Section 3

Protists

Reading Preview

Key Concept

- What are the characteristics of animal-like, plantlike, and funguslike protists?

Key Terms

- protist • protozoan
- pseudopod
- contractile vacuole • cilia
- symbiosis • mutualism
- algae • spore

Target Reading Skill

Outlining As you read, make an outline about protists that you can use for review. Use the red section headings for the main topics and the blue headings for the subtopics.

Protists
I. What is a protist?
II. Animal-like protists
A. Protozoans with pseudopods
B.
C.

Lab zone

Discover Activity

What Lives in a Drop of Pond Water?

1. Use a plastic dropper to place a drop of pond water on a microscope slide.
2. Put the slide under your microscope's low-power lens. Focus on the objects you see.
3. Find at least three different objects that you think might be organisms. Observe them for a few minutes.
4. Draw the three organisms in your notebook. Below each sketch, describe the movements or behaviors of the organism. Wash your hands thoroughly when you have finished.

Think It Over

Observing What characteristics did you observe that made you think that each organism was alive?

Look at the objects in Figure 13. What do they look like to you? Jewels? Beads? Stained glass ornaments? You might be surprised to learn that these beautiful, delicate structures are the walls of unicellular organisms called diatoms. Diatoms live in both fresh water and salt water and are an important food source for many marine organisms. They have been called the "jewels of the sea."

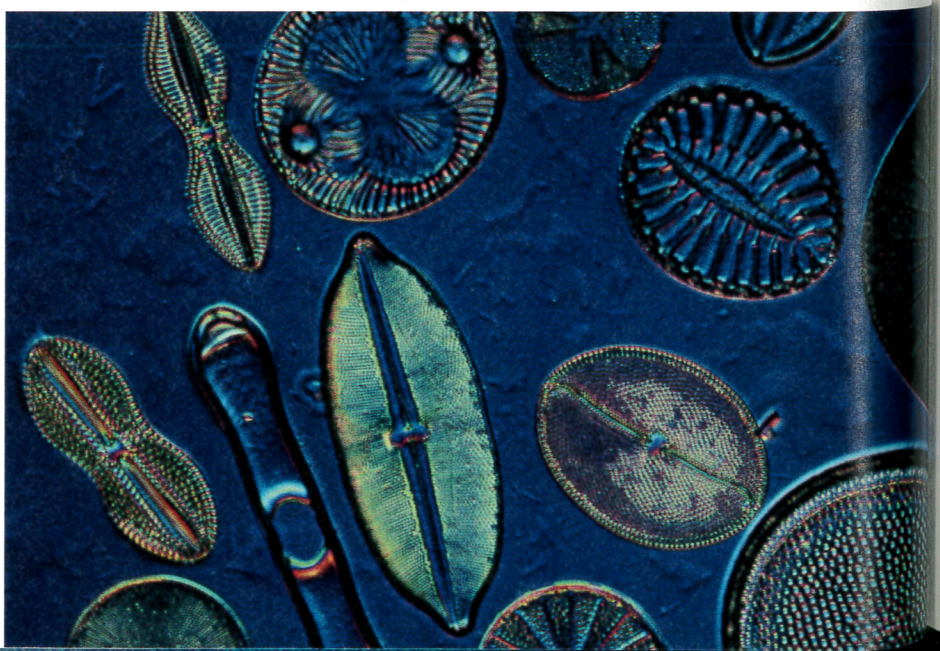
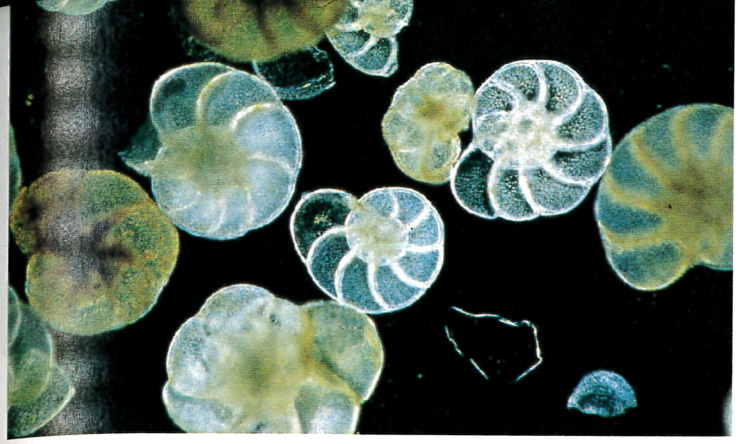


FIGURE 13
Diatoms
These glasslike organisms are classified as protists.



▲ These shells are the remains of unicellular, animal-like protists called foraminifera.

FIGURE 14 Protists

Protists include animal-like, plantlike, and funguslike organisms.

Comparing and Contrasting *In what ways do protists differ from one another?*

▲ This red alga is a multicellular, plantlike protist found on ocean floors.

▲ The yellow slime mold oozing off the leaf is a funguslike protist.

What Is a Protist?

Diatoms are only one of the vast varieties of protists. **Protists** are eukaryotes that cannot be classified as animals, plants, or fungi. Because protists are so different from one another, you can think of them as the "odds and ends" kingdom. However, protists do share some characteristics. In addition to being eukaryotes, all protists live in moist surroundings.

The word that best describes protists is *diversity*. For example, most protists are unicellular, but some are multicellular. Some are heterotrophs, some are autotrophs, and others are both. Some protists cannot move, while others zoom around their moist surroundings.

Because of the great variety of protists, scientists have proposed several ways of grouping these organisms. One useful way of grouping protists is to divide them into three categories, based on characteristics they share with organisms in other kingdoms: animal-like protists, plantlike protists, and funguslike protists.

Reading Checkpoint **In what kind of environment do all protists live?**

Animal-Like Protists

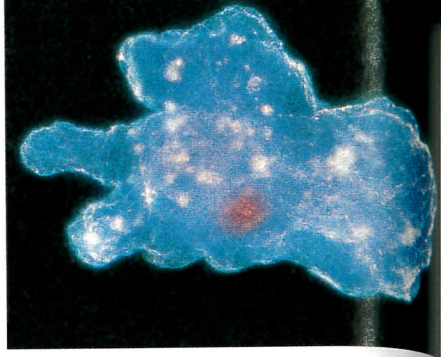
What image pops into your head when you think of an animal? A tiger chasing its prey? A snake slithering onto a rock? Most people immediately associate animals with movement. In fact, movement is often involved with an important characteristic of animals—obtaining food. All animals are heterotrophs that must obtain food by eating other organisms.

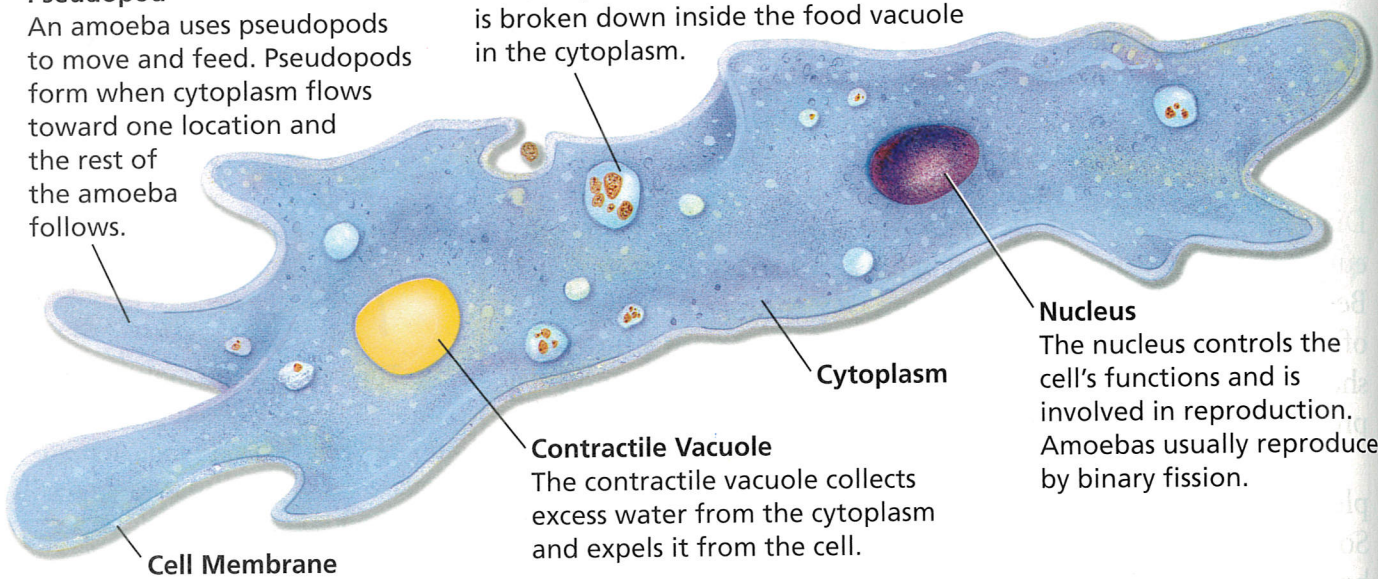
Like animals, animal-like protists are heterotrophs, and most are able to move from place to place to obtain food. But unlike animals, animal-like protists, or **protozoans** (proh tuh ZOH unz), are unicellular. Protozoans can be classified into four groups, based on the way they move and live.

FIGURE 15

Amoeba

Amoebas are sarcodines that live in either water or soil. They feed on bacteria and smaller protists.





Food Vacuole
When the ends of two pseudopods fuse, they form a food vacuole. Food is broken down inside the food vacuole in the cytoplasm.

Pseudopod
An amoeba uses pseudopods to move and feed. Pseudopods form when cytoplasm flows toward one location and the rest of the amoeba follows.

Nucleus
The nucleus controls the cell's functions and is involved in reproduction. Amoebas usually reproduce by binary fission.

Cytoplasm

Contractile Vacuole
The contractile vacuole collects excess water from the cytoplasm and expels it from the cell.

Cell Membrane
Because the cell membrane is very thin and flexible, an amoeba's shape changes constantly.

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Protozoans With Pseudopods The amoeba in Figure 15 belongs to the group of protozoans called sarcodines. Sarcodines move and feed by forming **pseudopods** (SOO duh pahdz)—temporary bulges of the cell. The word *pseudopod* means "false foot." Pseudopods form when cytoplasm flows toward one location and the rest of the organism follows. Pseudopods enable sarcodines to move. For example, amoebas use pseudopods to move away from bright light. Sarcodines also use pseudopods to trap food. The organism extends a pseudopod on each side of the food particle. The two pseudopods then join together, trapping the particle inside.

Protozoans that live in fresh water, such as amoebas, have a problem. Small particles, like those of water, pass easily through the cell membrane into the cytoplasm. If excess water were to build up inside the cell, the amoeba would burst. Fortunately, amoebas have a **contractile vacuole** (kun TRAK til VAK yoo ohl), a structure that collects the extra water and then expels it from the cell.

FIGURE 16
Paramecium

Paramecia are ciliates that live mostly in fresh water. Like amoebas, paramecia feed on bacteria and smaller protists.

Pellicle
A stiff but flexible covering, called the pellicle, surrounds a paramecium and gives it shape.

Contractile Vacuoles
Two contractile vacuoles collect excess water from the cytoplasm and expel it from the cell.

Large Nucleus

Small Nucleus

Anal Pore
Wastes leave through the anal pore.

Cytoplasm

Oral Groove
The oral groove is a funnel-like indentation lined with cilia. The cilia move water containing food into the vacuole that forms at the end of the oral groove.

Cilia
Thousands of cilia project through the pellicle. The beating cilia enable a paramecium to move smoothly in one direction.

Food Vacuole
A food vacuole forms and pinches off from the oral groove. It moves into the cytoplasm. Inside the vacuole, the food is broken down and then distributed.

Protozoans With Cilia The second group of animal-like protists are the ciliates. Ciliates have structures called **cilia** (SIL ee uh), which are hairlike projections from cells that move with a wavelike motion. Ciliates use their cilia to move and obtain food. Cilia act something like tiny oars to move a ciliate. Their movement sweeps food into the organism.

The cells of ciliates, like the paramecium in Figure 16, are complex. Notice that the paramecium has two contractile vacuoles that expel water from the cell. It also has more than one nucleus. The large nucleus controls the everyday tasks of the cell. The small nucleus functions in reproduction.

Paramecia usually reproduce asexually by binary fission. Sometimes, however, paramecia reproduce by conjugation. This occurs when two paramecia join together and exchange some of their genetic material.

Reading Checkpoint **What are cilia?**

FIGURE 17
Giardia
When people drink from freshwater streams and lakes, they can get hiker's disease. *Giardia intestinalis* (inset) is the protozoan responsible for this disease.
Inferring *Why is it important for hikers to filter stream water?*

Protozoans With Flagella The third group of protozoans are flagellates (FLAJ uh lits), protists that use long, whiplike flagella to move. A flagellate may have one or more flagella.

Some of these protozoans live inside the bodies of other organisms. For example, one type of flagellate lives in the intestines of termites. There, they digest the wood that the termites eat, producing sugars for themselves and for the termites. In turn, the termites protect the protozoans. The interaction between these two species is an example of **symbiosis** (sim bee OH sis)—a close relationship in which at least one of the species benefits. When both partners benefit from living together, the relationship is a type of symbiosis called **mutualism.**

Sometimes, however, a protozoan harms its host. For example, *Giardia* is a parasite in humans. Wild animals, such as beavers, deposit *Giardia* in freshwater streams, rivers, and lakes. When a person drinks water containing *Giardia*, these protozoans attach to the person's intestine, where they feed and reproduce. The person develops a serious intestinal condition commonly called hiker's disease.

Protozoans That Are Parasites The fourth type of protozoans are characterized more by the way they live than by the way they move. They are all parasites that feed on the cells and body fluids of their hosts. These protozoans move in a variety of ways. Some have flagella, and some depend on hosts for transport. One even produces a layer of slime that allows it to slide from place to place!

Many of these parasites have more than one host. For example, *Plasmodium* is a protozoan that causes malaria, a disease of the blood. Two hosts are involved in *Plasmodium's* life cycle—humans and a species of mosquitoes found in tropical areas. The disease spreads when a healthy mosquito bites a person with malaria, becomes infected, and then bites a healthy person. Symptoms of malaria include high fevers that alternate with severe chills. These symptoms can last for weeks, then disappear, only to reappear a few months later.

Reading Checkpoint **What is symbiosis?**

FIGURE 18
Malaria Mosquito
Anopheles mosquitoes can carry the parasitic protozoan *Plasmodium*, which causes malaria in people.

Plantlike Protists

Plantlike protists, which are commonly called **algae** (AL jee), are extremely diverse. **Like plants, algae are autotrophs.** Most are able to use the sun's energy to make their own food.

Algae play a significant role in many environments. For example, algae that live near the surface of ponds, lakes, and oceans are an important food source for other organisms in the water. In addition, much of the oxygen in Earth's atmosphere is made by these algae.

Algae vary greatly in size. Some algae are unicellular, while others are multicellular. Still others are groups of unicellular organisms that live together in colonies. Colonies can contain from a few cells up to thousands of cells. In a colony, most cells carry out all functions. But, some cells may become specialized to perform certain functions, such as reproduction.

Algae exist in a wide variety of colors because they contain many types of pigments. You may recall that pigments are chemicals that produce color. Depending on their pigments, algae can be green, yellow, red, brown, orange, or even black.

Diatoms Diatoms are unicellular protists with beautiful glasslike cell walls. Some float near the surface of lakes or oceans. Others attach to objects such as rocks in shallow water. Diatoms are a food source for heterotrophs in the water. Many diatoms can move by oozing chemicals out of slits in their cell walls. They then glide in the slime.

When diatoms die, their cell walls collect on the bottoms of oceans and lakes. Over time, they form layers of a coarse substance called diatomaceous (dy uh tuh MAY shus) earth. Diatomaceous earth makes a good polishing agent and is used in household scouring products. It is even used as an insecticide—the diatoms' sharp cell walls puncture the bodies of insects.

Dinoflagellates Dinoflagellates (dy noh FLAJ uh lits) are unicellular algae surrounded by stiff plates that look like a suit of armor. Because they have different amounts of green, orange, and other pigments, dinoflagellates exist in a variety of colors.

All dinoflagellates have two flagella held in grooves between their plates. When the flagella beat, the dinoflagellates twirl like toy tops as they move through the water. Many glow in the dark. They light up the ocean's surface when disturbed by a passing boat or swimmer.

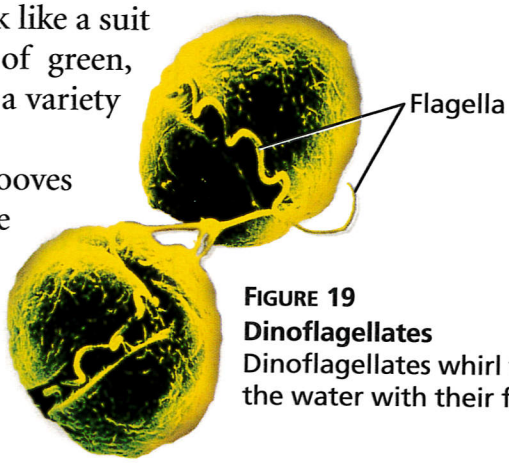


FIGURE 19
Dinoflagellates
Dinoflagellates whirl through the water with their flagella.

Lab zone **Try This Activity**

Watching Protists

In this activity you will watch the interaction between paramecium, an animal-like protist, and *Chlorella*, a plantlike protist.

1. Use a plastic dropper to place 1 drop of paramecium culture on a microscope slide. Add some cotton fibers to slow down the paramecia.
2. Use the microscope's low-power objective to find some paramecia.
3. Add 1 drop of *Chlorella* to the paramecium culture on your slide.
4. Switch to high power and locate a paramecium. Observe what happens. Then wash your hands.

Inferring What evidence do you have that paramecia are heterotrophs? That *Chlorella* are autotrophs?

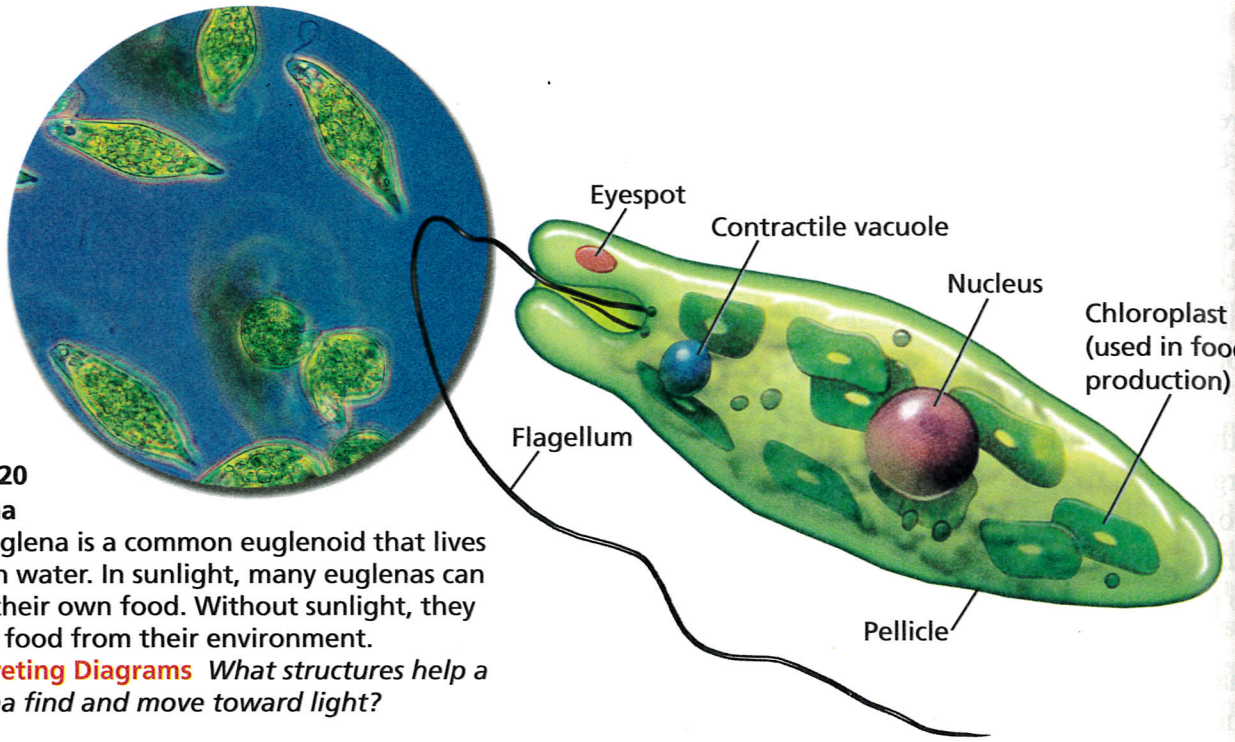


FIGURE 20
Euglena
The euglena is a common euglenoid that lives in fresh water. In sunlight, many euglenas can make their own food. Without sunlight, they obtain food from their environment.
Interpreting Diagrams *What structures help a euglena find and move toward light?*

Euglenoids Euglenoids (yoo GLEE noydz) are green, unicellular algae that are found mostly in fresh water. Unlike other algae, euglenoids have one animal-like characteristic—they can be heterotrophs under certain conditions. When sunlight is available, most euglenoids are autotrophs that produce their own food. However, when sunlight is not available, euglenoids will act like heterotrophs by obtaining food from their environment. Some euglenoids live entirely as heterotrophs.

In Figure 20, you see a euglena, which is a common euglenoid. Notice the long, whiplike flagellum that helps the organism move. Locate the eyespot near the flagellum. Although the eyespot is not really an eye, it contains pigments. These pigments are sensitive to light and help the euglena recognize the direction of a light source. You can imagine how important this response is to an organism that needs light to make food.

Red Algae Almost all red algae are multicellular seaweeds. Divers have found red algae growing more than 260 meters below the ocean's surface. Their red pigments are especially good at absorbing the small amount of light that is able to reach deep ocean waters.

People use red algae in a variety of ways. Carrageenan (ka ruh JEE nun) and agar, substances extracted from red algae, are used in products such as ice cream and hair conditioner. For people in many Asian cultures, red algae is a nutrient-rich food that is eaten fresh, dried, or toasted.

Lab zone Skills Activity

Predicting

Predict what will happen when you pour a culture of euglena into a petri dish, and then cover half the dish with aluminum foil. Give a reason for your prediction.

Then carry out the experiment with a culture of euglena in a plastic petri dish. Cover half the dish with aluminum foil. After 10 minutes, uncover the dish. What do you observe? Was your prediction correct? Explain why euglena behave this way.

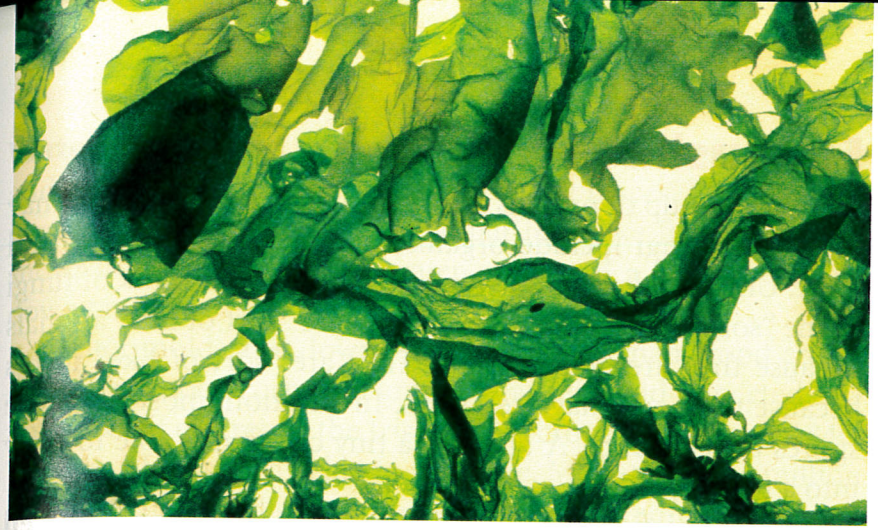


FIGURE 21
Green Algae
Green algae range in size from unicellular organisms to multicellular seaweeds. This multicellular sea lettuce, *Ulva*, lives in oceans.

Green Algae Green algae, which contain green pigments, are quite diverse. Most green algae are unicellular. Some, however, form colonies, and a few are multicellular. Most green algae live in either fresh water or salt water. The few that live on land are found on rocks, in the crevices of tree bark, or in moist soils.

Green algae are actually very closely related to plants that live on land. Green algae and plants contain the same type of chlorophyll and share other important similarities. In fact, some scientists think that green algae belong in the plant kingdom.

Brown Algae Many of the organisms that are commonly called seaweeds are brown algae. In addition to their brown pigment, brown algae also contain green, yellow, and orange pigments. As you can see in Figure 22, a typical brown alga has many plantlike structures. Holdfasts anchor the alga to rocks. Stalks support the blades, which are the leaflike structures of the alga. Many brown algae also have gas-filled sacs called bladders that allow the algae to float upright in the water.

Brown algae flourish in cool, rocky waters. Brown algae called rockweed live along the Atlantic coast of North America. Giant kelps, which can grow as long as 100 meters, live in some Pacific coastal waters. The giant kelps form large underwater "forests" where many organisms, including sea otters and abalone, live.

Some people eat brown algae. In addition, substances called algins are extracted from brown algae and used as thickeners in puddings and other foods.

Reading Checkpoint **What color pigments can brown algae contain?**

FIGURE 22 Brown Algae
Giant kelps are brown algae that have many plantlike structures.
Interpreting Diagrams *What plant structures do the kelp's holdfasts and blades resemble?*

Funguslike Protists

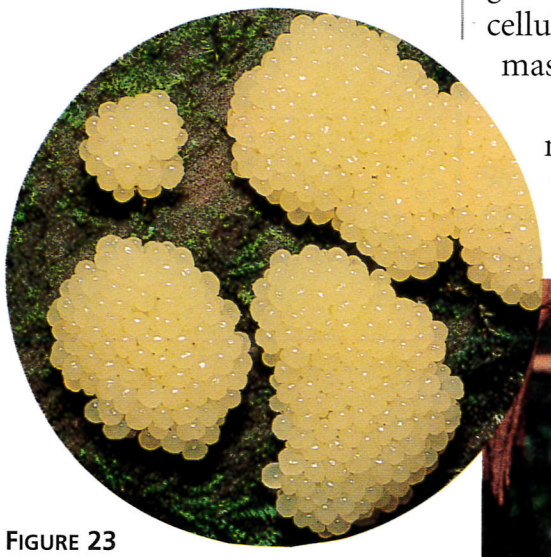
The third group of protists are the funguslike protists. You may recall that fungi include organisms such as mushrooms and yeast. Until you learn more about fungi, you can think of fungi as the "sort of like" organisms. Fungi are "sort of like" animals because they are heterotrophs. They are "sort of like" plants because their cells have cell walls. In addition, most fungi use spores to reproduce. A **spore** is a tiny cell that is able to grow into a new organism.

Like fungi, funguslike protists are heterotrophs, have cell walls, and use spores to reproduce. All funguslike protists are able to move at some point in their lives. The three types of funguslike protists are slime molds, water molds, and downy mildews.

Slime Molds Slime molds are often brilliantly colored. They live on forest floors and other moist, shady places. They ooze along the surfaces of decaying materials, feeding on bacteria and other microorganisms. Some slime molds are so small that you need a microscope to see them. Others may cover an area of several meters!

Slime molds begin their life cycle as tiny, individual amoeba-like cells. The cells use pseudopods to feed and creep around. Later, the cells grow bigger or join together to form a giant, jellylike mass. In some species, the giant mass is multicellular and forms when food is scarce. In others, the giant mass is actually a giant cell with many nuclei.

The mass oozes along as a single unit. When environmental conditions become harsh, spore-producing structures grow out of the mass and release spores. Eventually the spores develop into a new generation of slime molds.



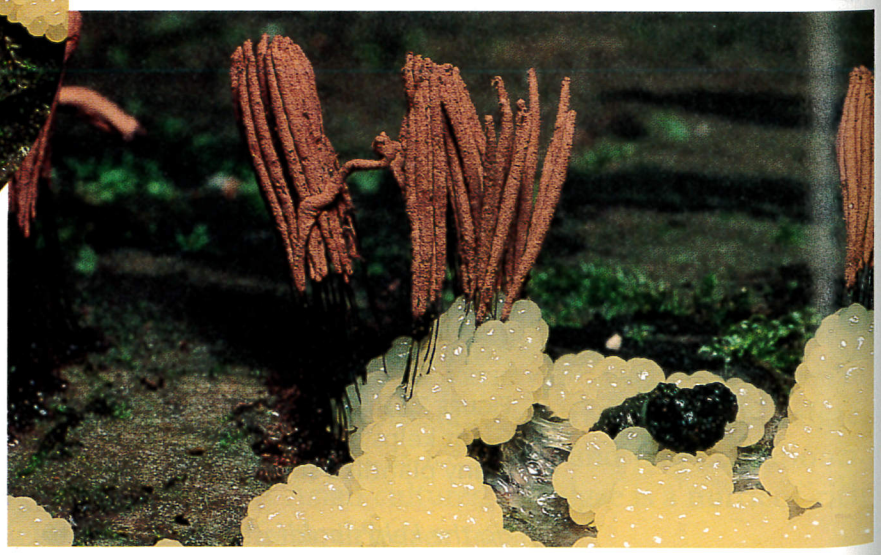
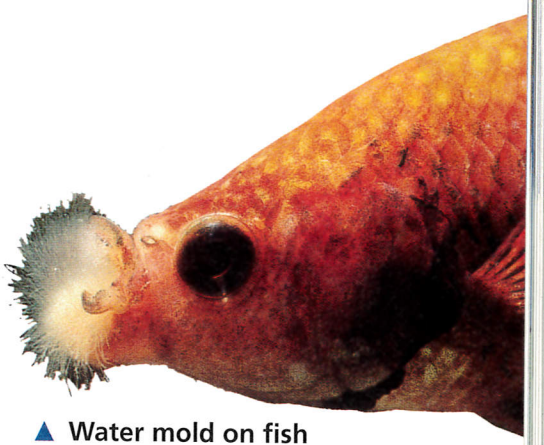


FIGURE 23
Slime Molds
The chocolate tube slime mold first forms a tapioca-like mass (top). When conditions become harsh, the mass grows spore-producing stalks (right). The stalks, or "chocolate tubes," are covered with millions of brown spores.

Water Molds and Downy Mildews Most water molds and downy mildews live in water or moist places. These organisms often grow as tiny threads that look like fuzz. Figure 24 shows a fish attacked by a water mold and a leaf covered by downy mildew.

Water molds and downy mildews attack many food crops, such as potatoes, corn, and grapes. A water mold impacted history when it destroyed the Irish potato crops in 1845 and 1846. The loss of these crops led to a famine. More than one million people in Ireland died, and many others moved to the United States and other countries.



▲ Water mold on fish

▼ Downy mildew on grape leaf

Reading Checkpoint In what environments are water molds found?

FIGURE 24
Water Molds and Downy Mildews
Many water molds are decomposers of dead aquatic organisms. Others are parasites of fish and other animals. Downy mildews are parasites of many food crops.

Section 3 Assessment

Target Reading Skill **Outlining** Use your outline about protists to help you answer the questions below.

Reviewing Key Concepts

1. a. **Listing** List the four types of animal-like protists. How does each type move or live?
   b. **Comparing and Contrasting** How are these four types of protists similar to animals? How are they different?
   c. **Classifying** You observe an animal-like protist under the microscope. It has no hairlike or whiplike structures. It moves by forming temporary bulges of cytoplasm. How would you classify this protist?
2. a. **Reviewing** In what way are diatoms, dinoflagellates, and other plantlike protists similar to plants?
   b. **Making Generalizations** Why is sunlight important to plantlike protists?
   c. **Making Judgments** Would you classify euglena as an animal-like protist or as a plantlike protist? Explain.
3. a. **Listing** What are the three types of funguslike protists?
   b. **Describing** In what ways are funguslike protists similar to fungi?

Lab zone At-Home Activity

Algae Scavenger Hunt Look around your house with a family member to find products that contain substances made from algae. Look at both food and nonfood items. Before you begin, tell your family member that substances such as diatomaceous earth, algin, and carrageenan are products that come from algae. Make a list of the products and the algae-based ingredient they contain. Share your list with the class.