

20-2 Animallike Protists: Protozoans

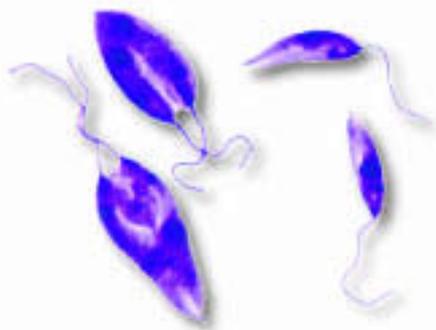
At one time, animallike protists were called protozoa, which means “first animals,” and were classified separately from more plantlike protists. Like animals, these organisms are heterotrophs. The four phyla of animallike protists are distinguished from one another by their means of movement. As you will read, zooflagellates swim with flagella, sarcodines move by extensions of their cytoplasm, ciliates move by means of cilia, and sporozoans do not move on their own at all.

Zooflagellates

Many protists easily move through their aquatic environments propelled by flagella. Flagella are long, whiplike projections that allow a cell to move.  **Animallike protists that swim using flagella are classified in the phylum Zoomastigina and are often referred to as zooflagellates.** Most zooflagellates (zoh-oh-FLAJ-uh-lits) have either one or two flagella, although a few species have many flagella. Two representative zooflagellates are shown in **Figure 20-3**.

Zooflagellates are generally able to absorb food through their cell membranes. Many live in lakes and streams, where they absorb nutrients from decaying organic material. Others live within the bodies of other organisms, taking advantage of the food that the larger organism provides.

Most zooflagellates reproduce asexually by mitosis and cytokinesis. Mitosis followed by cytokinesis results in two cells that are genetically identical. Some zooflagellates, however, have a sexual life cycle as well. During sexual reproduction, gamete cells are produced by meiosis. When gametes from two organisms fuse, an organism with a new combination of genetic information is formed.



Leishmania donovani
(magnification: 4800×)



Trichomonas vaginalis
(magnification: 11,500×)

Guide for Reading

Key Concepts

- What are the distinguishing features of the major phyla of animallike protists?
- How do animallike protists harm other living things?

Vocabulary

pseudopod
amoeboid movement
food vacuole • cilium
trichocyst • macronucleus
micronucleus • gullet
anal pore • contractile vacuole
conjugation

Reading Strategy: Building Vocabulary

Before you read, preview new vocabulary by skimming the section and making a list of the highlighted, boldface terms. Leave space to make notes as you read.

Figure 20-3  Zooflagellates are animallike protists that swim using flagella. Most zooflagellates live as solitary cells. Some form colonies of cells.

Section 20-2

1 FOCUS

Objectives

- 20.2.1 Describe** the major phyla of animallike protists.
- 20.2.2 Explain** how animallike protists harm other living things.

Guide for Reading

Vocabulary Preview

Have students write the Vocabulary terms, dividing each into its separate syllables as best they can. Remind students that each syllable usually has only one vowel sound. The correct syllabifications are: pseu•do•pod, a•moe•boid move•ment, food vac•u•ole, cil•i•um, trich•o•cyst, mac•ro•nu•cle•us, mic•ro•nu•cle•us, gul•let, a•nal pore, con•trac•tile vac•u•ole, con•ju•ga•tion.

Reading Strategy

Before students read, ask them to skim the section to find the boldface Key Concepts. Have them copy each of the concepts onto a notecard. Then, as they read they should note details and examples that support each Key Concept.

2 INSTRUCT

Zooflagellates

Make Connections

Health Science Explain that the zooflagellates include several parasitic protists that cause human diseases, such as the pathogens that cause African sleeping sickness and giardiasis. The zooflagellate *Trichomonas vaginalis* causes a common sexually transmitted disease that afflicts women, called vaginitis. Encourage interested students to find out how this disease is spread, what the symptoms are, and how it can be treated.

L2 L3



SECTION RESOURCES

Print:

- **Laboratory Manual B**, Chapter 20 Lab
- **Teaching Resources**, Section Review 20-2, Chapter 20 Design an Experiment
- **Reading and Study Workbook A**, Section 20-2
- **Adapted Reading and Study Workbook B**, Section 20-2
- **Lesson Plans**, Section 20-2

Technology:

- **iText**, Section 20-2
- **Transparencies Plus**, Section 20-2

20-2 (continued)

Sarcodines

Word Origins

The word *pseudonym* means “false name.” L2

Use Visuals

Figure 20-4 Ask students: Which animallike protist phylum includes *Amoeba proteus*? (Sarcodina) Why do you think an amoeba is often described as “shape-shifting”? (It has no permanent shape. It changes its shape as it pushes out projections called pseudopods.) What is the function of the food vacuole? (It temporarily stores and digests food.)

L1 L2

Build Science Skills

Observing Have each student gather a handful of grass from a field near the school. The grass should then be dried on a flat tray for at least one day. After the grass is dried, have students place the grass in a clean glass jar, add bottled water until the jar is about three-quarters full, and seal it tightly with a lid. After three days, students should open the jar in a well-ventilated area and gently stir the contents. Have students then use a dropper pipette to make slides from the water in the jar and observe the slides under a microscope. Typically, students will observe several different types of protists, such as paramecia and amoebas. Ask students to make drawings and try to identify the organisms they see. L2 L3

Word Origins

Pseudopod comes from the Greek words *pseudes*, meaning “false,” and *-pous*, meaning “foot.” So *pseudopod* means “false foot.” The suffix *-onym* comes from the Greek word *onama*, meaning “name.” What do you think the word *pseudonym* means?

Sarcodines

Members of the phylum Sarcodina, or sarcodines, move via temporary cytoplasmic projections known as **pseudopods** (SOO-doh-pahdz). Sarcodines are animallike protists that use pseudopods for feeding and movement. The best-known sarcodines are the amoebas, shown in **Figure 20-4**. Amoebas are flexible, active cells with thick pseudopods that extend out of the central mass of the cell. The cytoplasm of the cell streams into the pseudopod, and the rest of the cell follows. This type of locomotion is known as **amoeboid movement**.

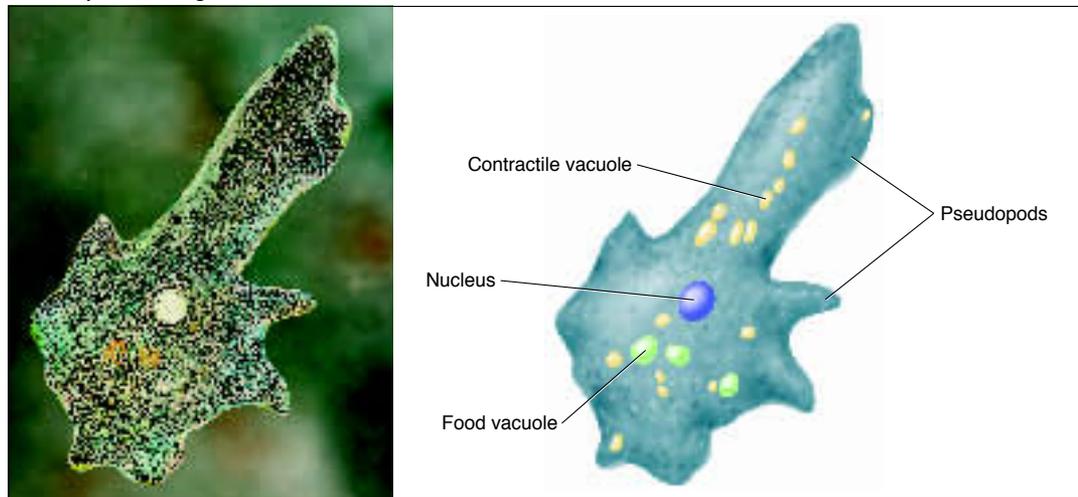
Amoebas can capture and digest particles of food and even other cells. They do this by surrounding their meal, then taking it inside themselves to form a food vacuole. A **food vacuole** is a small cavity in the cytoplasm that temporarily stores food. Once inside the cell, the material is digested rapidly and the nutrients are passed along to the rest of the cell. Undigestible waste material remains inside the vacuole until its contents are eliminated by releasing them outside the cell. Amoebas reproduce by mitosis and cytokinesis.

Foraminiferans, another member of Sarcodina, are abundant in the warmer regions of the oceans. Foraminiferans secrete shells of calcium carbonate (CaCO_3). As they die, the calcium carbonate from their shells accumulates on the bottom of the ocean. In some regions, thick deposits of foraminiferan shells have formed on the ocean floor. The white chalk cliffs of Dover, England, are huge deposits of foraminiferan skeletons that were raised above sea level by geological processes.

Heliozoans comprise another group of sarcodines. The name *heliozoa* means “sun animal.” Thin spikes of cytoplasm, supported by microtubules, project from their silica (SiO_2) shells, making heliozoans look like the sun’s rays.

Figure 20-4 Sarcodines use pseudopods for feeding and movement. The amoeba, a common sarcodine, moves by first extending a pseudopod away from its body. The organism’s cytoplasm then streams into the pseudopod. Amoebas also use pseudopods to surround and ingest prey.

Amoeba proteus (magnification: 330 \times)



Differentiated

Instruction

Solutions for All Learners

Less Proficient Readers

To reinforce the anatomies of two important animallike protists, have students make their own labeled drawings of *Amoeba proteus* and a paramecium, using Figures 20-4 and 20-5 for reference. Then, call on students at random to describe the function of each of the labeled structures in both drawings. L1 L2

English Language Learners

Help English language learners pronounce the term *sporozoite*, which is introduced on page 502. Explain that the word is derived from a Greek word meaning “seed.” Point out that knowledge of derivation can aid in understanding, but derivation can sometimes be misleading. For instance, a *sporozoite* is a single-celled stage of the sporozoan life cycle. A seed, by contrast, is a multicellular structure with clearly organized and specialized tissues. L1 L2

Ciliates

Use Visuals

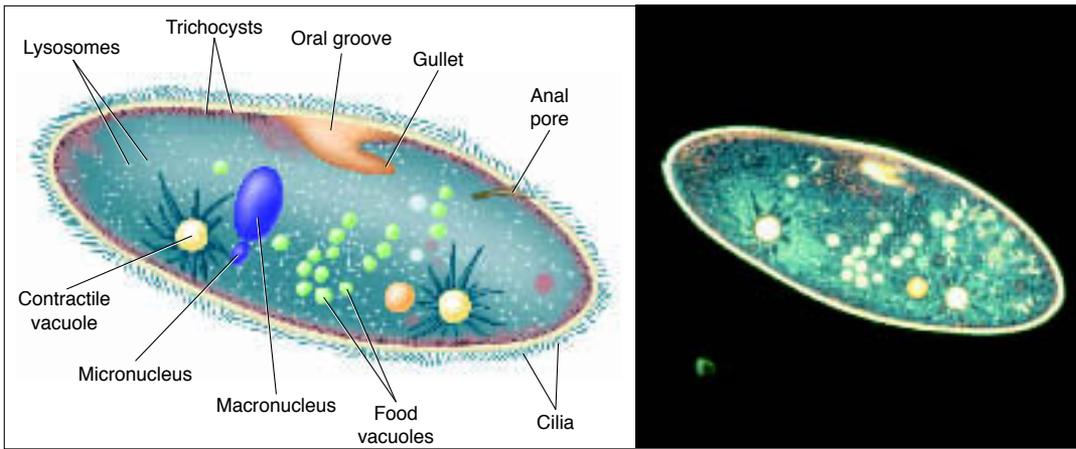
Figure 20–5 Ask students: Which animallike protist phylum includes paramecia? (*Ciliophora*) What structures do paramecia use for movement? (*Cilia*) What are some other structures in a paramecium cell? (An oral groove, a gullet, an anal pore, a contractile vacuole, a micronucleus, a macronucleus, and food vacuoles) **L1 L2**

Build Science Skills

Observing Provide students with a prepared slide of a paramecium. Have them use a microscope to observe the slide and make a labeled drawing of what they see. **L2**

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active art

For: Amoeba and Paramecium activity
Visit: PHSchool.com
Web Code: cbe-6202
Students learn about two types of protozoans—the amoeba and the paramecium.



Paramecium caudatum (magnification: 2500×)

Ciliates

The phylum Ciliophora is named for **cilia** (singular: cilium), short hairlike projections similar to flagella. **Members of the phylum Ciliophora, known as ciliates, use cilia for feeding and movement.** The internal structure of cilia and flagella are identical. The beating of cilia, like the pull of hundreds of oars in an ancient ship, propels a cell rapidly through water.

Ciliates are found in both fresh and salt water. In fact, a lake or stream near your home might contain many different ciliates. Most ciliates are free living, which means that they do not exist as parasites or symbionts.

CHECKPOINT What are cilia, and how do ciliates use them?

Internal Anatomy Some of the best-known ciliates belong to the genus *Paramecium*. A paramecium can be as long as 350 micrometers. Its cilia, which are organized into evenly spaced rows and bundles, beat in a regular, efficient pattern. The cell membrane of a paramecium is highly structured and has trichocysts just below its surface. **Trichocysts** (TRY-koh-sists) are very small, bottle-shaped structures used for defense. When a paramecium is confronted by danger, such as a predator, the trichocysts release stiff projections that protect the cell.

A paramecium's internal anatomy is shown in **Figure 20–5**. Like most ciliates, a paramecium possesses two types of nuclei: a macronucleus and one or more smaller micronuclei. Why does a ciliate need two types of nuclei? The **macronucleus** is a “working library” of genetic information—a site for keeping multiple copies of most of the genes that the cell needs in its day-to-day existence. The **micronucleus**, by contrast, contains a “reserve copy” of all of the cell's genes.

Figure 20–5 Ciliates use hairlike projections called cilia for feeding and movement. Ciliates, including this paramecium, are covered with short, hairlike cilia that propel them through the water. Cilia also line the organism's gullet and move its food—usually bacteria—to the organism's interior. There, the food particles are engulfed, forming food vacuoles. The contractile vacuoles collect and remove excess water, thereby helping to achieve homeostasis, a stable internal environment.

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FACTS AND FIGURES

No difference

Students may wonder what the real difference is between a cilium and a flagellum. Some might suspect that there must be a subtle difference in internal structure about which their textbook or teacher is not telling them. The truth is that there is no difference—a cilium and a flagellum are the same organelle. The difference in terminology is derived from the days of the light microscope,

when biologists thought that the many fine hairs surrounding some cells might well turn out to be different from the few long whips that move other cells. With the advent of the electron microscope, however, it became clear that the structure and biochemistry of both organelles are identical, at least in protists. There is a real difference, however, between the flagella of prokaryotes and those of protists.

Answer to . . .

CHECKPOINT Cilia are short hairlike projections that ciliates use for feeding and movement.

20-2 (continued)

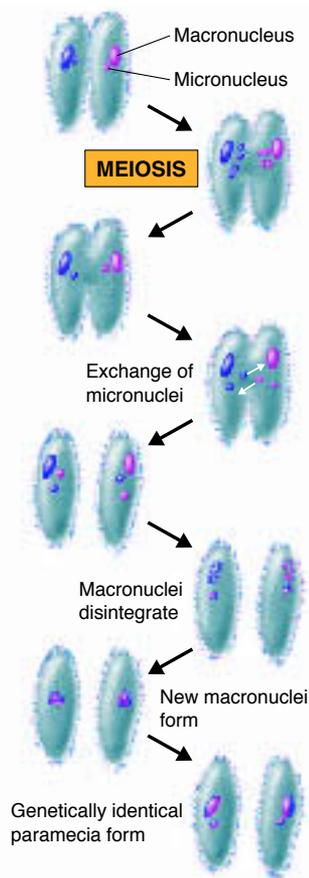
Use Visuals

Figure 20-6 After students have studied the figure, ask: **What is conjugation?** (*Conjugation is the process that allows paramecia to exchange genetic material with other individuals in times of stress.*) **What is the advantage of conjugation for a paramecium species?** (*Conjugation provides new combinations of genes, which help create and maintain genetic diversity. Biologists believe that genetic diversity provides a better chance for species to survive unfavorable changes in their environments.*) L1 L2

Sporozoans

Build Science Skills

Comparing and Contrasting Have students make a compare/contrast table that organizes the information they have learned about the four phyla of animallike protists. Column heads for this table should include Phylum, Means of Movement, Feeding, Other Characteristics, and Examples. After students have individually worked on their tables, divide the class into small groups and have students in each group compare tables, trade information, and collaborate on a group table. L2



▲ **Figure 20-6** During conjugation, two paramecia attach themselves to each other and exchange genetic information. The process is not reproduction because no new individuals are formed. Conjugation is a sexual process, however, and it results in an increase in genetic diversity.

Interpreting Graphics What structures do paramecia exchange during conjugation?

Many ciliates obtain food by using cilia to sweep food particles into the **gullet**, an indentation in one side of the organism. The particles are trapped in the gullet and forced into food vacuoles that form at its base. The food vacuoles pinch off into the cytoplasm and eventually fuse with lysosomes, which contain digestive enzymes. The material in the food vacuoles is digested, and the organism obtains nourishment. Waste materials are emptied into the environment when the food vacuole fuses with a region of the cell membrane called the **anal pore**.

In fresh water, water may move into the paramecium by osmosis. This excess water is collected in vacuoles. These vacuoles empty into canals that are arranged in a star-shaped pattern around contractile vacuoles. **Contractile vacuoles** are cavities in the cytoplasm that are specialized to collect water. When a contractile vacuole is full, it contracts abruptly, pumping water out of the organism. The expelling of excess water via the contractile vacuole is one of the ways the paramecium maintains homeostasis.

Conjugation Under most conditions, ciliates reproduce asexually by mitosis and cytokinesis. When placed under stress, paramecia may engage in a process known as **conjugation** that allows them to exchange genetic material with other individuals. The process of conjugation is shown in **Figure 20-6**.

Conjugation begins when two paramecia attach themselves to each other. Meiosis of their diploid micronuclei produces four haploid micronuclei, three of which disintegrate. The remaining micronucleus in each cell divides mitotically, forming a pair of identical micronuclei. The two cells then exchange one micronucleus from each pair. The macronuclei disintegrate, and each cell forms a new macronucleus from its micronucleus. The two paramecia that leave conjugation are genetically identical to each other, but both have been changed by the exchange of genetic information.

Conjugation is not a form of reproduction, because no new individuals are formed. It is, however, a sexual process—because it uses meiosis to produce new combinations of genetic information. In a large population, conjugation helps to produce and maintain genetic diversity.

Sporozoans

While many animallike protists are free living, some are parasites. 🟡 **Members of the phylum Sporozoa do not move on their own and are parasitic.** Sporozoans are parasites of a wide variety of organisms, including worms, fish, birds, and humans. Many sporozoans have complex life cycles that involve more than one host. Sporozoans reproduce by sporozoites. Under the right conditions, a sporozoite can attach itself to a host cell, penetrate it, and then live within it as a parasite.

✓ **Check Your Understanding** How do sporozoans reproduce?



FACTS AND FIGURES

Why conjugation?

Conjugation is an interesting aspect of ciliate reproduction, but many students find it confusing. During the process, the two cells exchange part of their micronuclear “libraries” and form new combinations of genetic information. Once these new combinations are formed, the cell destroys its old macronucleus and makes a new one from the new set of information. Each cell leaves the conjugation event with a genetic

makeup that is different from the one with which it entered. The macronuclei seem to contain the genes that must function on a daily basis to keep the cell alive. For the sake of efficiency, those genes have been copied hundreds of times. The existence of two kinds of nuclei seems to help the cell to express the genes required all the time. It also allows the cell to keep a repository of genetic information that may be passed on to future generations.

Animallike Protists and Disease

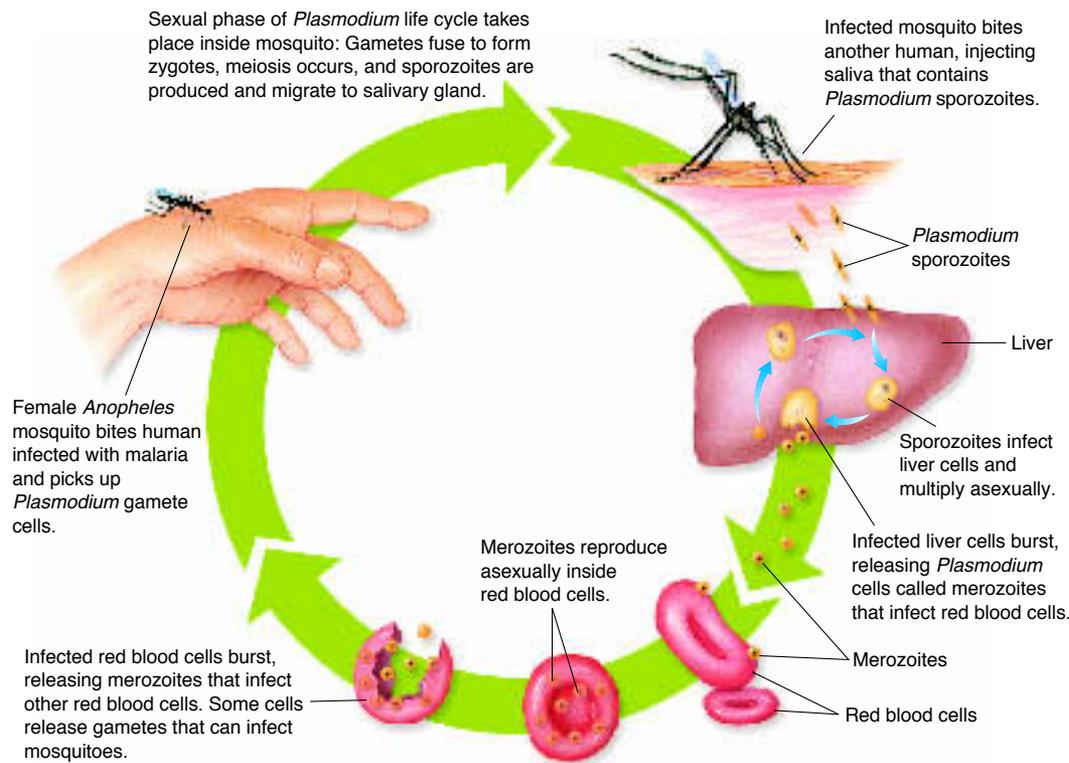
Make Connections

Health Science Ask students: **Where is malaria most common?** (Some students may know that malaria is common in tropical and subtropical regions of the world, including Africa, Southeast Asia, and Central and South America.) Explain that the classic treatment of malaria was with quinine, a medicine derived from the bark of the cinchona tree. Stronger, synthetic forms of that drug are used today. Eradicating the mosquito carriers and their breeding areas is an important preventive measure against malaria.

L1 L2

Use Community Resources

Invite a health professional to give a brief talk about this disease that still affects so many people around the world. There are many forms of malaria, so it makes an interesting discussion topic. L2



Animallike Protists and Disease

Unfortunately for humans and for other organisms, many protists are disease-causing parasites. **Some animallike protists cause serious diseases, including malaria and African sleeping sickness.**

Malaria Malaria is one of the world's most serious infectious diseases. As many as 2 million people still die from malaria every year. The sporozoan *Plasmodium*, which causes malaria, is carried by the female *Anopheles* mosquito.

The cycle of malarial infection is shown in **Figure 20-7**. When an infected mosquito bites a human, the mosquito's saliva, which contains sporozoites, enters the human's bloodstream. Once inside the blood, *Plasmodium* infects liver cells and then red blood cells, where it multiplies rapidly. When the red blood cells burst, the release of the parasites into the bloodstream produces severe chills and fever, symptoms of malaria.

Although drugs such as chloroquine are effective against some forms of the disease, many strains of *Plasmodium* are resistant to these drugs. Scientists have developed a number of vaccines against malaria, but to date most are only partially effective. For the immediate future, the best means of controlling malaria involve controlling the mosquitoes that carry it.



Figure 20-7 **Animallike protists can cause serious diseases, including malaria.** The bite of an *Anopheles* mosquito can transmit *Plasmodium* sporozoites. Once in the human body, *Plasmodium* infects liver cells and red blood cells and multiplies.



FACTS AND FIGURES

The nighttime is the right time

The symptoms of malaria include chills and fever. These symptoms are associated with the rupture of red blood cells and the release into the bloodstream of huge numbers of merozoites. Not all red blood cells become infected with merozoites. Yet, if only 1 percent of the red blood cells contain the protist cells, there would be about 100 trillion parasite cells in the circulatory system at the same time. The rupture of blood cells in a

person occurs simultaneously and at regular intervals—always a multiple of 24 hours. Between periods of rupture, the infected person feels normal. Why is there such perfect timing of these periods of rupture? Some scientists think that the parasite has evolved this adaptation to ensure that the gametes released are mature at night, which is when mosquitoes are more likely to be feeding. Thus, there is a greater likelihood that the sporozoans will be transmitted to new hosts.

Answers to . . .

CHECKPOINT Sporozoans reproduce by means of sporozoites that live within host cells as parasites.

Figure 20-6 Two paramecia exchange one micronucleus from a pair of identical micronuclei in each.

Quick Lab

Objective Students will be able to formulate a hypothesis about how paramecia feed.

Skills Focus **Observing, Formulating Hypotheses**

Materials Paramecium culture, 2 dropper pipettes, microscope, microscope slide, coverslip, *Chlorella* culture, toothpick, carmine dye

Time 20 minutes

Advance Prep Order cultures of *Paramecium* and *Chlorella*, as well as carmine dye, from a biological supply house.

Safety Make sure that students wash their hands with warm soap and water before they leave the lab.

Strategies

- Demonstrate the use of a toothpick in transferring granules of carmine dye to the drops on the slide.
- You may choose to have students observe the organisms through the microscope before adding carmine red.

Expected Outcomes Students should observe that the paramecia feed on the *Chlorella* cells by trapping the cells in the gullet and then moving the cells into the cytoplasm in food vacuoles.

Analyze and Conclude

1. Students should observe that the *Chlorella* cells and the carmine dye accumulate inside the paramecia.
2. Students should infer from their observations that the paramecia trapped the *Chlorella* cells and dye granules in the gullet and then forced the particles into food vacuoles.
3. Students should hypothesize that the paramecia took in the *Chlorella* cells and the dye granules by endocytosis.

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SCIENCE NEWS[®]
Science News provides students with the most current information on protozoans.

Quick Lab

What are the functions of a paramecium's gullet and food vacuoles?

Materials paramecium culture, 2 dropper pipettes, microscope, microscope slide, coverslip, *Chlorella* (green alga) culture, toothpick, carmine dye

Procedure

1. Use separate dropper pipettes to place a drop of paramecium culture and a drop of *Chlorella* culture next to each other on a microscope slide.
2. Use a toothpick to transfer a few granules of carmine dye to the drops on the slide. Add a coverslip so that the two drops mix.

3. Place the slide on the stage of a microscope. Use the low-power objective to locate several paramecia.
4. Use the high-power objective to observe the contents and behavior of the paramecia.

Analyze and Conclude

1. **Observing** Where did the *Chlorella* cells and carmine dye granules accumulate?
2. **Inferring** How do you think this accumulation of cells and dye granules occurs?
3. **Formulating Hypotheses** What process in the paramecia do you think resulted in this change?



Other Protistan Diseases Zooflagellates of the genus *Trypanosoma* cause African sleeping sickness. The trypanosomes that cause this disease are spread from person to person by the bite of the tsetse fly. Trypanosomes destroy blood cells and infect other tissues in the body. Symptoms of infection include fever, chills, and rashes. Trypanosomes also infect nerve cells. Severe damage to the nervous system causes some individuals to lose consciousness, lapsing into a deep and sometimes fatal sleep from which the disease gets its name. The control of the tsetse fly and the protist pathogens that it spreads is a major goal of health workers in Africa.

In certain regions of the world, many people are infected with species of *Entamoeba*. The parasitic protist *Entamoeba* causes a disease known as amebic dysentery. The parasitic amoebas that cause this disease live in the intestines, where they absorb food from the host. They also attack the wall of the intestine itself, destroying parts of it in the process and causing severe bleeding. These amoebas are passed out of the body in feces. In places where sanitation is poor, the amoebas may then find their way into supplies of food and water. In some areas of the world, amebic dysentery is a major health problem, weakening the human population and contributing to the spread of other diseases.

Amebic dysentery is common in areas with poor sanitation, but even crystal-clear streams may be contaminated with the flagellated pathogen, *Giardia*. *Giardia* produces tough, microscopic cysts that can be killed only by boiling water thoroughly or by adding iodine to the water. Infection by *Giardia* can cause severe diarrhea and digestive system problems.

CheckPoint What is one method for controlling amebic dysentery?

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**FACTS AND FIGURES****Trypanosomes in disguise**

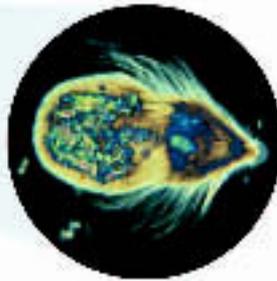
African sleeping sickness is one of the worst infectious diseases known, and it has had a devastating effect across central Africa. About 45,000 new cases of the disease are diagnosed each year, and without treatment it is almost always fatal. There is no good treatment for the disease because the protist that causes it, *Trypanosoma*, has a remarkable ability to thwart the human immune system. Normally, when a pathogen invades the body, the

immune system makes antibodies that can destroy the invader and end the infection. When trypanosomes infect a person, the immune system produces antibodies that destroy almost all of the invading cells. But about 1 percent of the trypanosomes react through changes in the proteins on the surfaces of their cells, and the antibodies made to destroy trypanosomes no longer recognize the cells as enemies.



(magnification: 10×)

Figure 20–8 *Trichonympha* (below), a wood-digesting protist, lives in the digestive systems of insects such as a termite (left). Digestive enzymes produced by the protist break down the particles of wood, which you can see inside the protist's body. **Predicting** What would happen to a termite if its *Trichonympha* colony died?



(magnification: about 250×)

Trichonympha

Ecology of Animallike Protists

Many animallike protists play essential roles in the living world. Some live symbiotically within other organisms. Others recycle nutrients by breaking down dead organic matter. Many animallike protists live in seas and lakes, where they are eaten by tiny animals, which in turn serve as food for larger animals.

Some animallike protists are beneficial to other organisms. *Trichonympha*, shown in **Figure 20–8**, is a zooflagellate that lives within the digestive systems of termites. This protist makes it possible for the termites to eat wood. Termites do not have enzymes to break down the cellulose in wood. (Incidentally, neither do humans, so it does us little good to nibble on a piece of wood.) How, then, does a termite digest cellulose? In a sense, it doesn't. *Trichonympha* does.

Trichonympha and other organisms in the termite's gut manufacture cellulase. Cellulase is an enzyme that breaks the chemical bonds in cellulose and makes it possible for termites to digest wood. Thus, with the help of their protist partners, termites can munch away, busily digesting all the wood they can eat.

20–2 Section Assessment

- Key Concept** What are the four major phyla of animallike protists? How do members of each of these groups move?
- Key Concept** What animallike protists cause disease?
- How does a macronucleus differ in function from a micronucleus?
- Describe the role of animallike protists in the environment.
- Critical Thinking Comparing and Contrasting** Compare animallike protists that have flagella to those that have cilia.
- Critical Thinking Making Judgments** Summarize how *Plasmodium* can cause a major disruption in the equilibrium of a human population.

Connecting Concepts

Comparing and Contrasting

Compare asexual and sexual processes in paramecia. Include the terms *mitosis* and *meiosis* in your answer. You may wish to refer back to Chapters 10 and 11 to review mitosis and meiosis.

Connecting Concepts

Students should define the terms *mitosis* and *meiosis*. Then, they should explain that under most conditions, paramecia reproduce by mitosis and cytokinesis. Under certain conditions, paramecia engage in conjugation, which is not a form of reproduction but is a sexual process because it uses meiosis.

20–2 Section Assessment

- Zooflagellates swim with flagella; sarcodines move by extensions of their cytoplasm; ciliates move by means of cilia; and sporozoans do not move at all.
- Plasmodium* causes malaria; *Trypanosoma* causes African sleeping sickness; *Entamoeba* causes amebic dysentery; and *Giardia* can cause diarrhea and digestive problems.
- A macronucleus contains multiple copies of most of the genes that the cell needs; a micronucleus contains a copy of all the genes.
- Some live symbiotically. Others recycle nutrients by breaking down dead matter. Many live in seas and lakes, where they are eaten.
- Zooflagellates have flagella; some live within other organisms. Ciliates have cilia; most are free living.
- Students should describe the effects of the disease malaria, caused by *Plasmodium*.



If your class subscribes to the iText, use it to review the Key Concepts in Section 20–2.

Answers to . . .

CHECKPOINT Improve sanitation

Figure 20–8 The termite would also die because of its inability to break down cellulose for food.