### Chapter 19 Organizer

**Refer to pages 457-51 of the Teacher Guide for an explanation of the National Science Education Standards correlations.**

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<td>1. Identify the characteristics of Kingdom Protista. 2. Compare and contrast the four groups of prototaxans.</td>
<td>Minilab 19-1: Observing Ciliate Motion, p. 522&lt;br&gt;Inside Story: A Paramecium, p. 523&lt;br&gt;Problem-Solving Lab 19-1, p. 524</td>
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<td><strong>Section 19.2</strong>&lt;br&gt;Algae: Plantlike Protists&lt;br&gt;National Science Education Standards UCP1, UCP2, UCP5; A1, A2, C1, C4, C5, C6; F1, F4, F5 (2 sessions, 1 block)</td>
<td>3. Compare and contrast the variety of plantlike protists. 4. Explain the process of alternation of generations in algae.</td>
<td>Minilab 19-2: Going on an Algae Hunt, p. 527&lt;br&gt;Problem-Solving Lab 19-2, p. 530&lt;br&gt;Design Your Own BioLab: How do Paramecium and Euglena respond to light? p. 538</td>
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<td>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.</td>
<td>Problem-Solving Lab 19-3, p. 534&lt;br&gt;Social Studies Connection: The Irish Potato Famine, p. 540</td>
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**Need Materials? Contact Carolina Biological Supply Company at 1-800-334-5551 or at [http://www.carolina.com](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 seed, 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

**Teacher Classroom Resources**

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**Assessment Resources**
- Chapter Assessment, pp. 109-114
- MindToggler 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 L2 L3 L4
- English/Spanish Audiocassettes L2 L3 L4
- Cooperative Learning in the Science Classroom [COORD LEARN]
- Lesson Plans/Block Scheduling

**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.
- L4: ELL activities should be within the ability range of English Language Learners.
- COOPERLEARN: Cooperative Learning activities are designed for small group work.
- These strategies represent student products that can be placed into a bell-work portfolio.
- These strategies are useful in a block scheduling format.
**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.

### Section 19.1 The World of Protists

**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 (proh T0H z0h) (singular, protozoan). Unlike animals, though, all protozoa are unicellular. Other protists are plantlike autotrophs, using photosynthesis to make food. Plantlike protists are called algae (AL je). (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
The food becomes ensnared in a food vacuole. As an amoeba approaches food, pseudopodia form and eventually surround the food. Digestive enzymes break down the food, and the nutrients diffuse into the cytoplasm.

Diversity of Protozoans

Many protozoans are grouped according to the way they move. Some protozoans use cilia or flagella to move. Others move by sending out cytoplasm-containing extensions of their plasma membrane. These extensions are called pseudopodia (seed poid). Other protozoans are grouped together because they are parasites. There are four main groups of protozoans: the amoebas, the foraminifera, the radiolarians, and the flagellates, the ciliates, and the sporozoans (L1 2013 unit).

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.

Amoebas live in both freshwater and marine environments. As an amoeba approaches food, pseudopodia form down the food, and the pseudopodia eventually surround the food. Pseudopodia do not actually move the food toward the amoeba; they move the cell itself toward the food.

In some cases, the pseudopodia of an amoeba may surround food items that are analogous in structure, such as cilia, flagella, and pseudopodia.

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In some cases, the pseudopodia of an amoeba may surround food items that are analogous in structure, such as cilia, flagella, and pseudopodia.
Flagellates: Protozoans with Flagella

The phylum Zoomastigina consists of protozoa called flagellates, which have one or more flagella. Flagellated protozoans 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 mutu-

Critical Thinking

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

1. Cells swell and burst.
2. The paramecium moves faster.
3. The cell remains the same size.

Expected Results

Paramecium typically reverses the direction in which its cilia are moved 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.

Microscopy

Carefully place a drop of water containing wheat seedling root tips on a microscope slide. Dispose of the wheat seedlings when finished.

Critical Thinking

A Paramecium contains flagellate food vacuoles. The food vacuoles are for any:

1. Plants.
2. Bacteria.
3. None of the above.

Expected Results

Paramecium

Observe the cilia that cover their outer covering called a pellicle. The cell is encased by an outer covering called a pellicle.

Critical Thinking

A Paramecium

Observe the cilia that cover their outer covering called a pellicle. The cell is encased by an outer covering called a pellicle.

Critical Thinking

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Observe the cilia that cover their outer covering called a pellicle. The cell is encased by an outer covering called a pellicle.
Malaria and Sickle-Cell Anemia

Linguistic

Have students use references to report about the correlation between the genetic disease sickle-cell anemia and the prokaryotic disease malaria.

They should include the evolutionary significance of such a relationship.

Section Assessment

Thinking Critically

1. What role do contractile vacuoles play in helping freshwater protists maintain homeostasis?

Skill Review

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

Section Assessment

1. Protoplasts are eukaryotes without tissues. Protostomes are unicellular, heterotrophic protists. Rhizopods have pseudopodia. Ciliophora have cilia, and flagella propel pellicular protists. Sporozoa are parasites.

2. Pseudopodia entrap prey.

3. Flagellates have long, whip-like flagella. Ciliates have many short, hair-like 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. Students should answer the following: What are some species of Plasmodium that have begun to resist these drugs? Therefore, quinine is once again being used to treat the resistant strains.

Reteach

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

Extension

Have students research the phylogeny of the protist Trophalax cystica. Ask them to draw and label this protist.

Assessment

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

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, sarcosomes, asexual reproduction, cyst, micro-nucleus, 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.

Resource Manager

Reinforcement and Study Guide, p. 83
Content Mastery, p. 94
Prepare

1 Focus

Bellringer

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

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 (lite uh PLANK ton), 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, and use the Mitochondrion 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 (yo GLAY 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 they 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 protozoa. In other words, euglenoids can be heterotrophs. In Figure 19.7, you can see a typical euglenoid.

Euglenoids might also remind you of protozoa 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 a hard, glassy cell wall. Diatoms live in fresh and salt water and are abundant in aquatic ecosystems. Some diatoms have a hard, glassy cell wall that can be found on the bottoms of lakes and streams. This cell wall is called the frustule.

Protists and algae are microscopic. How can you tell them apart?

1. Autotrophs contain chlorophyll. Plant-like protists and algae most have chlorophyll and pho- tosynthesize.

2. If the algae are unicellular or multicellular.

3. 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.
Figure 19.8 Diatom shells have many shapes.

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 toothpaste and metal polishers, or added to paint to give the sparkle that makes pavement lines more visible at night.

Dinoflagellates: The spinning alga

Dinoflagellates (di mh FLA) are free-living species that vary in shape and size. They reproduce by budding and by sexual reproduction, where gametes that fuse to form zygotes. The zygote develops into a full-sized diatom, which will divide asexually to form gametes. New generations before asexually for several generations before reproducing sexually.

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 toxic-producing dinoflagellate, Phalacroma poisona, 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 catenella, 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 80 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 flagella propel them through water.

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).
**Problem-Solving Lab 19.2**

**Recognizing Cause and Effect**

**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. 
   
2. A or B—Shellfish are not affected by dinoflagellate toxins, but whales do.

**Problem-Solving Lab 19.2**

**Recognizing Cause and Effect**

**Why is the number of red tides increasing?**Scientists have been aware of red tide phenomena for centuries, but in recent years the number of events associated with red tides has increased. When dinoflagellates—unicellular marine organisms—grow in large numbers, they cause the water to turn red, green, or brown. Dinoflagellates produce potent toxins that can be harmful to animals that consume them. In the case of red tides, the dinoflagellates produce a toxin that affects shellfish and other animals that eat them. The toxins accumulate in the mackerel that feed on shellfish, and the mackerel are then eaten by whales. The result is a significant increase in the number of red tides in recent years.

**Analysis**

- The following associations are associated with the appearance of red tides.
- The following association causes illness and sometimes death in humans in the biological tissues of shellfish, such as clam and oyster.
- Within five weeks, 14 humpback whales died on beaches in Massachusetts. The whales' stomachs contained hundreds of thousands of cells per milliliter of water. The whales' stomachs contained high levels of dinoflagellate toxins.
- 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.
- Studies show that red tides are increasing worldwide.
- Algae bloom occurs when algae, using sunlight and abundant nutrients, increase in number to hundreds of thousands of cells per milliliter of water.

**Thinking Critically**

1. Which statement above provides evidence that supports the following association: Between 1976 and 1986, the human population of Hong Kong increased sixfold, and its harbor had an eightfold increase in red tides? 
   
2. Which statement above provides evidence that supports the following association: Algae bloom occurs when algae, using sunlight and abundant nutrients, increase in number to hundreds of thousands of cells per milliliter of water? 
   
3. Which statement above provides evidence that supports the following association: The following associations are associated with the appearance of red tides? 
   
4. Which statement above provides evidence that supports the following association: The following association causes illness and sometimes death in humans in the biological tissues of shellfish, such as clam and oyster? 
   
**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.
3 Assess

Check for Understanding

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

Reteach

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

Extension

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

4 Close

Discussion Questions

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

Section 19.3

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 glowing 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.

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 the 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.
frame 1

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

Teach molecular biology, 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

Performance

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

Assessment

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

Alternative Lab

Observing Slime Mold

Purpose

Allow students to observe a plasmodium-type slime mold.

Materials

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 drops 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 plasmodial slime molds:
    1. 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 masses. Merritt's takes place within these masses. The spore masses form reproducibly the structures and produces haploid spores, which the wind disperses. A spore germinates into either a flagellated or amoeboid cell or a spore that can fuse with another cell to form a zygote. The diploid zygote grows into a new plasmodium.
3. Design a way to determine if the plasmodium would cross your textbook page in eight hours.
4. Record your macroscopic observations.
5. Design an interpretive question to ask the class based on the diagram and your understanding of the entire life cycle.
6. Wash your hands thoroughly when you finish.

Analysis

1. Describe the plasmodium’s appearance and behavior: Is it a plasmodial or cellular slime mold? Yellow, bloblike, stringy, multicellular—amoeboid like slime molds make spores 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.
2. Describe the plasmodium’s microscopic appearance and behavior: Material flows within the slime mold, stops, then flows in the opposite direction.

Materials

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 drops 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 plasmodial slime mold.
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.

Understanding Main Ideas

1. Describe the protozoan and funguslike characteristics of slime molds.
2. Why might some biologists refer to plasmodial slime molds as cellular slime molds? (Hint: Look in Appendix B for the origin 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?
5. In what kinds of environments would you expect to find slime molds? Explain your answer.

Thinking Critically

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.

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 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.

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

**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**
With 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 Hypotheses**
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.

**Possible Materials**
- Paramecium culture
- Euglena culture
- Paramecium culture microscope slides
- Euglena culture microscope slides
- Microscope
- Metric ruler
- Index cards
- Toothpicks
- Methyl cellulose
- Dropper
- Coveralls

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

**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 Paramecium 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.

**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 5X 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.
- Use the index cards as a light and dark area for Paramecium to observe.
- Prepare slides of Paramecium and Euglena cultures and observe swimming patterns in the two organisms.
- Compare how these two different protists respond to light.

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

**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 responses to light and darkness might you observe using other heterotrophic or autotrophic protists?

**Error Analysis**
Advisors need to discuss several trials for each organism. Ask them why this is important.

**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.

**Going Further**
Students may wish to test the response of these protists to other factors, such as different concentrations of salt solutions.
The Irish Potato Famine

A fungoid-like 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.

Mass emigration of the Irish
Many Irish people starved in the years that followed. Many others emigrated from Ireland. By 1851, 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-grandson of an Irish tenant farmer who immigrated to the United States in 1848.

Today, fungicides, chemicals that prevent fungal growth, control outbreaks of Phytophthora infestans. How might this information affect research on the evolutionary relationships of fungoid-like protists?

Find out more about the Irish potato famine and Phytophthora, visit the Glencoe Science Web Site.

www.glencoe.com/sec/science
3. Include 4.
22. Oak forest
21. Finding a suitable host; producing many spores will improve the possibility of survival
20. Cilia; 19. Plasmodium
16. Algae
15. Fragmentation
14. Flagellum
13. Colony
12. Euglenoids are unique algae because of their flagella
11. Gametophyte; sporophyte
10. Protozoans
9. Plasmodium
8. Apoikiospsid
7. Bacteria
6. All protists are eukaryotes
5. Protons are classified on the basis of their size.
4. Photosynthesis
3. Nutrition
2. Method of locomotion
1. Reproductive abilities

Chapter 19 Assessment

APPLYING MAIN IDEAS
21. A suitable host; producing many spores will improve the possibility of survival because some of the spores may find a host.
22. Oak forest
23. Answers will vary, but may include cilia, pseudopodia, flagella, eyespots, contractile vacuoles, or others.

Thinking Critically
25. Observing and Inferring: Why do you suppose many people who own aquariums add snails to their tanks? 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.

TEST–TAKING TIP
27. Sequencing: Sequence the stages of both sexual and asexual reproduction in diatoms.

Concept Mapping: Complete the concept map by using the following vocabulary terms: amoebas, sporozoans, flagellates, protozoans, ciliates

THINKING CRITICALLY
24. Up to the late 1800s, malaria was common in the 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?
23. The protozoan that causes malaria is classified as a ________, because it is a spore-producing parasite.
22. Flea is an alga that lives in a ________, a group of cells in close association.
21. What type of structure does the protozoan shown to the right use to move?

INTERPRETING DATA
27. 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
24. Mosquitoes breed in water. The elimination of breeding grounds reduces the mosquito population and reduces the risk of contracting malaria.
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 wall 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.


24. Up to the late 1800s, malaria was common in the 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?