The animallike protists play another major role in the living world. Enormous numbers of protists living in the seas are food for tiny multicellular animals that in turn serve as food for larger animals. A similar role is played by protists in freshwater lakes, streams, and ponds. Without such tiny organisms, the larger fish would have no food supply. The animallike protists thus perform an essential function for all other living things.

18–2 SECTION REVIEW

1. List the four phyla of animallike protists. Give an example of each.
2. Compare the forms of locomotion used by the four phyla of animallike protists.
3. Describe the process of conjugation. Is conjugation a form of reproduction? Explain your answer.
4. **Connection—Ecology** In what ways are animallike protists helpful to other living things?

Guide For Reading

- What are the major characteristics of the five phyla of plantlike protists?
- How do plantlike protists fit into the world?

18–3 Plantlike Protists

In addition to the four phyla of animallike protists, we recognize five phyla of plantlike protists. Like other protists, these organisms are unicellular and most of them are motile. We call them plantlike because most contain the pigment chlorophyll and carry out photosynthesis. Like zoomastiginans, many plantlike protists are called flagellates because they have flagella. These organisms are known as phytoflagellates, which means plant flagellates, to distinguish them from zoomastiginans (zooflagellates).

Three of the phyla of plantlike protists—Euglenophyta, Pyrrophyta, and Chrysophyta—are considered to be types of algae. These simple plantlike organisms, found in water or damp places, lack true roots, stems, and leaves. As a result, these three phyla are sometimes classified as plants. The unusual slime molds, which are placed in phyla Acrasiomycota and Myxomycota, are not photosynthetic and have many funguslike characteristics. They are sometimes known as funguslike protists, or are even classified as fungi.

Euglenophyta: Flagellates with Chloroplasts

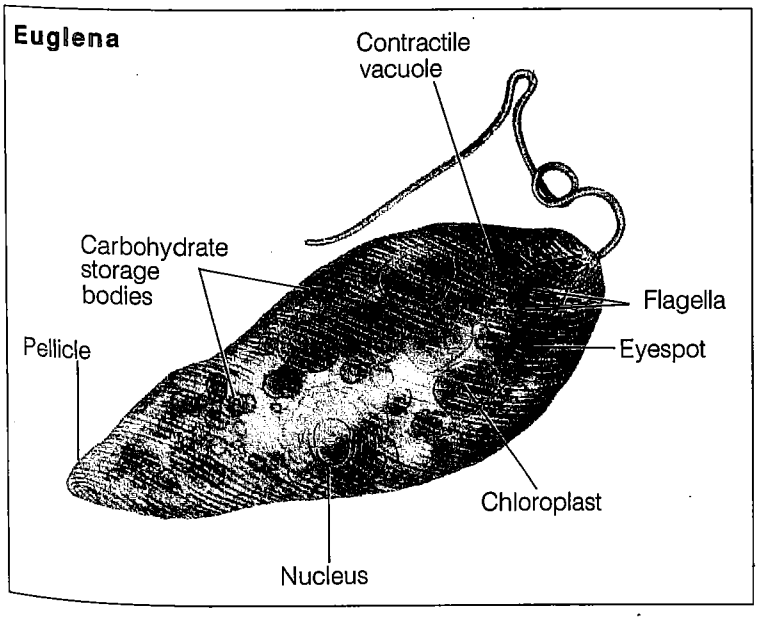
The members of the phylum **Euglenophyta** (yoo-glee-nuh-FIGHT-uh) are closely related to zoomastiginans. In some classification schemes, euglenophytes and zoomastiginans are actually considered to be in the same phylum. The main reason

for grouping them together is that except for the fact that euglenophytes possess chloroplasts, the two phyla of protists closely resemble each other.

The most famous members of the phylum Euglenophyta belong to the genus from which the entire phylum takes its name: *Euglena*. As you can see in Figure 18–18, a **euglena** is a long cell that has a pouch that contains two flagella at its front end. The longer of these two flagella extends far out of the euglena's pouch and is used to propel the cell forward through the water. A euglena is an excellent swimmer and can move very quickly in this manner. However, when a euglena is forced against a surface—for example, when it is squeezed down on a glass laboratory slide—it is able to move in a different manner. The euglena changes shape rapidly and crawls along the surface by a process called euglenoid movement. Thus a euglena is able to move along in a distinctly animallike fashion.

A red eyespot at the front end of the cell (the end with the flagella) helps a euglena find the brightest areas of its immediate environment. Finding sunlight is important to a euglena because it is filled with between 10 and 20 oval chloroplasts. A euglena is a full-fledged phototrophic autotroph, or an organism that makes its own food from light and simple raw materials, and thus is able to carry out the light and dark reactions of photosynthesis.

When sunlight is not available, a euglena can also live as a heterotroph, or an organism that eats food made by other organisms. If dissolved nutrients are available in the water, a euglena can absorb them and get along in darkness with no ill effects. In nature this gives euglenas the ability to live as saprophytes, or organisms that absorb the nutrients available in decayed organic material.



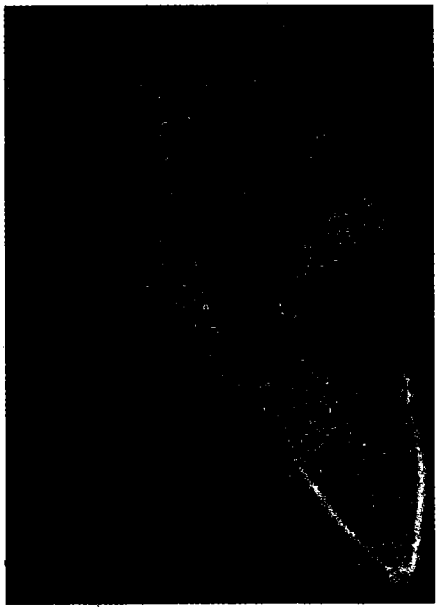
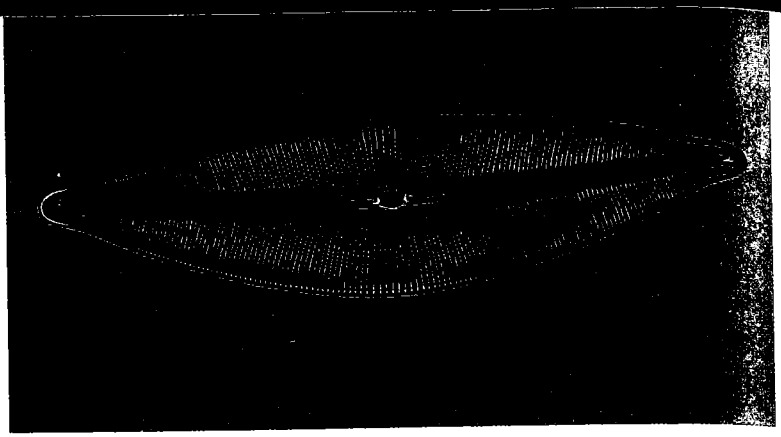


Figure 18–18 *A euglena's organelles include a large prominent nucleus, whiplike flagella, green chloroplasts, and grainy yellow food-storage structures.*



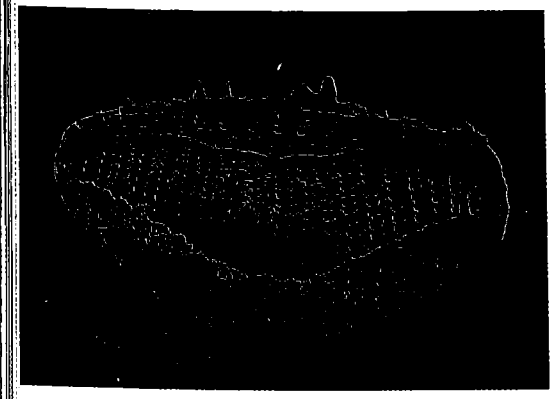


Figure 18–21 *Diatom cells are enclosed within delicate and ornate two-part shells of silica. These glassy shells are quite beautiful.*

Chrysophyta: Golden Protists

There are three general kinds of organisms found within the phylum **Chrysophyta** (krihs-uh-FIGHT-uh): yellow-green algae, golden-brown algae, and diatoms. The name of the phylum, which means golden plants, refers to the one or two gold-green chloroplasts found in the cells of most species of chrysophytes.

The cell walls of chrysophytes contain the carbohydrate pectin rather than cellulose, and they generally store food in the form of oil rather than starch. Chrysophytes are extremely diverse. They reproduce asexually and sexually. Most are solitary, but some form threadlike colonies. Some have flagella and others do not. And some live within cell walls of glass! All but about 2000 of the species in this phylum belong to the **diatoms**.

The diatoms are cells that produce intricate cell walls rich in silicon (Si)—the main ingredient in glass. These walls are shaped like the two sides of a petri dish or flat pillbox, with one side fitting snugly into the other. They are etched with fine lines and designs that seem to be carved into the glasslike brilliance of both sides. Even a modest sampling of the range of diatom species will serve to establish that they are among the most beautiful organisms on Earth. Diatoms are photosynthetic and are among the most abundant species in the oceans.

The Slime Molds: Unusual Protists

Slime molds are found near rich sources of food such as rotting wood, piles of compost, and even thick wet lawns. The slime molds are organisms that are extremely difficult to classify. At one stage of their life cycle they appear as amebalike cells. At other stages they produce moldlike masses that give rise to spores. As a result, slime molds have been classified as amebas and as fungi. They are now placed in two phyla within the kingdom Protista.

ACRASIOMYCOTA: CELLULAR SLIME MOLDS Cellular slime molds belong to the phylum **Acrasiomycota** (uh-kras-ee-oh-migh-KOH-tuh). Cellular slime molds begin their life cycle as individual cells that look very much like amebas. In fact, cellular slime molds spend most of their lives as free-living cells not

easily distinguishable from soil amebas. These ameboid, or amebalike, cells reproduce very rapidly. When the food supply is exhausted, groups of ameboid cells gather together to produce a large mass of cells that begins to function as a single organism. This unusual behavior forces scientists to stretch the definition of protists. Protists are defined as being unicellular —but here is a group of protists acting like a primitive multicellular organism!

These solid masses of cells may migrate for several centimeters. They then form a reproductive structure called a fruiting body that produces spores by mitosis. These spores give rise to ameboid cells that repeat the cycle.

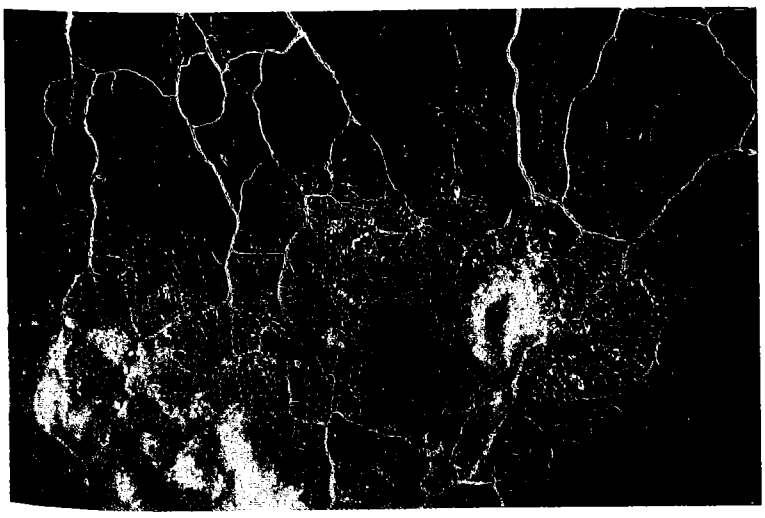
Cellular slime molds are an interesting system for biologists who study how cells communicate. The formation of an intricate structure such as the fruiting body from what was previously a mass of independent cells is a most intriguing process. It has kept biologists busy for decades, and its secrets are still not fully understood.

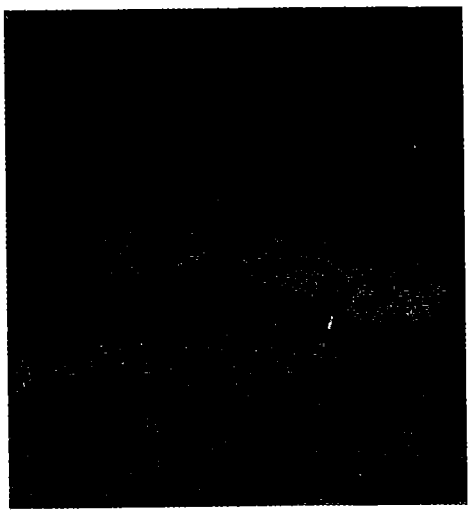
Figure 18–22 *When the food supply runs out, cellular slime mold cells come together. The collection of cells that results from this process looks and acts much like a simple multicellular organism.*

MYXOMYCOTA: ACELLULAR SLIME MOLDS Acellular slime molds belong to the phylum **Myxomycota** (mihks-uh-migh-KOH-tuh). Like a cellular slime mold, an acellular slime mold begins its life cycle as an amebalike cell. However, acellular slime molds produce structures known as **plasmodia** (singular: plasmodium) that contain thousands of nuclei enclosed in a single cell membrane. In contrast to the cellular slime molds, the large plasmodium of an acellular slime mold is a single multinucleate cell. A plasmodium may grow as large as several centimeters in diameter.

Eventually small structures known as fruiting bodies spring up from the plasmodium. The fruiting bodies produce haploid spores by meiosis. These spores scatter to the ground where they germinate into flagellated cells. These flagellated cells fuse to produce diploid ameboid cells that repeat the cycle.

Figure 18–23 *At one point in its life cycle, an acellular slime mold forms a structure called a plasmodium, which contains many nuclei and creeps about like a giant ameba (left). Later, reproductive structures called fruiting bodies are produced by the plasmodium (right).*





Summary of the Plantlike Protists

- **Members of the phylum Euglenophyta are very similar to zoomastiginans. Euglenophytes, such as *Euglena,* are photosynthetic flagellates.**
- **Members of the phylum Pyrrophyta are called dinoflagellates. Most dinoflagellates are photosynthetic, and some are luminescent.**
- **The phylum Chrysophyta is a diverse group of protists that have gold-colored chloroplasts. Most of the species of chrysophytes are diatoms, photosynthetic protists that lack flagella and live in beautiful glasslike "boxes."**
- **Slime molds are unusual organisms that are difficult to classify. Cellular slime molds belong to the phylum Acrasiomycota. Acellular slime molds belong to the phylum Myxomycota.**

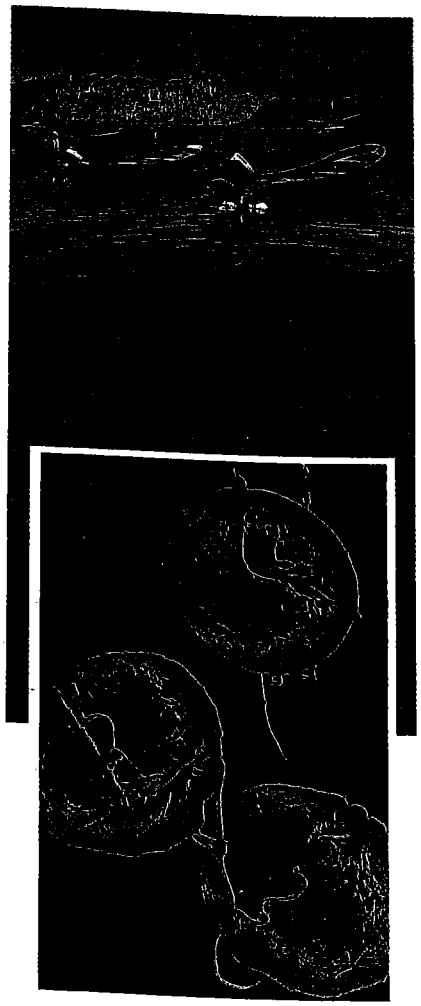


Figure 18–24 *Red tide (top) is produced by blooms of the dinoflagellate* Gonyaulax *(bottom).* Gonyaulax *contains a toxin that can become concentrated in the tissues of shellfish such as clams and oysters, making them unfit to eat. This toxin can also kill fish and other marine animals.*

How the Plantlike Protists Fit into the World

Like the animallike protists, plantlike protists are found throughout the world in bodies of fresh water, in the ocean, and on land. Unlike animallike protists, most plantlike protists are autotrophs rather than heterotrophs. Although plantlike protists can be harmful to other organisms, few plantlike protists are truly parasitic.

HARMFUL RELATIONSHIPS In lakes and ponds, euglenophytes are among the most common organisms. In areas into which large amounts of sewage are discharged, euglenophytes may thrive. Because they are able to absorb organic material directly and use it for food, they grow rapidly in such regions and their presence may actually turn the water of a lake or slow-moving stream a murky green. They play a vital role in helping to recycle sewage and other waste materials. But when the amount of waste dumped into a body of water is excessive, the euglenophytes and other green organisms may grow into enormous masses of cells known as **blooms**. While not harmful in themselves, these blooms quickly run out of nutrients and the cells begin to die in great numbers, compounding the problem of disposing of waste matter.

Great blooms of the dinoflagellate *Gonyaulax polyhedron* have occurred in recent years on the east coast of the United States, although scientists are not sure of the reasons. This species contains a toxin that can cause paralysis and even death if ingested in large amounts. Fortunately for all but the most allergic people, it simply is not possible to swallow enough of the "red tide" of *Gonyaulax* while swimming to be affected by the toxin. Thus the blooms of dinoflagellates are not harmful to most swimmers. However, shellfish such as clams

and oysters filter enormous amounts of sea water in order to trap organisms like *Gonyaulax* for food and thus become filled with the toxin. Eating shellfish from areas infected with red tide can cause serious illness. In addition, the toxin can kill fish and weaken or even kill dolphins.

HELPFUL RELATIONSHIPS The plantlike protists form some spectacular symbiotic relationships with other organisms. Many types of coral contain intercellular dinoflagellates. These dinoflagellates allow the tiny animals that form the coral to use the products of photosynthesis, allowing coral to grow in areas where nutrients are few. In turn, the dinoflagellates can use many of the waste products of the coral organisms before they are diluted by diffusion through sea water.

Other dinoflagellates make their homes with other organisms. In the giant clam *Tridacna gigas*, a special tissue called the mantle contains large numbers of symbiotic photosynthetic protists. These dinoflagellates are held in a position from which they are able to gather as much sunlight as possible and increase the nutrient benefit to the organism.

Plantlike protists play a major ecological role: They make up a considerable part of the **phytoplankton**. The term phytoplankton is applied to any small photosynthetic organism found in great numbers near the surface of the ocean. Thus it can apply to any photosynthetic organism, regardless of kingdom or phylum.

The importance of the phytoplankton for other forms of life cannot be underestimated. More than 70 percent of the photosynthesis that occurs on Earth goes on near the surface of the oceans. The result of this photosynthesis is that the rest of the organisms on our planet are provided with enormous amounts of oxygen and food. The phytoplankton provide a direct source of nourishment for organisms as diverse as shrimp and whales. And even land animals such as humans obtain nourishment indirectly from the phytoplankton. When you eat a tuna fish sandwich, you are eating fish that fed on smaller fish that fed on still smaller animals that fed on phytoplankton!

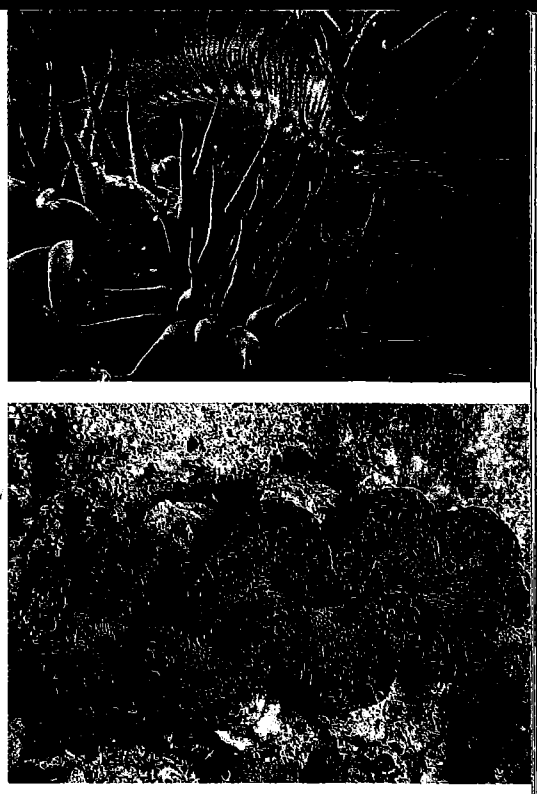
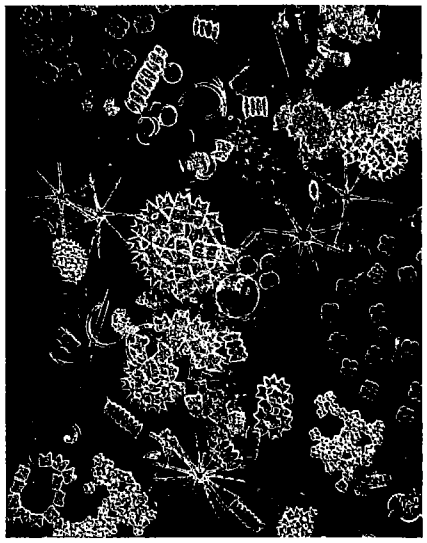


Figure 18–25 *Symbiotic photosynthetic protists live inside the tissues of animals such as sea anemones (top) and giant clams (bottom).*

Figure 18–26 *Phytoplankton provide enormous amounts of food and oxygen for other organisms on Earth.*



18–3 SECTION REVIEW

1. List the five phyla of plantlike protists. Give an example of an organism in each phylum.
2. What are slime molds? Why is it appropriate for the slime molds to be considered protists?
3. Why is red tide particularly damaging to the shellfish industry?
4. **Critical Thinking—Expressing an Opinion** "Life on Earth depends on plantlike protists." Defend or refute this statement.