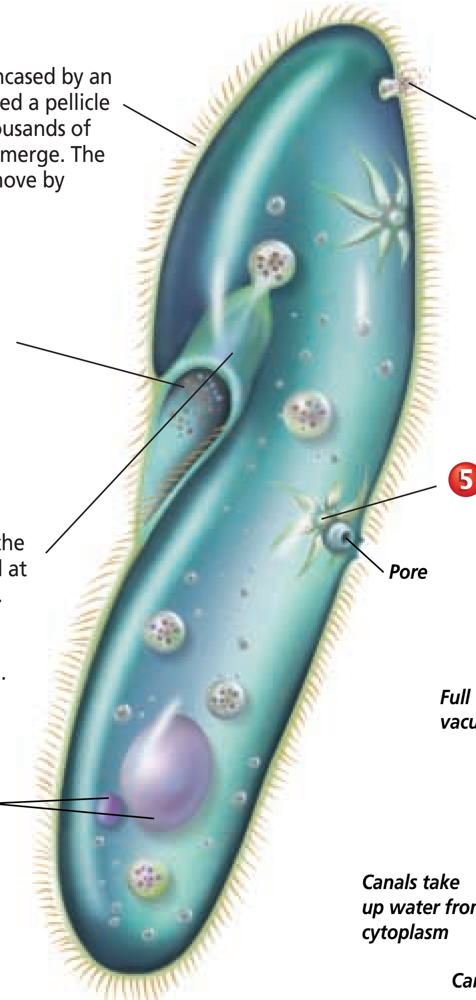
A Paramecium

Paramecia are unicellular organisms, but their cells are quite complex. Within a paramecium are many organelles and structures that are each adapted to carry out a distinct function.

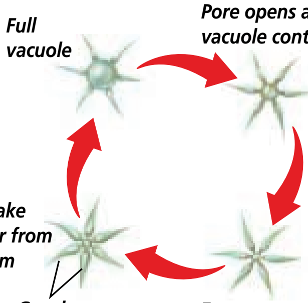
Critical Thinking ***How might the contractile vacuoles of a paramecium respond if the organism were placed in a dilute salt solution?***



Paramecium caudatum



1. **Cilia** The cell is encased by an outer covering called a pellicle through which thousands of tiny, hairlike cilia emerge. The paramecium can move by beating its cilia.
2. **Oral groove** Paramecia feed primarily on bacteria that are swept into the gullet by cilia that line the oral groove.
3. **Gullet** Food moves into the gullet, becoming enclosed at the end in a food vacuole. Enzymes break down the food, and the nutrients diffuse into the cytoplasm.
4. **Micronucleus and macronucleus** The small micronucleus plays a major role in sexual reproduction. The large macronucleus controls the everyday functions of the cell.
5. **Contractile vacuole** Because a paramecium lives in a freshwater, hypotonic environment, water constantly enters its cell by osmosis. A pair of contractile vacuoles pump out the excess water.
6. **Anal pore** Waste materials leave the cell through the anal pore.



INSIDE STORY

Purpose

Students learn about the role of *Paramecium's* organelles.

Teaching Strategies

- Ask students to explain the action of the contractile vacuoles.

Visual Learning

- Have students describe the location, shape, and function of each organelle. L1
- Have students make a table with the headings Function and Organelle. Beneath the Function head, have students list: Digestion, Locomotion, Protection, Excretion, Homeostasis, and Reproduction. Instruct the students to use the diagram to complete their tables. L2

Critical Thinking

Because less water would move into the cell if it were in a dilute salt solution, the contractile vacuoles would collect less water and contract less frequently.

NATIONAL GEOGRAPHIC

VIDEODISC
STV: The Cell
Cilia on Paramecium, SEM Image

Macro- and Micronucleus Identified

TechPrep

Charting Protist Diseases

Visual-Spatial Have students use an encyclopedia to make a table about the causal agents and symptoms of the following diseases: malaria, sleeping sickness, Chagas disease, giardiasis, and amoebic dysentery. Ask them to use the column headings: Kingdom, Phylum, Means of locomotion, Method of transmission, Parasitic or free-living, and Disease symptoms. L2

Problem-Solving Lab 19-1

Purpose
Analyze the role of digestive enzymes in *Paramecium*.

Process Skills
observe and infer, interpret scientific illustrations, recognize cause and effect

Teaching Strategies
■ Review pH. Inform students that there are both liquid and paper pH indicators.

Thinking Critically
It varies. The pH in a food vacuole forming at the end of the gullet is above 5. As digestion begins, the pH drops to below 3 and changes again as digestion progresses. As digestion nears completion, the pH increases until it is above 5 again. There are many digestive enzymes involved in *Paramecium* digestion, and they work at acidic and basic pHs.

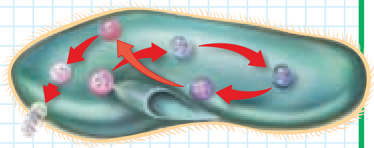
Assessment
Performance Give students liquids with different pHs. Have them use pH paper to find which liquids match the pH in *Paramecium's* food vacuole at the start and end of digestion. Use the Performance Task Assessment List for Carrying Out a Strategy and Collecting Data in **PASC**, p. 25. L2 ELL

3 Assess

Check for Understanding
Visual-Spatial Have students make a concept map showing Kingdom Protista's three subgroups. Ask them to expand their maps to include the four protozoan phyla. L2

Problem-Solving Lab 19-1 — Drawing a Conclusion

How do digestive enzymes function in paramecia? Paramecia ingest food particles and enclose them in food vacuoles.



Each food vacuole circulates in the cell as the food is digested by enzymes that enter the vacuole. Digested nutrients are absorbed into the cytoplasm.

Analysis
1. Some digestive enzymes function best at high pH levels, while others function best at low (more acidic) pH levels.
2. Congo red is a pH indicator dye; it is red when the pH is above 5 and blue when the pH is below 3 (very acidic).
3. Yeast cells that contain Congo red can be produced by adding dye to the solution in which the cells are growing.
4. When paramecia feed on dyed yeast cells, the yeast is visible inside food vacuoles.
5. Examine the drawing above. The appearance of a yeast-filled food vacuole over time is indicated by the colored circles inside the paramecium. Each arrow indicates movement and the passing of time.

Thinking Critically
What happens to the pH in the food vacuole over time? Explain what sequence of digestive enzymes might function in a paramecium.

Figure 19.5
A paramecium is dividing into two identical daughter cells.

Many structures found in ciliates' cells may work together to perform just one important life function. For example, *Paramecium* uses its cilia, oral groove, gullet, and food vacuoles in the process of digestion. Use the *Problem-Solving Lab* on this page to explore how a paramecium digests the food in a vacuole.

A paramecium usually reproduces asexually by dividing crosswise and separating into two daughter cells, as you can see in ***Figure 19.5.*** Whenever their food supplies dwindle or their environmental conditions change, paramecia usually undergo a form of conjugation. In this complex process, two paramecia join and exchange genetic material. Then they separate, and each divides asexually, passing on its new genetic composition.

Sporozoans: Parasitic protozoans

Protists in the phylum Sporozoa are often called **sporozoans** because most produce spores. A **spore** is a reproductive cell that forms without fertilization and produces a new organism.

All sporozoans are parasites. They live as internal parasites in one or more hosts and have complex life cycles. Sporozoans are usually found in a part of a host that has a ready food supply, such as an animal's blood or intestines. *Plasmodium*, members of the sporozoan genus, are organisms that cause the disease malaria in humans and other mammals and in birds.

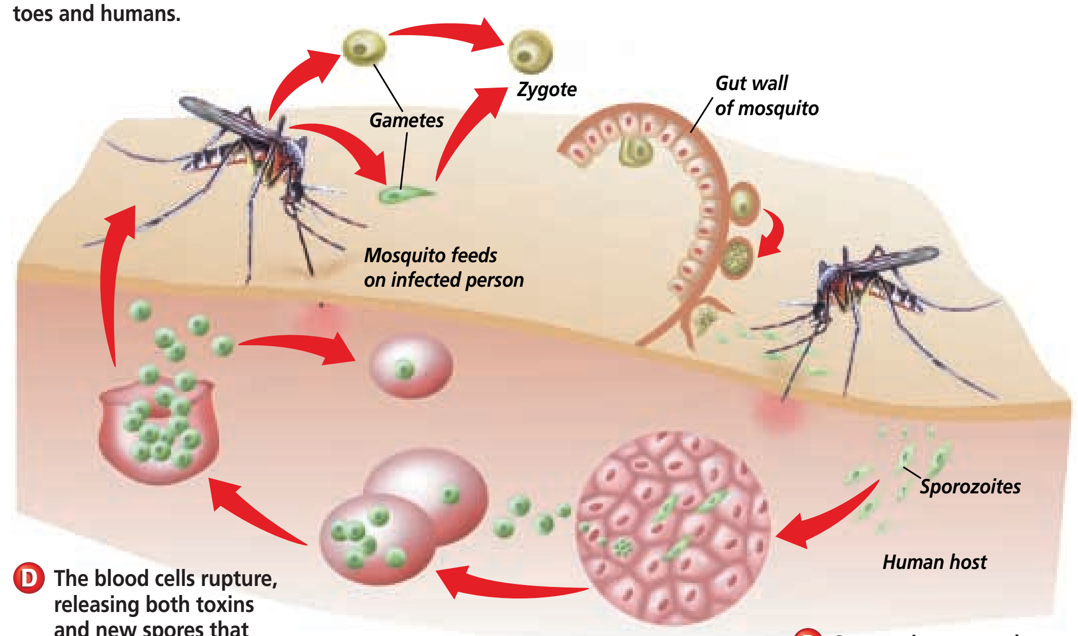
Sporozoans and malaria

Throughout the world today, more than 300 million people have malaria, a serious disease that usually occurs in places that have tropical climates. The *Plasmodium* that mosquitoes transmit to people cause human malaria. As you can see in ***Figure 19.6***, malaria-causing *Plasmodium* live in both humans and mosquitoes.

Until World War II, the drug quinine was used to treat malaria. Today, a combination of the drugs chloroquine and primaquine are most often used to treat this disease because they cause few serious side effects in humans. But, some species of *Plasmodium* have begun to resist these drugs. Therefore, quinine is once again being used to treat the resistant strains.

Figure 19.6
The life cycle of *Plasmodium* involves two hosts—mosquitoes and humans.

A Spores of *Plasmodium* enter the mosquito from infected human blood and produce a zygote. In the mosquito's gut, the zygote develops and eventually releases cells called sporozoites.



D The blood cells rupture, releasing both toxins and new spores that infect more red blood cells and multiply.

C The sporozoites reproduce asexually in the human's liver, forming spore-like cells that enter the human's red blood cells and multiply rapidly.

B Sporozoites enter the mosquito's salivary gland, and are injected into the mosquito's human host.

Section Assessment

Understanding Main Ideas
1. Describe the characteristics of the organisms called protists. Then compare the characteristics of the four major groups of protozoans. How is each group of protozoans animal-like?
2. How do amoebas obtain food?
3. Explain any differences that exist between ciliates and flagellates.
4. What makes a sporozoan different from other protozoan groups?

Thinking Critically
5. What role do contractile vacuoles play in helping freshwater protozoans maintain homeostasis?

Skill Review
6. **Sequencing** Trace the life cycle of a *Plasmodium* that causes human malaria. Identify all forms of the sporozoan and the role each plays in the disease. For more help, refer to *Organizing Information* in the **Skill Handbook**.

Reteach
Have students list five general protist traits and then make a second list of protozoan-specific traits. L1

Extension
Have students research the phylum of the organism *Trypanosoma cruzi*. Ask them to draw and label this protist. L2

Assessment
Knowledge Have students identify the unrelated word in each of the following groups: amoeba, foraminiferan, *Paramecium*, radiolarian; *pseudopodia*, cilia, oral groove, pellicle; dysentery, *AIDS*, sleeping sickness, Chagas disease. L2

4 Close

Activity
Logical-Mathematical Make five sets of ten index cards with one of the following words on each card: locomotion, cilia, pseudopodia, flagella, sarcodines, asexual reproduction, cyst, micronucleus, spore, sexual reproduction. Give a set of cards to each of five student groups, telling them to logically sequence the cards and then explain their sequences. L2

Resource Manager
Reinforcement and Study Guide, p. 83 L2
Content Mastery, p. 94 L1

Resource Manager
Critical Thinking/Problem Solving, p. 19 L3
Laboratory Manual, pp. 133-136 L2

Biology Journal
Malaria and Sickle-Cell Anemia
Linguistic Have students use references to report about the correlation between the genetic disease sickle-cell anemia and the protist disease malaria. They should include the evolutionary significance of such a relationship. L3

Section Assessment

1. Protists are eukaryotes without tissues. Protozoans are unicellular, heterotrophic protists. Rhizopods have pseudopodia, Ciliophorans have cilia, and flagella propel Mastigophorans. Sporozoans are parasites.
2. Pseudopodia entrap prey.
3. Flagellates have long, whiplike flagella. Ciliates have many short, hairlike cilia.
4. All are parasitic, many produce spores, and some cannot move.
5. Contractile vacuoles pump out excess water that enters the cell by osmosis.
6. Student answers should include the information in Figure 19.6. Both the human and mosquito hosts and the forms that *Plasmodium* take in each host should be distinguished.

Prepare

Key Concepts

In this section, the diversity of algae is explored by focusing on the characteristics and adaptations of members of the six algae phyla. Finally, alternation of generations in algae is discussed.

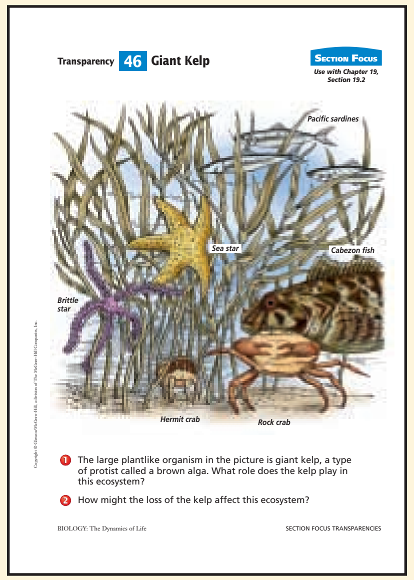
Planning

- Collect pond water or fish tank scum for MiniLab 19-2.
- Buy algae for students to taste.

1 Focus

Bellringer

Before presenting the lesson, display **Section Focus Transparency 46** on the overhead projector and have students answer the accompanying questions. L1 ELL



SECTION PREVIEW

Objectives

Compare and contrast the variety of plantlike protists.

Explain the process of alternation of generations in algae.

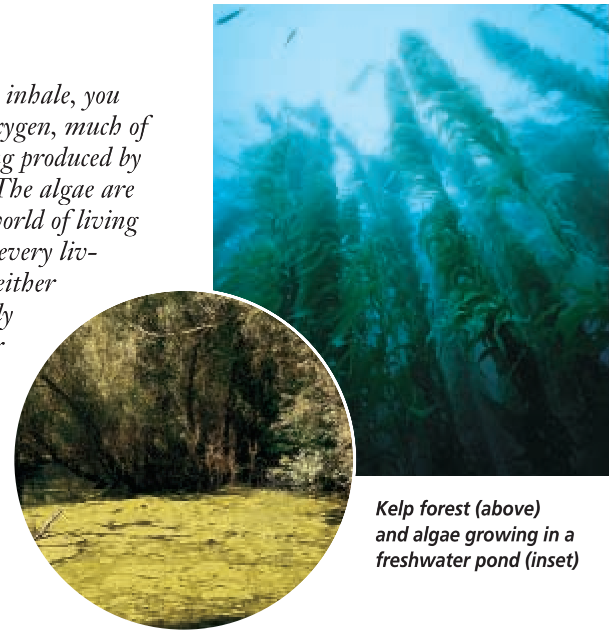
Vocabulary

thallus
colony
fragmentation
alternation of generations
gametophyte
sporophyte

Section

19.2 Algae: Plantlike Protists

Each time you inhale, you breathe in oxygen, much of which is being produced by plantlike protists. The algae are important in the world of living things. Just about every living thing depends either directly or indirectly on these protists for oxygen and food.



Kelp forest (above) and algae growing in a freshwater pond (inset)

What Are Algae?

Photosynthesizing protists are called algae. All algae contain up to four kinds of chlorophyll as well as other photosynthetic pigments. These pigments produce a variety of colors in algae, including purple, rusty-red, olive-brown, yellow, and golden-brown, and are a way of classifying algae into groups.

Algae include both unicellular and multicellular organisms. The photosynthesizing unicellular protists, known as phytoplankton (fite uh PLANK tun), are so numerous that they are one of the major producers of nutrients and oxygen in aquatic ecosystems in the world. It's been estimated that algae produce more than half of the oxygen generated by Earth's photosynthesizing organisms. Although multicellular algae may look like plants because they are large and sometimes green, they have no roots, stems, or leaves. Use the *MiniLab* on the next page to observe some algae.

Diversity of Algae

Algae are classified into six phyla. Three of these phyla—the euglenoids, diatoms, and dinoflagellates—include only unicellular species. However, in the other three phyla, which are the green, red, and brown algae, most species are multicellular.

Euglenoids: Autotrophs and heterotrophs

Hundreds of species of euglenoids (yoo GLEE noydz) make up the phylum Euglenophyta. Euglenoids are unicellular, aquatic protists that have both plant and animal characteristics. Unlike plant cells, they lack a cell wall made of cellulose. However, they do have a flexible pellicle made of protein that surrounds the cell membrane. Euglenoids are plantlike in that most have chlorophyll and photosynthesize. However, they are also animal-like because, when light is not available, they can ingest food in ways that might remind you of some protozoans. In other words, euglenoids can be heterotrophs. In ***Figure 19.7***, you can see a typical euglenoid.

Euglenoids might also remind you of protozoans because they have one or more flagella to move. They use their flagella to move toward light or food. In the *BioLab* at the end of this chapter you can learn more about how a euglenoid responds to light.

Diatoms: The golden algae

Diatoms (DI uh tahmz), members of the phylum Bacillariophyta, are unicellular photosynthetic organisms with

MiniLab 19-2 Observing

Going on an Algae Hunt Pond water may be teeming with organisms. Some are macroscopic organisms, but the majority are microscopic. Some may be heterotrophs, and others autotrophs. How can you tell them apart?

Procedure

1. Copy the data table.

Data Table

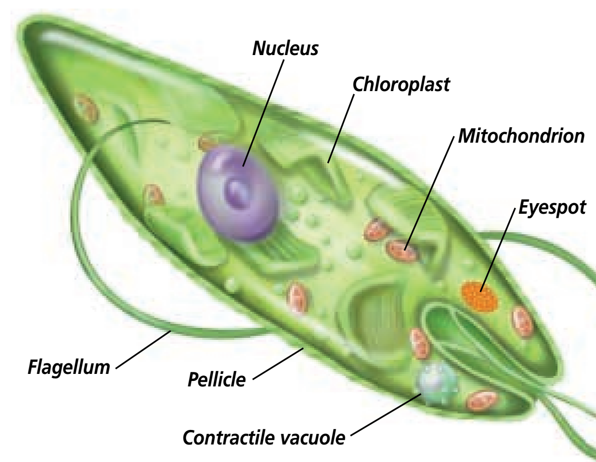
Diagram	Motile/Nonmotile	Unicellular/Multicellular

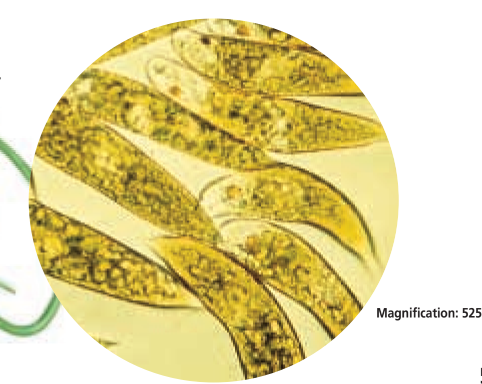
2. Place a drop of pond water onto a glass slide and add a coverslip. **CAUTION:** *Use caution when working with a microscope, glass slides, and coverslips.*
3. Observe the pond water under low magnification of your microscope, and look for algae that may be present. Algae from a pond will usually be green or yellow-green in color.
4. Diagram several different species of algae in your data table and indicate if each is motile or nonmotile. Indicate if the algae are unicellular or multicellular.

Analysis

1. What characteristic distinguished algae from any protozoans that may have been present?
2. Explain how the characteristic in question 1 categorizes algae as autotrophs.
3. Did you observe any relationship between movement and size? Explain your answer.

Figure 19.7
Notice the eyespot in this *Euglena gracilis.* It shades a light-sensitive receptor that helps *E. gracilis* orient itself toward light.





2 Teach

MiniLab 19-2

Purpose

Students will examine pond water for evidence of algae.

Process Skills

apply concepts, classify, compare and contrast, observe and infer

Teaching Strategies

- Collect pond water or scrape algae from the inside of a fish tank and stir into water.
- Remind students to wear a lab apron, gloves, and goggles, to handle slides carefully, and to wash their hands after their work.

Expected Results

Students will find many algae.

Analysis

1. Algae are green in color.
2. Autotrophs contain chlorophyll for photosynthesis.
3. The smaller the algae the more likely they are motile.

Assessment

Performance Have students use fertilizers to aid algal growth. Use the Performance Task Assessment List for Carrying Out a Strategy and Collecting Data in **PASC**, p. 25. L2 ELL

The BioLab at the end of the chapter can be used at this point in the lesson. DESIGN YOUR OWN BioLab

NATIONAL GEOGRAPHIC

VIDEODISC
STV: The Cell
Magnified View of Euglenas (1)

Resource Manager

BioLab and MiniLab Worksheets, p. 90 L2
Section Focus Transparency 46 and Master L1 ELL

BIOLOGY JOURNAL

Protozoans and Algae

Naturalist Have students prepare a table that compares and contrasts protozoans and algae. Suggest that they use the headings Similarities and Differences. The rows can include topics such as Cell organization, Nutrition, and Cell structures. L2

PROJECT

Culturing *Euglena*

Kinesthetic Have students establish a culture of *Euglena* in the following way. Add 20 rice grains and 5 mL skim milk to 1 L of spring water. Boil for 5 minutes on a hot plate in a glass container. Remind the students to wear heat protective gloves or use tongs to lift heated objects. Add 3 L of spring water and allow the mixture to cool overnight. Add 100 mL of a *Euglena* culture you purchased. Students can maintain the culture in a well-lit area without direct sunlight while they design an experiment to determine how the numbers of *Euglena* change over time. After getting your approval for their designs, ask the students to carry out their procedures. L3 ELL COOP LEARN

Assessment

Skill Have the students observe, draw, and label prepared slides of *Euglena gracilis.* Then, ask them to estimate the size of the organism, using the **Skill Handbook** if they need help. L2

Reinforcement

Visual-Spatial Have students make a concept map that shows how the six algae phyla are related. Ask them to use the following terms: plantlike protists, autotrophic, unicellular, mostly multicellular, diatoms, euglenoids, dinoflagellates, green algae, brown algae, red algae. Have them share their maps on overhead transparencies. L2

Activity

Kinesthetic Have students prepare wet mounts of diatomaceous earth and diagram the diatoms' shapes. For a source of diatoms, scrape the inside of a fish tank. Remind students to handle microscopes, slides, and coverslips carefully. L2 ELL

GLENCOE TECHNOLOGY

VIDEODISC
Biology: The Dynamics of Life
Protists (Ch. 12)
Disc 1, Side 2, 26 sec.

NATIONAL GEOGRAPHIC

VIDEODISC
STV: The Cell: *Diatom, Magnified 300 Times*

Diatom, Magnified 3,000 Times

Figure 19.8
Diatom shells have many shapes.

shells composed of silica. They are abundant in both marine and freshwater ecosystems, where they are a large component of the phytoplankton.

The delicate shells of diatoms, like those you see in ***Figure 19.8***, might remind you of boxes with lids. Each species has its own unique shape, decorated with grooves and pores.

Diatoms contain chlorophyll as well as other pigments called carotenoids (KER uh teen oydz) that usually give them a golden-yellow color. The food that diatoms make is stored as oils rather than starch. These oils give fishes that feed on diatoms an oily taste. They also give diatoms buoyancy so that they float near the surface where light is available.

When diatoms reproduce asexually, the two halves of the box separate; each half then produces a new half to fit inside itself. This means that half of each generation's offspring are smaller than the parent cells. When diatoms are about one-quarter of their original size, they reproduce sexually by producing gametes that fuse to form zygotes. The zygote develops into a full-sized diatom, which will divide asexually for a while. You can see both the asexual and sexual reproductive processes of diatoms in ***Figure 19.9***.

Figure 19.9
Diatoms reproduce asexually for several generations before reproducing sexually.

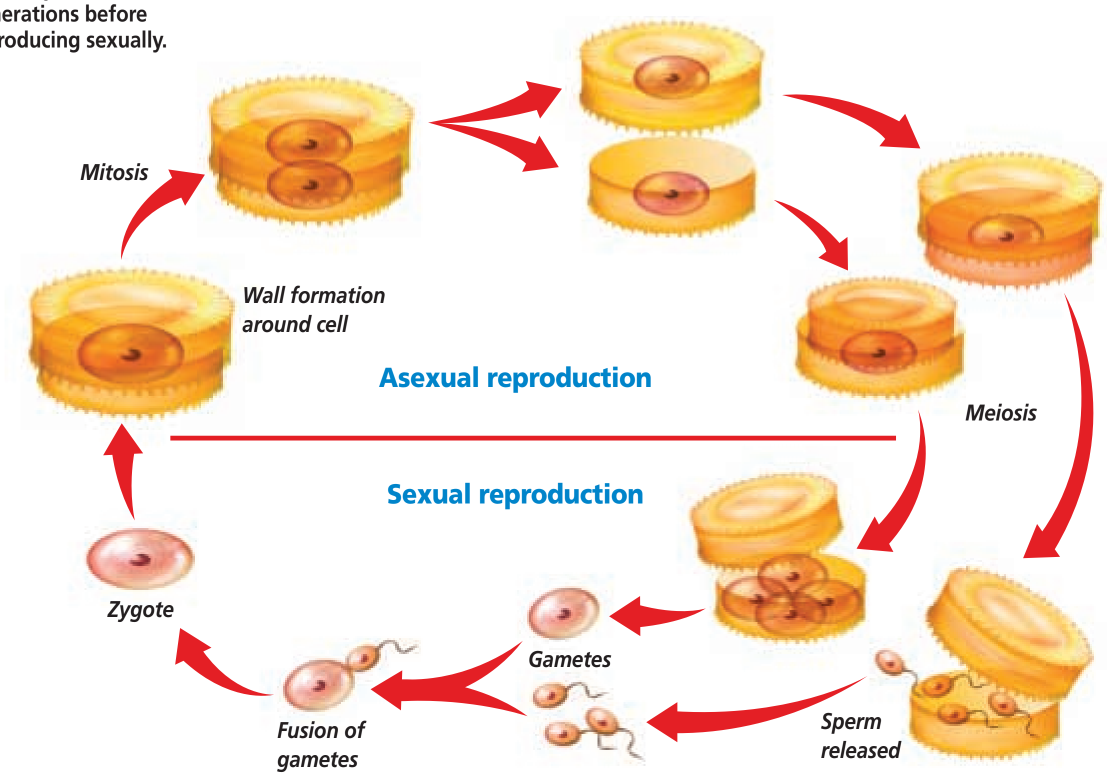


Figure 19.10
Red tides, such as the one shown here **(a)**, are often caused by dinoflagellates such as this one called *Gonyaulax* **(b)**.

When diatoms die, their shells sink to the ocean floor. The deposits of diatom shells—some of which are millions of years old—are dredged or mined, processed, and used as abrasives in tooth and metal polishes, or added to paint to give the sparkle that makes pavement lines more visible at night.

Dinoflagellates: The spinning algae

Dinoflagellates (di nuh FLAJ uh layts), members of the phylum Dinoflagellata, have cell walls that are composed of thick cellulose plates. They come in a great variety of shapes and styles—some even resemble helmets, and others look like suits of armor.

Dinoflagellates contain chlorophyll, carotenoids, and red pigments. They have two flagella located in grooves at right angles to each other. The cell spins slowly as the flagella beat. A few species of dinoflagellates live in freshwater, but most are marine and, like diatoms, are a major component of phytoplankton. Many species live symbiotically with jellyfishes, mollusks, and corals. Some free-living species are bioluminescent, which means that they emit light.

Several species of dinoflagellates produce toxins. One toxin-producing dinoflagellate, *Pfiesteria piscicida*, that some North Carolina researchers discovered in 1988 has caused a number of fish kills in the coastal areas of North Carolina.

Another toxic species, *Gonyaulax catanella*, produces an extremely strong nerve toxin that can be lethal. In the summer, these organisms may become so numerous that the ocean takes on a reddish color as you can see in ***Figure 19.10.*** This population explosion is called a red tide. In some red tides, there can be as many as 40 to 60 million dinoflagellates per liter of seawater.

The toxins produced during a red tide may make humans ill. During red tides, the harvesting of shellfish is usually banned because shellfish feed on the toxic algae and the toxins concentrate in their tissues. People who eat such shellfish risk being poisoned. You can learn more about the causes and effects of red tides in the

Using Science Terms

Tell students that the prefix *dino* means "whirling" and the suffix *flagellate* means "whip." Ask them why the name dinoflagellates is appropriate for these algae. *They spin as their flagellas propel them through water.* L1

Concept Development

Describe coral as a heterotroph and ask students to explain the role of dinoflagellates and coral when they live symbiotically. *Dinoflagellates make food for the corals, and the coral reef helps safeguard dinoflagellates from predators.*

Reinforcement

Check that students know the meaning of shellfish, bioluminescent, and toxins. Discuss why the term shellfish is a misnomer. *Shellfish are not classified as fishes, but as arthropods (shrimp and crabs) or mollusks (clams and squid).*

GLENCOE TECHNOLOGY

VIDEODISC
The Infinite Voyage
Secrets from a Frozen World
The Antarctic Peninsula: Pack Ice and Life Cycles (Ch. 6)
10 min. 30 sec.

Effects of UV Radiation on Phytoplankton (Ch. 8)
4 min. 30 sec.

Meeting Individual Needs

Visually Impaired

Kinesthetic Allow students to hold a petri dish and explain that its halves fit together in a manner similar to that of a diatom's halves. L1 ELL

Portfolio

Algal Names

Linguistic Although algae are often called "seaweed, scum, and sea moss," none of these terms are scientifically correct. Have students find the meaning of each term and then explain why it is scientifically incorrect. L2 ELL P

NATIONAL GEOGRAPHIC

VIDEODISC
STV: The Cell

Dinoflagellates

Red Tide

Quick Demo

Purchase preserved brown and red algae for class display. If possible, buy some edible algae for students to taste.

Problem-Solving Lab 19-2

Purpose

Students will analyze real-life events associated with red tides.

Process Skills

think critically, acquire information, draw a conclusion, recognize cause and effect

Teaching Strategies

- Have students work in small groups, discussing each event thoroughly.
- Have groups share answers.

Thinking Critically

1. a. A or B—Toxins accumulate in shellfish that humans eat; mackerel eat dinoflagellates and whales eat the mackerel.
   b. E—Autotrophs use sunlight and nutrients to grow.
   c. C—Human population growth correlates with the frequency of red tides.
2. A or B—Shellfish are not affected by dinoflagellate toxins, but humans are; mackerel do not die from dinoflagellate toxins, but whales do.

Assessment

Portfolio Have students diagram dinoflagellates they observe on prepared slides. Use the Performance Task Assessment List for Scientific Drawing in **PASC**, p. 55. L1

Problem-Solving Lab 19-2 — Recognizing Cause and Effect

Why is the number of red tides increasing? Scientists have been aware of red tide poisoning of birds, fishes, and mammals such as whales and humans for years. Could the rise in red tide poisoning be related to human activities?

A sperm whale's carcass

Analysis

The following events are associated with the appearance of red tides.

- **A** The dinoflagellate toxin that causes illness and sometimes death in humans accumulates in the body tissues of shellfish, such as clams and oysters.
- **B** Within five weeks, 14 humpback whales died on beaches in Massachusetts. The whales' stomachs contained mackerel with high levels of dinoflagellate toxin.
- **C** Between 1976 and 1986, the human population of Hong Kong increased sixfold, and its harbor had an eightfold increase in red tides. Human waste water was commonly emptied into the harbor.
- **D** Studies show that red tides are increasing world wide.
- **E** An algal bloom occurs when algae, using sunlight and abundant nutrients, increase rapidly in number to hundreds of thousands of cells per milliliter of water.

Thinking Critically

1. Which statement above provides evidence that supports each of the following ideas. Explain each answer.
   a. Dinoflagellate poisons flow through the food chain.
   b. Dinoflagellates are autotrophs.
   c. There is a correlation between human activities and algae growth.
2. All animals equally tolerate dinoflagellate toxins. Which statement contradicts this idea? Explain your answer.

Problem-Solving Lab on the next page.

Red algae

Red algae, members of the phylum Rhodophyta, are multicellular marine seaweeds. The body of a seaweed, as well as that of some plants and other organisms, is called a **thallus** and lacks roots, stems, or leaves. Red algae use structures called holdfasts to attach to rocks. They grow in tropical waters or along rocky coasts in cold water. You can see a red alga in *Figure 19.11.*

In addition to chlorophyll, red algae also contain photosynthetic pigments called phycobilins. These pigments absorb green, violet, and blue light—the only part of the light spectrum that penetrates water below depths of 100 m. Therefore, the red algae can live in deep water where most other seaweeds cannot thrive.

Brown algae

About 1500 species of multicellular brown algae make up the phylum Phaeophyta. Almost all of these species live in salt water along rocky coasts in cool areas of the world. Brown algae contain chlorophyll as well as a yellowish-brown carotenoid called fucoxanthin, which gives them their brown color. Many species of brown algae have air bladders that keep their bodies floating near the surface, where light is available.

The largest and most complex of brown algae are kelp. In kelp, the thallus is divided into the holdfast, stipe, and blade. The holdfasts anchor kelp to rocks or the sea bottom. Some giant kelps may grow up to 60 meters long. In some parts of the world, such as off the California coast, giant kelps form dense, underwater forests. These kelp forests are rich ecosystems and provide a wide variety of marine organisms with their habitats.

Figure 19.11 This Coralline alga is only one of about 4000 species of red algae. Some species are popular foods in Japan and other countries.

Green algae

Green algae make up the phylum Chlorophyta. The green algae are the most diverse algae, with more than 7000 species. The major pigment in green algae is chlorophyll, but some species also have yellow pigments that give them a yellow-green color. Most species of green algae live in freshwater, but some live in the oceans, in moist soil, on tree trunks, in snow, and even in the fur of sloths—large, slow-moving mammals that live in the tropical rain forest canopy.

Green algae can be unicellular, colonial, or multicellular in organization. As you can see in *Figure 19.12, Chlamydomonas* is a unicellular and flagellated green alga. *Spirogyra* is a multicellular species that forms slender filaments. *Volvox* is a green alga that can form a **colony,** a group of cells that lives together in close association.

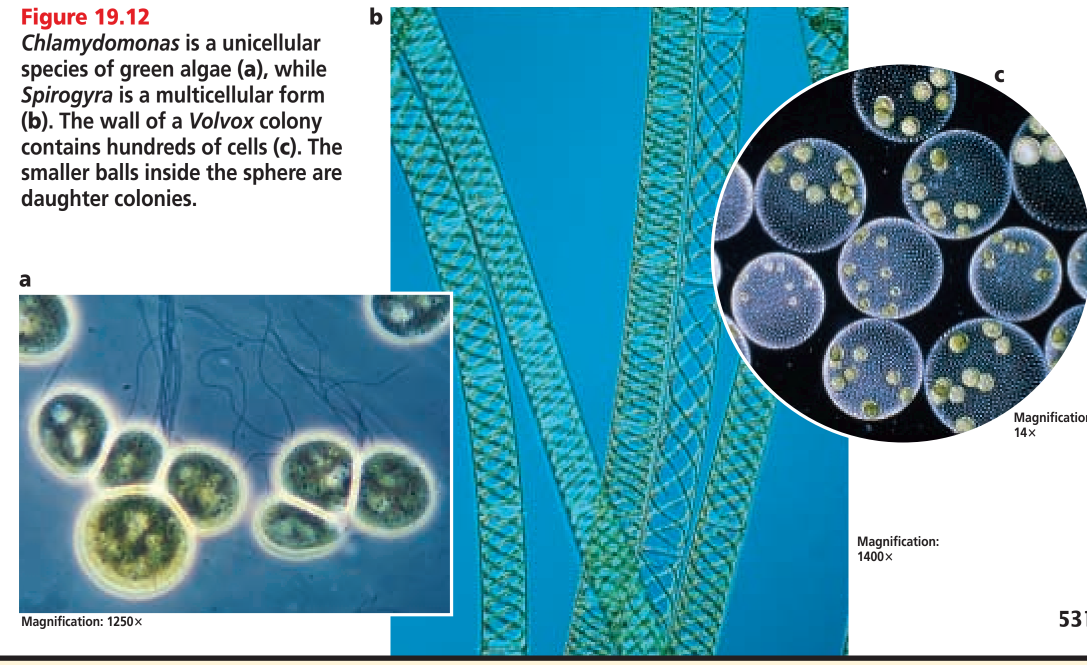
A *Volvox* colony is composed of hundreds, or thousands, of flagellated cells arranged in a single layer forming a hollow, ball-shaped structure. The cells are connected by strands of cytoplasm, and the flagella of individual cells face outward. The flagella can beat in a coordinated fashion, spinning the colony through the water. Small balls of daughter colonies form inside the large sphere. The wall of the large colony will eventually break open and release the daughter colonies.

Green algae reproduce both asexually and sexually. For example, *Spirogyra* reproduces asexually by fragmentation. During **fragmentation,** an

Word Origin

thallus
From the Greek word *thallos,* meaning "green shoot." A thallus is a plant without stems, roots, or leaves.

Figure 19.12 *Chlamydomonas* is a unicellular species of green algae (a), while *Spirogyra* is a multicellular form (b). The wall of a *Volvox* colony contains hundreds of cells (c). The smaller balls inside the sphere are daughter colonies.



Quick Demo

Allow students to feel the texture of agar in a petri dish. Then, display an ingredient label from an ice cream carton that lists alginate, agar, or carrageenan, a protein found in red algae. Discuss why algal products are used in ice cream and agar. Encourage students to think of other products that might have a similar alga ingredient. L1

Assessment

Portfolio Have students make a flowchart of the life cycle of *Ulva* and include the terms: alternation of generations, gametophyte, sporophyte, mitosis, meiosis, zygote, and gamete. L2 P

GLENCOE TECHNOLOGY

CD-ROM
Biology: The Dynamics of Life
Video: *Kelp Forests,* Disc 3

VIDEODISC
Biology: The Dynamics of Life
Kelp Forests (Ch. 13)
Disc 1, Side 2
26 sec.

NATIONAL GEOGRAPHIC

VIDEODISC
STV: The Cell
Volvox With Chloroplasts

Cultural Diversity

Algae Harvesting in Japan

Inform students that people in many areas of the world, particularly Asia, eat some algae. Point out that algae contain nutrients, such as protein, and many vitamins and minerals. Algae are eaten fresh and boiled or fried in many Asian recipes. One edible algae used in Japanese cooking is *Porphyra,* a red alga commonly called nori. Since the seventeenth century, the Japanese have harvested nori from Tokyo Bay. Have students research how the Japanese harvest algae. Bring in some Japanese foods that contain algae for the class to sample. L3

Meeting Individual Needs

Visually Impaired

Kinesthetic Have students make a textural circle graph that shows the number of species in each algal phylum. Provide the following data: Euglenoids = 800, Diatoms = 10 000, Dinoflagellates = 2000, Red algae = 4000, Brown algae = 1500, Green algae = 7000. L2

Resource Manager

Tech Prep Applications, p. 27 L2
Laboratory Manual, pp. 137-140 L2

3 Assess

Check for Understanding

Have students describe briefly three unicellular and three multicellular algae phyla. L2

Reteach

Have the class develop a concept map of the material in this chapter's first two sections. L2

Extension

Ask students to compile a list of foods that contain algae. L2

Assessment

Knowledge Make six line drawings showing an alga from each of the six phyla. Give students sets of the drawings and ask them to list three facts or ideas about each alga. L2

4 Close

Discussion Questions

Have each student prepare three questions about algae. Collect the questions and have the students answer them. L1

GLENCOE TECHNOLOGY

VIDEODISC
The Infinite Voyage
The Living Clock, Circadian Rhythm and the Biological Clock (Ch. 4)
5 min.

Resource Manager

Reinforcement and Study Guide, pp. 84-85 L2

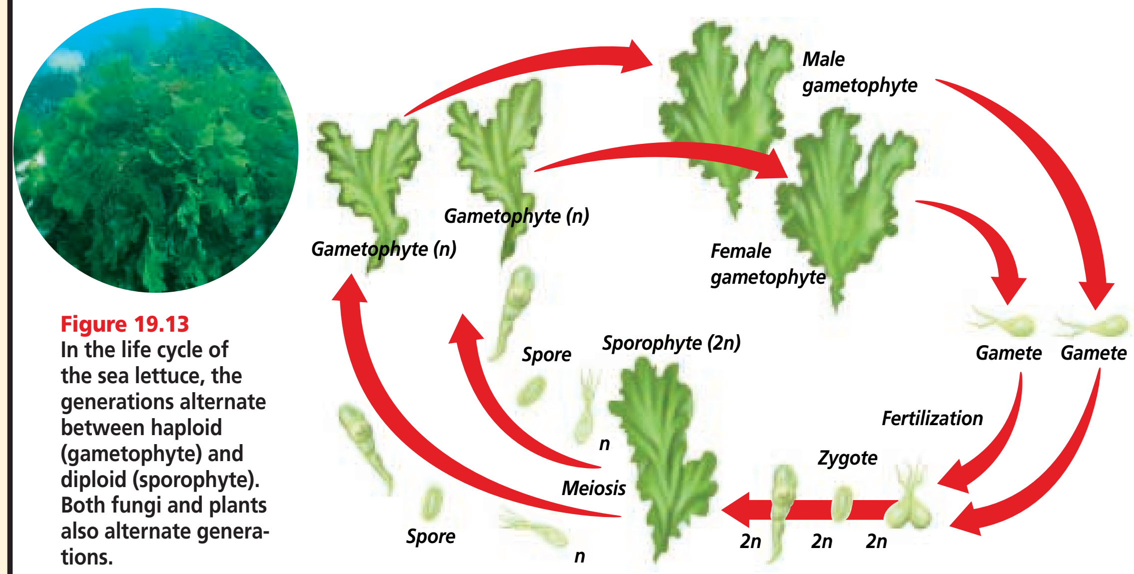


Figure 19.13
In the life cycle of the sea lettuce, the generations alternate between haploid (gametophyte) and diploid (sporophyte). Both fungi and plants also alternate generations.

individual breaks up into pieces and each piece grows into a new individual.

Green algae, and some other types of algae, have a complex life cycle. This life cycle consists of individuals that alternate between producing reproductive cells called spores and producing gametes.

Alternation of Generations

The life cycles of some algae and all plants have a pattern called **alternation of generations.** An organism that has this pattern alternates between a haploid and a diploid generation.

The haploid form of the organism is called the **gametophyte** because it produces gametes. The gametes fuse to form a zygote from which the diploid form of the organism, which is called the **sporophyte,** develops. Certain cells in the sporophyte undergo meiosis. Eventually, these cells become haploid spores that can develop into a new gametophyte. Look

Section Assessment

Understanding Main Ideas

1. In what ways are algae important to all living things on Earth?
2. Give examples that show why the green algae are considered to be the most diverse of the six phyla of algae.
3. In what ways do the sporophyte and gametophyte generations of an alga such as *Ulva* differ from each other?
4. Why are phycobilins an important pigment in red algae?

Thinking Critically

5. Use a table to list the reasons why euglenoids should be classified as protozoans and also as algae.

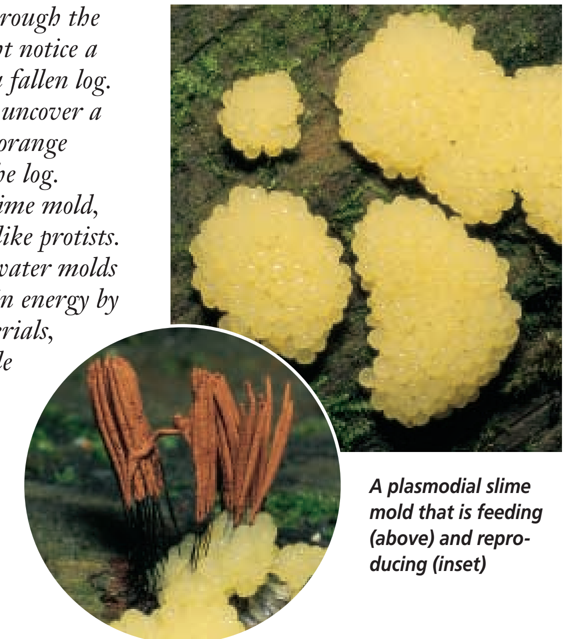
SKILL REVIEW

6. **Making and Using Tables** Construct a table listing the different phyla of algae. Indicate whether they have one or more cells, their color, and give an example of each. For more help, refer to *Organizing Information* in the **Skill Handbook.**

Section

19.3 Slime Molds, Water Molds, and Downy Mildews

When you walk through the woods, you might notice a spot of color on a fallen log. Turning the log over, you uncover a glistening mass of yellow-orange slime that fans out over the log. What you've found is a slime mold, one of a variety of funguslike protists. Slime molds, along with water molds and downy mildews, obtain energy by decomposing organic materials, and play an important role in recycling nutrients in many ecosystems.



A plasmodial slime mold that is feeding (above) and reproducing (inset)

SECTION PREVIEW

Objectives

Contrast the cellular differences and life cycles of the two types of slime molds.

Discuss the economic importance of the downy mildews and water molds.

Vocabulary

plasmodium

What are Funguslike Protists?

Certain groups of protists, the slime molds, the water molds, and the downy mildews, consist of organisms with some funguslike features. Recall that fungi are heterotrophic organisms that decompose organic materials to obtain energy. Like fungi, the funguslike protists decompose organic materials.

There are three phyla of funguslike protists. Two of these phyla consist of slime molds. Slime molds have characteristics of both protozoans and fungi and are classified by the way they reproduce. Water molds and downy mildews make up the third phylum of funguslike protists. Although funguslike protists are not an everyday part of human lives, some disease-causing species damage vital crops.

Slime Molds

Many slime molds are beautifully colored, ranging from brilliant yellow or orange to rich blue, violet, and jet black. They live in cool, moist, shady places where they grow on damp,

Section 19.3

Prepare

Key Concepts

This section presents the characteristics of funguslike protists. The phyla of plasmodial slime molds, cellular slime molds, and water molds and downy mildews are described. Finally, the origin of protists is discussed.

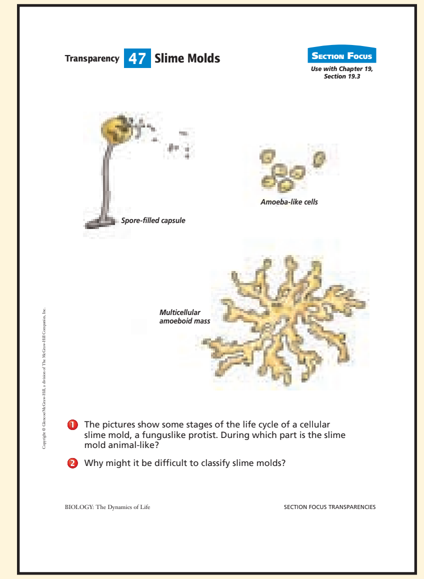
Planning

- Obtain meat, string, and an aquarium for the Quick Demo.

1 Focus

Bellringer

Before presenting the lesson, display **Section Focus Transparency 47** on the overhead projector and have students answer the accompanying questions. L1 ELL



Section Assessment

1. They are producers of oxygen and the primary autotrophs of many food chains.
2. *Chlamydomonas* is a unicellular example. *Volvox* is a colonial form. *Ulva* is a multicellular alga.
3. Haploid gametophytes form gametes and diploid sporophytes form spores.
4. They can absorb the green, violet, and blue light that penetrates deep water.
5. Their chloroplasts are algaelike and their locomotion is protozoanlike.
6. Euglenophyta—one, green, euglena; Bacillariophyta—one, golden, diatom; Dinoflagellata—one, green, yellow, and red, dinoflagellate; Rhodophyta—many, red, red seaweed; Phaeophyta—many, brown, brown seaweed; Chlorophyta—one or many, green, green algae.

MEETING INDIVIDUAL NEEDS

English Language Learners

Linguistic Reinforce terms students can use to recall the three groups of protists. For animal-like protists, use unicellular, motile, and heterotroph. For plantlike protists, use photosynthetic, autotroph, unicellular, and multicellular. For funguslike protists, use heterotroph and decomposer. ELL

Resource Manager

Section Focus Transparency 47 and Master L1 ELL
Basic Concepts Transparency 28 and Master L2 ELL

2 Teach

Problem-Solving Lab 19-3

Purpose
Students will relate cell division to a slime mold's life cycle.

Process Skills
apply concepts, interpret scientific illustrations, think critically

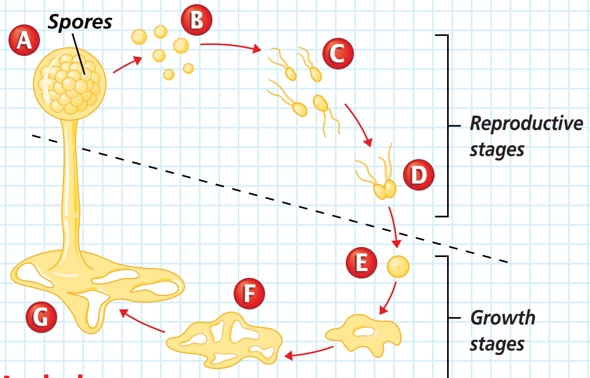
Teaching Strategies
- Grow slime molds and have students observe them with a stereo microscope.
- Review mitosis, meiosis, fertilization, and spore formation.

Thinking Critically
1. mitosis—cell growth; meiosis—haploid gamete formation (gametes form at C)
2. D—two gamete cells join; C—cells with flagella; E—it results from fertilization.
3. growth stage—organisms use food to grow

Assessment
Performance Have students grow slime molds from purchased spores. Use the Performance Task Assessment List for Carrying Out a Strategy and Collecting Data in **PASC**, p. 25. L3 ELL

Problem-Solving Lab 19-3 — Predicting

What changes occur during a slime mold's life cycle?
Plasmodial slime molds undergo a number of different stages during their life cycle. The most visible stage is the plasmodial stage, where the organism looks like a slimy mass of material. The plasmodium changes into a reproductive stage that is microscopic and, therefore, less visible.



Analysis
Examine the life cycle of a plasmodial slime mold. The structures below the dashed line are diploid in chromosome number. Based on the diagram and your understanding of mitosis and meiosis, answer the questions below.

Thinking Critically
1. What cell process, mitosis or meiosis, takes place between F and G? Explain why. Between A and B? Explain why.
2. What letter best shows fertilization occurring? Motile spores? An embryo? Explain why in each case.
3. During which stage does the slime mold feed? Explain.

organic matter such as rotting leaves or decaying tree stumps and logs.

There are two major types of slime molds—plasmodial slime molds and cellular slime molds. The plasmodial slime molds belong to the phylum Myxomycota, and the cellular slime molds make up another grouping, the phylum Acrasiomycota.

Slime molds are animal-like during much of their life cycle, moving about and engulfing food in a way similar to that of amoebas. However, like fungi, slime molds make spores to reproduce. Use the *Problem-Solving Lab* on this page to learn more about the life cycle of a slime mold.

Plasmodial slime molds

Plasmodial slime molds get their name from the fact that they form a **plasmodium** (plaz MOHD ee um), a mass of cytoplasm that contains many diploid nuclei but no cell walls or membranes. This slimy, multinucleate mass, like the one you see in *Figure 19.14,* is the feeding stage of the organism. The plasmodium creeps like an amoeba over the surfaces of decaying logs or leaves. Some plasmodiums move at the rate of about 2.5 centimeters per hour, engulfing microscopic organisms and digesting them in food vacuoles. At that rate, a plasmodium would cross your textbook page in eight hours.

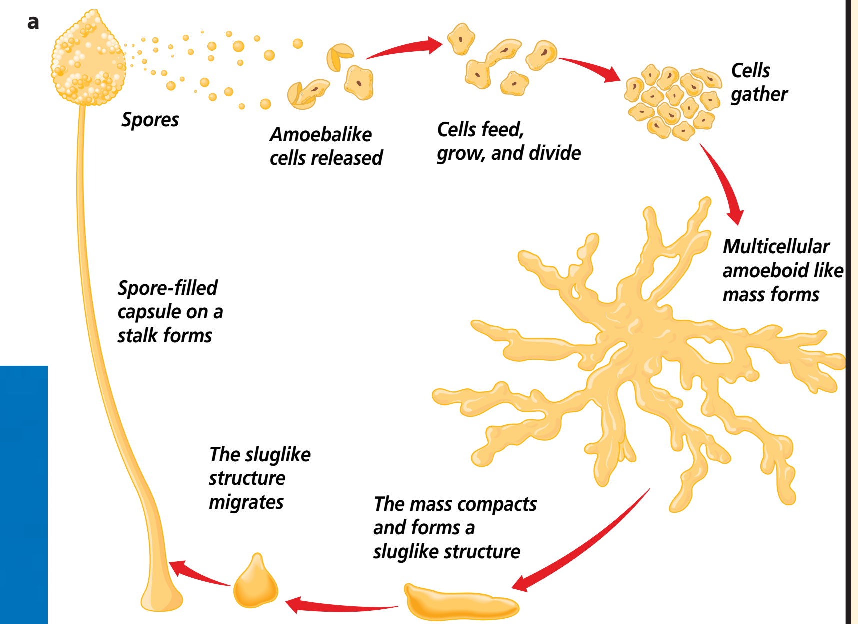
A plasmodium may reach more than a meter in diameter and contain thousands of nuclei. However, when moisture and food become scarce in its surroundings, a plasmodium transforms itself into many separate, stalked, spore-producing structures. Meiosis takes place within these structures and produces haploid spores, which the wind disperses. A spore germinates into either a flagellated or an amoeboid cell, or a gamete, that can fuse with another cell to form a zygote. The diploid zygote grows into a new plasmodium.

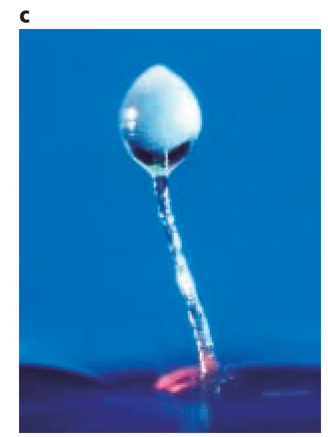
Cellular slime molds

Unlike plasmodial slime molds, cellular slime molds spend part of their life cycle as an independent amoeboid cell that feeds, grows, and divides by cell division, as shown in *Figure 19.15.* When food becomes scarce, these independent cells join with hundreds or thousands of others to reproduce. Such an aggregation of amoeboid cells resembles a plasmodium. However, this mass of cells is multicellular—made up of many individual amoeboid cells, each with a distinct cell membrane. Cellular slime molds are haploid during their entire life cycle.

Figure 19.14
The moving, feeding form of a plasmodial slime mold is a multinucleate blob of cytoplasm.

Figure 19.15
The reproductive cycle of a cellular slime mold is complex (a). Single cells clump and form a structure that resembles a small garden slug (b). Eventually, the clump forms a stalked reproductive structure that produces spores (c).





Word Origin
plasmodium
From the Greek word *plassein,* meaning "mold," and the Latin word *odium,* meaning "hateful." One form of a slime mold is a plasmodium.

Reinforcement
Prepare an overview that illustrates the relationship between the phyla Myxomycota and Acrasiomycota and Kingdom Protista.

Assessment
Performance Have each student write two questions about slime molds. Divide the class into pairs and have students quiz each other. L1

GLENCOE TECHNOLOGY

VIDEODISC
VIDEOTAPE
The Secret of Life
On the Brink: Portraits of Modern Science

CD-ROM
Biology: The Dynamics of Life
Video: *Slime Mold*
Disc 3

VIDEODISC
Biology: The Dynamics of Life
Slime Mold (Ch. 14)
Disc 1, Side 2, 14 sec.

Resource Manager
- Concept Mapping, p. 19 L3 ELL
- Basic Concepts Transparency 29 and Master L2 ELL
- Reteaching Skills Transparency 30 and Master L1 ELL

Alternative Lab

Observing Slime Mold

Purpose
Allow students to observe a plasmodium-type slime mold.

Materials
petri dish with plasmodium stage of *Physarum polycephalum* (Prepare subcultures two days in advance by cutting sections from the culture, putting the pieces on plastic agar plates that contain a few flakes of oat cereal moistened with distilled water.); stereo microscope

Procedure
Give students the following directions.
1. Wear a lab apron, gloves, and safety goggles during this lab.
2. Observe the slime mold.
3. Design a way to determine if the organism moves or not.
4. Record your macroscopic observations.
5. Use a stereo microscope to observe the slime mold. Record your observations about its microscopic appearance and behavior.
6. Wash your hands thoroughly when you finish. Dispose of the slime mold as your teacher directs.

Analysis
1. Describe the slime mold's appearance and behavior. Is it a plasmodial or cellular slime mold? *yellow, bloblike, stringy, moves very slowly—plasmodium*
2. Describe the slime mold's microscopic appearance and behavior. *Material flows within the slime mold, stops, then flows in the opposite direction.*

Assessment
Knowledge Write a paragraph explaining if you observed the feeding or the reproductive stage of the slime mold. Use the Performance Task Assessment List for Writing in Science in **PASC,** p. 87. L2

Quick Demo

Visual-Spatial Tie string around a piece of meat and suspend it in the water of an aquarium. After several days, remove the meat and have students examine it both macroscopically and with a stereo microscope and re-cord their observations. Have students wear a lab apron and disposable gloves.

Visual Learning

Figure 19.17 Review the relationships among the different protist phyla shown in the figure.

3 Assess

Check for Understanding

Naturalist Have students compare and contrast the three funguslike protist phyla. Ask them to explain why these organisms are classified as protists and not fungi. L2

Reteach

Naturalist Have student groups prepare charts that compare and contrast the phyla Myxomycota, Acrasiomycota, and Oomycota. L2 COOP LEARN

Extension

Visual-Spatial Have students make flowcharts of the life cycles of Myxomycota and Acrasiomycota organisms and include the chromosome number for each stage. L3

Resource Manager

Basic Concepts Transparency 30 and Master L2 ELL

Water Molds and Downy Mildews

Water molds and downy mildews are both members of the phylum Oomycota. Most members of this large and diverse group of funguslike protists live in water or moist places. As shown in ***Figure 19.16***, some feed on dead organisms and others are plant parasites.

Most water molds appear as fuzzy, white growths on decaying matter. They resemble some fungi because they grow as a mass of threads over a food source, digest it, and then absorb the nutrients. But at some point in their life cycle, water molds produce flagellated reproductive cells—something that fungi never do. This is why water molds are classified as protists rather than fungi.

One economically important member of the phylum Oomycota is a downy mildew that causes disease in many plants. In the *Social Studies Connection* at the end of the chapter, you can read about a downy mildew called *Phytophthora infestans* that has affected the lives of many people by destroying their major food crop.

Origin of Protists

How are the many different kinds of protists related to each other and to fungi, plants, and animals? You can see the relationships of protists to each other in ***Figure 19.17.***

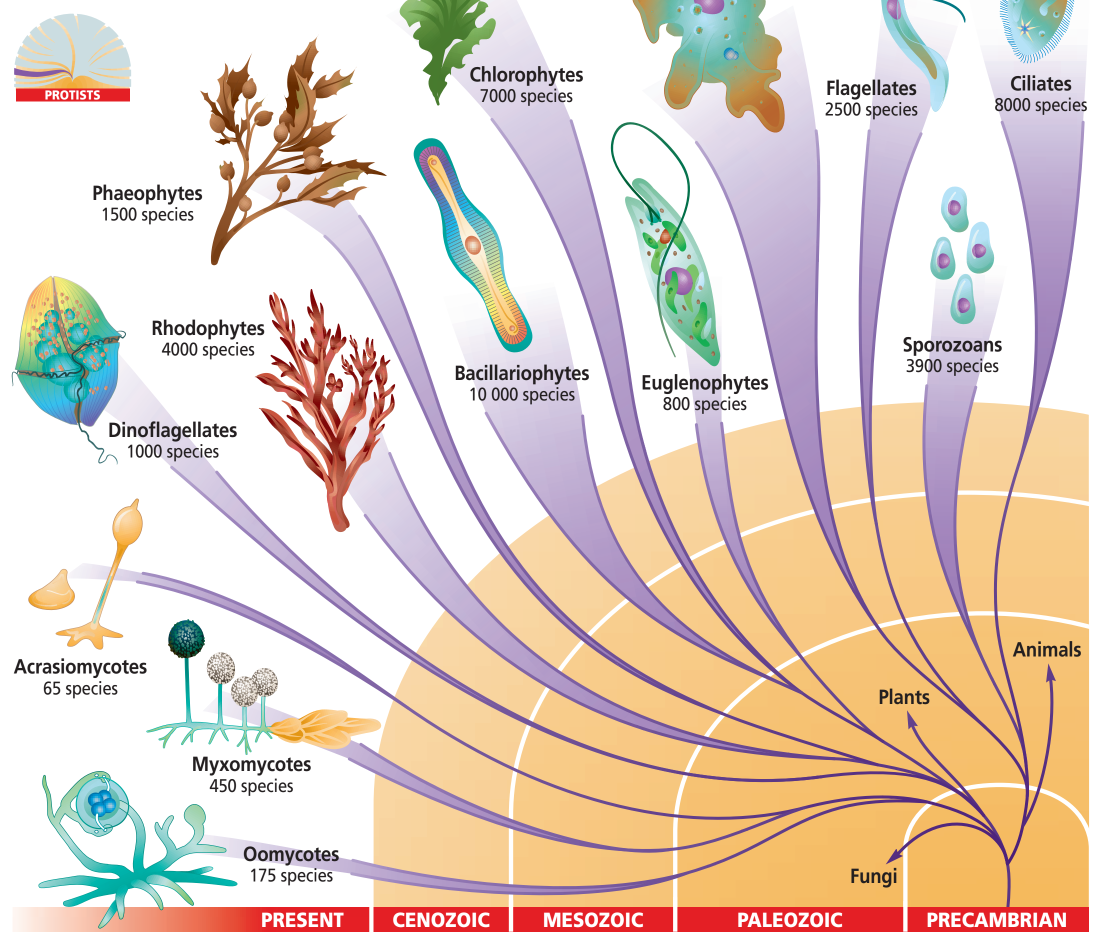
Although taxonomists are now comparing the RNA and DNA of these groups, there is little conclusive evidence to indicate whether ancient protists were the evolutionary ancestors of fungi, plants, and animals or whether protists emerged as evolutionary lines that were separate. Because of evidence from comparative RNA sequences in modern green algae and plants, many biologists agree that ancient green algae were probably ancestral to modern plants.

Figure 19.16
Water molds and downy mildews live in moist places and cause both plant and animal diseases.

A The downy mildew *Phytophthora infestans* is killing this potato plant.

B The water mold growing on this insect is decomposing the insect's tissues and absorbing the nutrients.

Figure 19.17
This fanlike diagram shows the relationships of the different protist phyla on the Geologic Time Scale.



Section Assessment

Understanding Main Ideas

1. Describe the protozoan and funguslike characteristics of slime molds.
2. Why might some biologists refer to plasmodial slime molds as acellular slime molds. (Hint: Look in Appendix B for the origins of scientific terms.)
3. How could a water mold eventually kill a fish?
4. How does a plasmodial slime mold differ from a cellular slime mold?

Thinking Critically

5. In what kinds of environments would you expect to find slime molds? Explain your answer.

Skill Review

6. **Observing and Inferring** If you know that a plasmodium consists of many nuclei within a single cell, what can you infer about the process that formed the plasmodium? For more help, refer to *Thinking Critically* in the **Skill Handbook.**

Assessment

Knowledge Ask students to list several protozoanlike traits and several funguslike traits of the funguslike protists.

4 Close

Activity

Have students list five words related to funguslike protists. Tell them that four words must be related to each other, and the fifth word must be unrelated. Collect the lists. Copy some lists onto the chalkboard and, in each case, have the class find the unrelated word and describe how the remaining words are related. L2

Resource Manager

Reinforcement and Study Guide, p. 86 L2
Content Mastery, pp. 93, 95-96 L1

Internet Address Book

interNET CONNECTION Note Internet addresses that you find useful in the space below for quick reference.

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Biology Journal

Origin of Protists

Linguistic Have students write a paragraph offering their views on the origin of and relationships among protists. L3

Section Assessment

1. They are protozoanlike in that at different stages they have flagella and the ability to move like amoebas. They are funguslike in that they produce spores, and many are saprophytic decomposers.
2. The plasmodium is a mass of cytoplasm containing many nuclei but no cell walls or membranes that separate cells.
3. The mold digests its tissues.
4. Plasmodial slime molds feed as a multinucleated plasmodium, but cellular slime molds feed as amoeboid cells.
5. Slime molds should live in moist environments where the moisture would prevent dehydration and provide the conditions their food supply needs to thrive.
6. The process suggests mitosis without cell division.

DESIGN YOUR OWN BioLab

Time Allotment
One class period

Process Skills
observe and infer, experiment, form a hypothesis, identify and control variables

Safety Precautions
Remind students to be careful when working with microscopes, slides, and coverslips and to use special care when viewing a slide under high power. Have students wash their hands after finishing the lab.

PREPARATION

- To demonstrate how *Euglena* and *Paramecium* respond to light, cover a test tube containing *Euglena* with black paper containing a narrow, slitlike opening. Leave the tube in bright light for 12 hours and then remove the paper. Where the slit was located, students should observe a green band of *Euglena*. Cover half of a test tube containing *Paramecium* with black paper, place the tube on its side in bright light for 12 hours. *Paramecium* should congregate in the covered side.

Possible Hypotheses
If *Paramecium* are attracted to light, then they will move to the light zone on a glass slide containing both light and dark zones.
If *Euglena* are attracted to light, then they will move to the light zone on a glass slide containing both light and dark zones.

DESIGN YOUR OWN BioLab

How do *Paramecium* and *Euglena* respond to light?

Members of the genus Paramecium *are ciliated protozoans—unicellular, heterotrophic protists that move around in search of small food particles.* Euglena *are unicellular algae—autotrophic protists that usually contain numerous chloroplasts. In this* BioLab, *you'll investigate how these two protists respond to light in their environment.*

PREPARATION

Problem
Do both *Paramecium* and *Euglena* respond to light and do they respond in different ways? Among the members of your group, decide on one type of protist activity that would constitute a response to light.

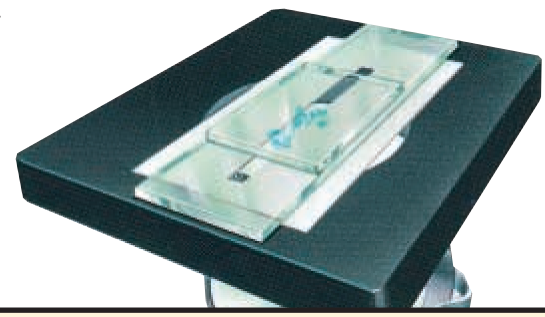
Hypotheses
Decide on one hypothesis that you will test. Your hypothesis might be that *Paramecium* will not respond to light and *Euglena* will respond, or that *Paramecium* will move away from light and *Euglena* will move toward light.

Objectives
In this BioLab, you will:
- **Prepare** slides of *Paramecium* and *Euglena* cultures and observe swimming patterns in the two organisms.
- **Compare** how these two different protists respond to light.

Possible Materials
Euglena culture
Paramecium culture
microscope
microscope slides
dropper
methyl cellulose
coverslips
metric ruler
index cards
scissors
toothpicks

Safety Precautions
Always wear goggles in the lab. Use caution when working with a microscope, glass slides, and coverslips. Wash your hands with soap and water immediately after working with protists and chemicals.

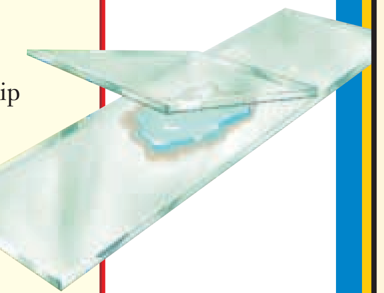
Skill Handbook
Use the **Skill Handbook** if you need additional help with this lab.



PLAN THE EXPERIMENT

1. Decide on an experimental procedure that you can use to test your hypothesis.
2. Record your procedure, step-by-step, and list the materials you will be using.
3. Design a data table in which to record your observations and results.

Check the Plan
Discuss all the following points with other group members to determine your final procedure.
1. What variables will you have to measure?
2. What will be your control?
3. What will be the shape of the light-controlled area(s) on your microscope slide?
4. Decide who will prepare materials, make observations, and record data.
5. ***Make sure your teacher has approved your experimental plan before you proceed further.***
6. To mount drops of *Paramecium* culture and *Euglena* culture on microscope slides, use a toothpick to place a small ring of methyl cellulose on a clean microscope slide. Place a drop of *Paramecium* or *Euglena* culture within this ring. Place a coverslip over the ring and culture. The thick consistency of methyl cellulose should slow down the organisms for easy observation.
7. Make preliminary observations of swimming *Paramecia* and *Euglena*. Then think again about the observation times that you have planned. Maybe you will decide to allow more or less time between your observations.
8. Carry out your experiment.



ANALYZE AND CONCLUDE

1. **Checking Your Hypothesis** Did your data support your hypothesis? Why or why not?
2. **Comparing and Contrasting** Compare and contrast all the responses of the *Paramecium* and *Euglena* to both light and darkness. What explanations can you suggest for their behavior?
3. **Making Inferences** Can you use your results to suggest what sort of responses to light and darkness you might observe using other heterotrophic or autotrophic protists?

Going Further
Project You may want to extend this experiment by varying the shapes or relative sizes of light and dark areas or by varying the brightness or color of the light. In each case, make hypotheses before you begin. Keep your data in a notebook, and draw up a table of your results at the end of your investigations.

interNET CONNECTION To find out more about protists, visit the Glencoe Science Web Site.
www.glencoe.com/sec/science

DESIGN YOUR OWN BioLab

ANALYZE AND CONCLUDE

1. Answers may vary. Data must be used to either support or reject student hypotheses.
2. *Euglena* are attracted to light. Paramecium avoid bright light. *Euglena* need light to make food. Heterotrophic, *Paramecium* can find food in dim and dark places.
3. Most autotrophs show a positive response to light whereas most heterotrophs show a negative response.

Error Analysis
Advise students to do several trials for each organism. Ask them why this is important.

Assessment
Portfolio Have students write an evaluation of what they learned in this investigation. Use the Performance Task Assessment List for Writing in Science in **PASC**, p. 87. L2

Going Further
Students may wish to test the response of these protists to other factors, such as different concentrations of salt solutions. L3 ELL

PLAN THE EXPERIMENT

Teaching Strategies
- Provide time for students to observe the organisms' size, speed, and mobility under a microscope before they begin.
- Have students use low power to observe *Paramecium* (a 5× objective works best) and high power to observe *Euglena*.
- Advise students that they must count organisms quickly.

Possible Procedures
- Index cards can provide a light and dark microscope zone. Cut the cards to fit over part of the coverslip. Students should focus on the edge of the card to observe each organism's direction of movement. If possible, use coverslips (22 × 30 mm or 22 × 40 mm) that cover a large area.
- Prepare or purchase methyl cellulose.

Data and Observations
Data should indicate that *Euglena* are attracted to light; *Paramecium* are not.

Resource Manager
BioLab and MiniLab Worksheets, pp. 91-92 L2

Social Studies Connection

Purpose

Students will learn why a balance between humans and the organisms in their environment is important.

Teaching Strategies

- Ask what influences other than famine might lead to mass emigrations? *Climatic changes, particularly droughts, political upheavals, wars, economic devastation.*

Connection to Biology

With fewer infestations of *Phytophthora infestans*, it is more difficult to determine its evolutionary relationships. Outbreaks of *P. infestans* are minimized by the use of fungicides, but new resistant strains have arisen that are difficult to control and that destroy many crops. In addition, the overuse of pesticides has increased the number of crop-damaging insects, making some crops more susceptible to insect destruction.

Social Studies Connection

The Irish Potato Famine

A funguslike protist known as Phytophthora infestans *causes a disease called potato blight. Between the years 1845–1847, the disease damaged or totally destroyed the Irish potato crop—a primary food source for about one-third of the Irish population at the time. A severe seven-year famine resulted.*

The potato was first grown in Ireland in the late 1500s and within 200 years was a widespread food crop. Potatoes grew well in the temperate, rainy Irish climate. They were not vulnerable to many diseases, needed no processing, and were nutritious. In addition, most Irish people were tenant farmers with farms averaging fewer than 15 acres. Enough potatoes could be grown on a few acres to support an entire family for a year. By 1845, the potato crop fed a large percentage of the Irish population.

Invasion of a downy mildew Historians suggest that *Phytophthora infestans* arrived in Ireland in 1845 on a ship that arrived from North America. The wet conditions in Ireland during July and August that year were ideally suited for the spread of the protist, a downy mildew, which is classified in the phylum Oomycota. In addition, the wind probably widely dispersed the *P. infestans* spores, infecting the leaves and stems of mature potato plants. The spores also washed into the soil and infected the underground stems, or tubers, of the potatoes. The potato blight damaged the Irish potato crop in 1845, and it destroyed nearly the entire potato crop in one week's time in the summer of 1846.

Mass emigration of the Irish Many Irish people starved in the years that followed. Many others emigrated from Ireland. By 1855, the population of Ireland had fallen from about eight million to four million. The Irish immigrated primarily to four countries, the United States, England, Canada, or Australia. The large numbers of immigrants greatly affected the social structure of these four countries as well as that of Ireland.

Most of the Irish quickly adapted to their new homes. For example, in the United States, some Irish became politically active. In fact, John F. Kennedy, who was president of the United States from 1960–1963, was the great-great-grandson of an Irish tenant farmer who immigrated to the United States in 1848.

Many Irish people who immigrated to the United States at the time of this famine settled in the large East Coast cities, such as New York, Philadelphia, and Boston. Their descendants are now an integral part of American society and live throughout the United States.

Connection to Biology

Today, fungicides, chemicals that prevent fungal growth, control outbreaks of *Phytophthora infestans.* How might this information affect research about the evolutionary relationships of funguslike protists?

interNET CONNECTION To find out more about the Irish potato famine and *Phytophthora*, visit the Glencoe Science Web Site.
www.glencoe.com/sec/science

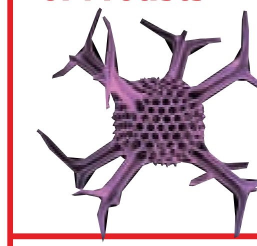
Internet Address Book

interNET CONNECTION Note Internet addresses that you find useful in the space below for quick reference.

Chapter 19 Assessment

Summary

Section 19.1 The World of Protists



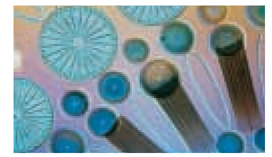
Main Ideas

- Kingdom Protista is a diverse group of living things that contains animal-like, plantlike, and funguslike organisms.
- Some protists are heterotrophs, some are autotrophs, and some get their nutrients by decomposing organic matter.
- Amoebas move by extending pseudopodia. The flagellates use one or more flagella to move. The beating of cilia produces cilliate movement. Sporozoans live as parasites and produce spores.

Vocabulary

algae (p. 519)
asexual reproduction (p. 521)
ciliate (p. 522)
flagellate (p. 522)
protozoan (p. 519)
pseudopodia (p. 520)
spore (p. 524)
sporozoan (p. 524)

Section 19.2 Algae: Plantlike Protists



Main Ideas

- Algae are unicellular and multicellular photosynthetic autotrophs. Unicellular species include the euglenoids, diatoms, dinoflagellates, and some green algae. Multicellular species include red, brown, and green algae.
- Green, red, and brown algae, often called seaweeds, have complex life cycles that alternate between haploid and diploid generations.

Vocabulary

alternation of generations (p. 532)
colony (p. 531)
fragmentation (p. 531)
gametophyte (p. 532)
sporophyte (p. 532)
thallus (p. 530)

Section 19.3 Slime Molds, Water Molds, and Downy Mildews

Main Ideas

- Slime molds, water molds, and downy mildews are funguslike protists that decompose organic material to obtain nutrients.
- Plasmodial and cellular slime molds change in appearance and behavior before producing reproductive structures.

Vocabulary

plasmodium (p. 534)

Understanding Main Ideas

1. Which organisms cause red tides?
   a. dinoflagellates
   b. euglenoids
   c. green algae
   d. red algae
2. Which organelle in protists is able to eliminate excess water?
   a. anal pore
   b. mouth
   c. contractile vacuole
   d. gullet
3. Which of the following pairs contains terms most related to each other?
   a. paramecium—alternation of generations
   b. asexual reproduction—gametophyte
   c. sporozoan—cilia
   d. amoeba—pseudopodia
4. Producers in aquatic food chains include ________.
   a. algae
   b. protozoans
   c. slime molds
   d. amoebas

Chapter 19 Assessment

Main Ideas

Summary statements can be used by students to review the major concepts of the chapter.

Using the Vocabulary

To reinforce chapter vocabulary, use the Content Mastery Booklet and the activities in the Interactive Tutor for Biology: The Dynamics of Life on the Glencoe Science Web Site.
www.glencoe.com/sec/science

THE PRINCETON REVIEW *All Chapter Assessment questions and answers have been validated for accuracy and suitability by The Princeton Review.*

Understanding Main Ideas

1. a
2. c
3. d
4. a

GLENCOE TECHNOLOGY

VIDEOTAPE
MindJogger Videoquizzes
Chapter 19: *Protists*
Have students work in groups as they play the videoquiz game to review key chapter concepts.

Resource Manager

Chapter Assessment, pp. 109-114
MindJogger Videoquizzes
Computer Test Bank
BDOL Interactive CD-ROM, Chapter 19 quiz

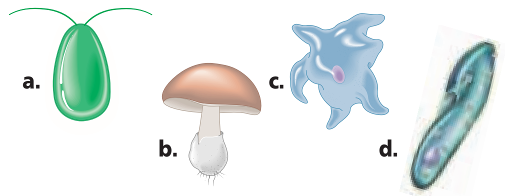
5. a
6. d
7. b
8. b
9. a
10. c
11. eukaryotes
12. sporozoan
13. colony
14. flagellum
15. fragmentation
16. algae
17. gametophyte; sporophyte
18. protozoans
19. plasmodium
20. cilia; flagellum

Applying Main Ideas

21. Finding a suitable host; producing many spores will improve the possibility of survival because some of the spores may find a host.
22. oak forest—dry conditions stimulate spore-producing structures.
23. Answers will vary, but may include cilia, pseudopodia, flagella, eyespots, contractile vacuoles, or others.

Chapter 19 Assessment

5. Protists are classified on the basis of their ________.
   - a. nutrition
   - b. method of locomotion
   - c. reproductive abilities
   - d. size
6. Euglenoids are unique algae because of their ________.
   - a. flagella
   - b. cilia
   - c. silica walls
   - d. heterotrophic nature
7. Which of the following is not a protist?

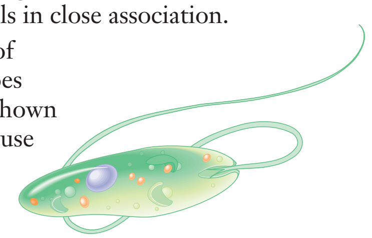


8. The algae that can survive in the deepest water are the ________?
   - a. brown algae
   - b. red algae
   - c. diatoms
   - d. green algae
9. The largest and most complex of brown algae are the ________.
   - a. kelp
   - b. *Chlamydomonas*
   - c. sea lettuce
   - d. *Spirogyra*
10. Which of the following are protected by armored plates?
    - a. kelp
    - b. fire algae
    - c. dinoflagellates
    - d. diatoms
11. Unlike bacteria, all protists are ________.

THE PRINCETON REVIEW — Test-Taking Tip

Work Weak Areas, Maintain Strong Ones
It's sometimes difficult to focus on all the concepts needed for a test. So ask yourself "What's my strongest area?" and "What's my weakest area?" Focus most of your energy on your weak areas. But also put in some "upkeep" time in your strongest areas.

12. The protozoan that causes malaria is classified as a ________ because it is a spore-producing parasite.
13. *Volvox* is an alga that lives in a ________, a group of cells in close association.
14. What type of structure does the protist shown to the right use to move?



15. Asexual reproduction may occur when an organism breaks into pieces in a process known as ________.
16. Diatoms and dinoflagellates are two phyla of protists in the group collectively called ________.
17. The haploid form of an alga that has alternation of generations is known as the ________, and the diploid form is the ________.
18. Amoebas, cilliates, flagellates, and sporozoans are collectively called ________.
19. Individual cells of a cellular slime mold may fuse to form a structure that resembles a ________ and that reproduces.
20. Paramecia move about using short projections called ________, but euglenas move using a long projection, the ________.

Applying Main Ideas

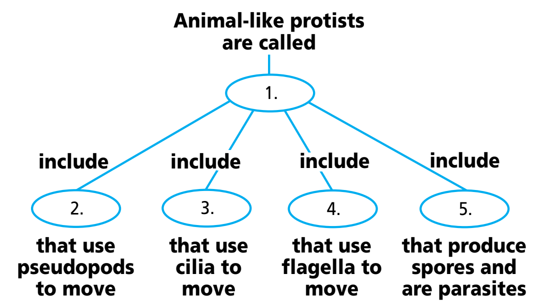
21. Why is it a disadvantage for a sporozoan to be a parasite? How might a sporozoan's method of asexual reproduction offset this disadvantage?
22. In which ecosystem would a plasmodial slime mold transform itself into spore-producing structures more frequently: a rainy forest in the Pacific Northwest or a dry, oak forest in the Midwest? Explain your answer.
23. Give three examples of organelles that help protists maintain homeostasis in their environments.

Chapter 19 Assessment

24. Up to the late 1800s, malaria was common in the extreme southeastern part of the United States. In an attempt to fight the disease, ponds and wetlands were often filled in or drained. How do you suppose this action helped cut down on the number of malaria cases?

Thinking Critically

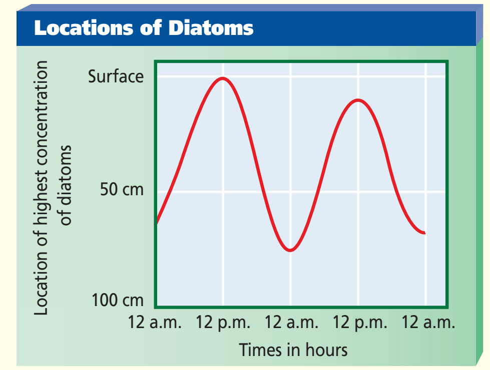
25. **Observing and Inferring** Why do you suppose many people who own aquariums add snails to them?
26. **Formulating Hypotheses** In agricultural regions where farmers use large amounts of nitrogen fertilizers in their fields, local ponds and lakes often develop a thick, green scum containing algae in late summer. Hypothesize why this happens.
27. **Sequencing** Sequence the stages of both sexual and asexual reproduction in diatoms.
28. **Concept Mapping** Complete the concept map by using the following vocabulary terms: amoebas, sporozoans, flagellates, protozoans, ciliates



CD-ROM
For additional review, use the assessment options for this chapter found on the ***Biology: The Dynamics of Life Interactive CD-ROM*** and on the Glencoe Science Web Site.
www.glencoe.com/sec/science

Assessing Knowledge & Skills

During a summer ecology class, a group of high school students studied unicellular algae at a site in the middle of a pond. For three days and nights, they measured the number of cells in the water at various depths. They produced the following graph based on their data.



Interpreting Data Use the graph to answer the following questions.

1. At what time were the highest concentrations of diatoms at the surface?
   - a. midnight
   - b. noon
   - c. 3 a.m.
   - d. 6 p.m.
2. At what time were the highest concentrations of diatoms about a meter below the surface?
   - a. midnight
   - b. noon
   - c. 3 a.m.
   - d. 6 p.m.
3. Which of the following is the best description of the movement of diatoms in the water column?
   - a. 6-hour cycle
   - b. 12-hour cycle
   - c. 24-hour cycle
   - d. irregular cycling
4. **Interpreting Data** Why might the diatoms show the pattern found by the group of high school students?

24. Mosquitoes breed in water. The elimination of breeding grounds reduces the mosquito population and reduces the risk of contracting malaria.

Thinking Critically

25. Snails help keep the growth of unwanted algae in check.
26. The nitrogen fertilizers run off into water sources, where they stimulate the growth and reproduction of algae.
27. A diatom reproduces asexually for several generations, with its cell walls getting progressively smaller and smaller. Eventually, the cell undergoes meiosis and releases gametes that grow a new cell with a large cell wall. Then, the new diatoms begin reproducing asexually.
28. 1. Protozoans; 2. Amoebas; 3. Ciliates; 4. Flagellates; 5. Sporozoans

Assessing Knowledge & Skills

1. b
2. a
3. c
4. They are photosynthetic and move to the surface to utilize sunlight during daylight hours.