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21.3 The Ecology of Protists

Lesson Objectives

- Describe the ecological significance of photosynthetic protists.
- Describe how heterotrophic protists obtain food.
- Identify the symbiotic relationships that involve protists.

Lesson Summary

Autotrophic Protists Protists that perform photosynthesis are autotrophic. The position of photosynthetic protists at the base of the food chain makes much of the diversity of aquatic life possible.

- They feed fish and whales, support coral reefs, and provide shelter to marine life.
- In areas where sewage is dumped, protists help recycle the waste. However, when the amount of waste is excessive, algae grow into enormous masses called **algal blooms**.

Heterotrophic Protists Some heterotrophic protists engulf and digest their food, while others live by absorbing molecules from the environment.

- Amoebas capture and digest their food, surrounding a cell or particle and then taking it inside themselves to form a food vacuole. A **food vacuole** is a small cavity in the cytoplasm that temporarily stores food.
- *Paramecia* and other ciliates use their cilia to sweep food particles into the **gullet**, an indentation in one side of the organism.
- Slime molds and water molds are important recyclers of organic material. At one stage of their life cycle, some slime molds fuse to form large cells with many nuclei. These structures are known as **plasmodia**. Sporangia develop from a plasmodium.

Symbiotic Protists—Mutualists and Parasites Some protists have symbiotic relationships with other organisms. *Trichonympha* has a mutualistic relationship with termites. It lives within their digestive system and helps them digest wood. Other protists are parasitic and cause disease. The protist *Trypanosoma* causes African sleeping sickness. The protist *Plasmodium* causes malaria.

Autotrophic Protists

1. How do autotrophic protists make the diversity of aquatic life possible?

They are at the base of the food chain.

2. What are phytoplankton?

Phytoplankton are small photosynthetic organisms found near the surface of the ocean; many are autotrophic protists.

3. How do protists help maintain homeostasis in coral reef ecosystems?

The protists called red algae support coral reefs by providing much needed nutrients for coral animals. Red algae also produces minerals corals need to form reefs.

4. How can algal blooms be harmful?

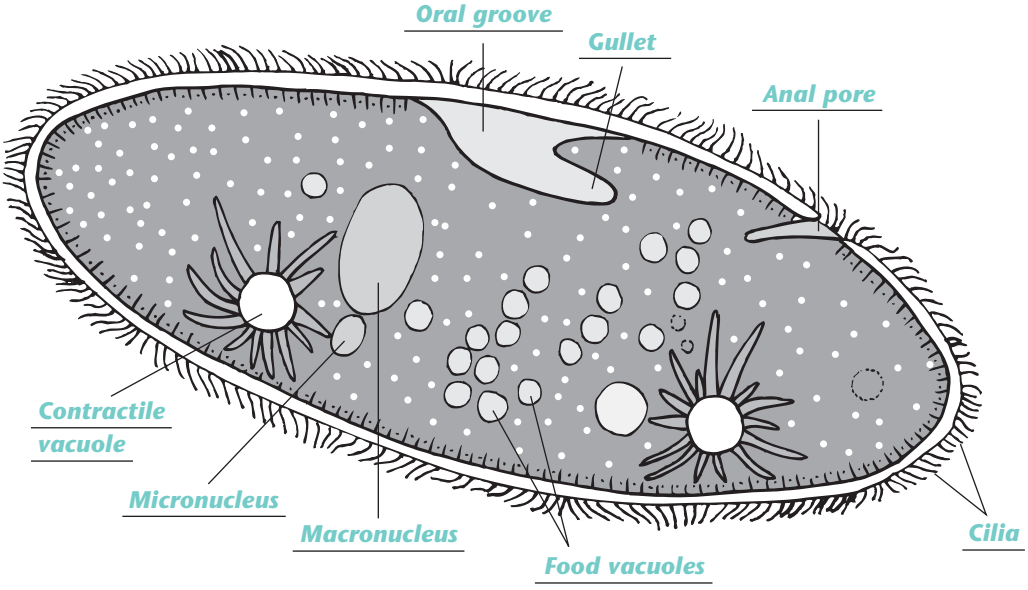
A bloom can quickly deplete the water of nutrients. The decomposition of the dead algae can rob the water of its oxygen, choking resident fish and invertebrate life.

Heterotrophic Protists

5. What is the function of a food vacuole?

It temporarily stores food until it can be digested.

6. Label the illustration of a paramecium.



7. What are slime molds?

They are heterotrophic protists that thrive on decaying organic matter.

8. By what process are haploid spores made by a water mold? Where does the process occur?

Spores are made by meiosis inside the sporangium.

9. What structure does a plasmodium eventually develop into and what is the function of that structure?

A plasmodium eventually changes into sporangia, which produce haploid spores.

For Questions 10–13, write True if the statement is true. If the statement is false, change the underlined word or words to make the statement true.

food **10.** In amoebas, indigestible materials remain inside <u>contractile</u> vacuoles.

feeding **11.** A gullet is a structure used by a paramecium for <u>reproduction</u>.

True **12.** In a slime mold's life cycle, germinating spores release <u>amoeba-like</u> cells.

True **13.** <u>Water molds</u> grow on dead or decaying plants and animals.

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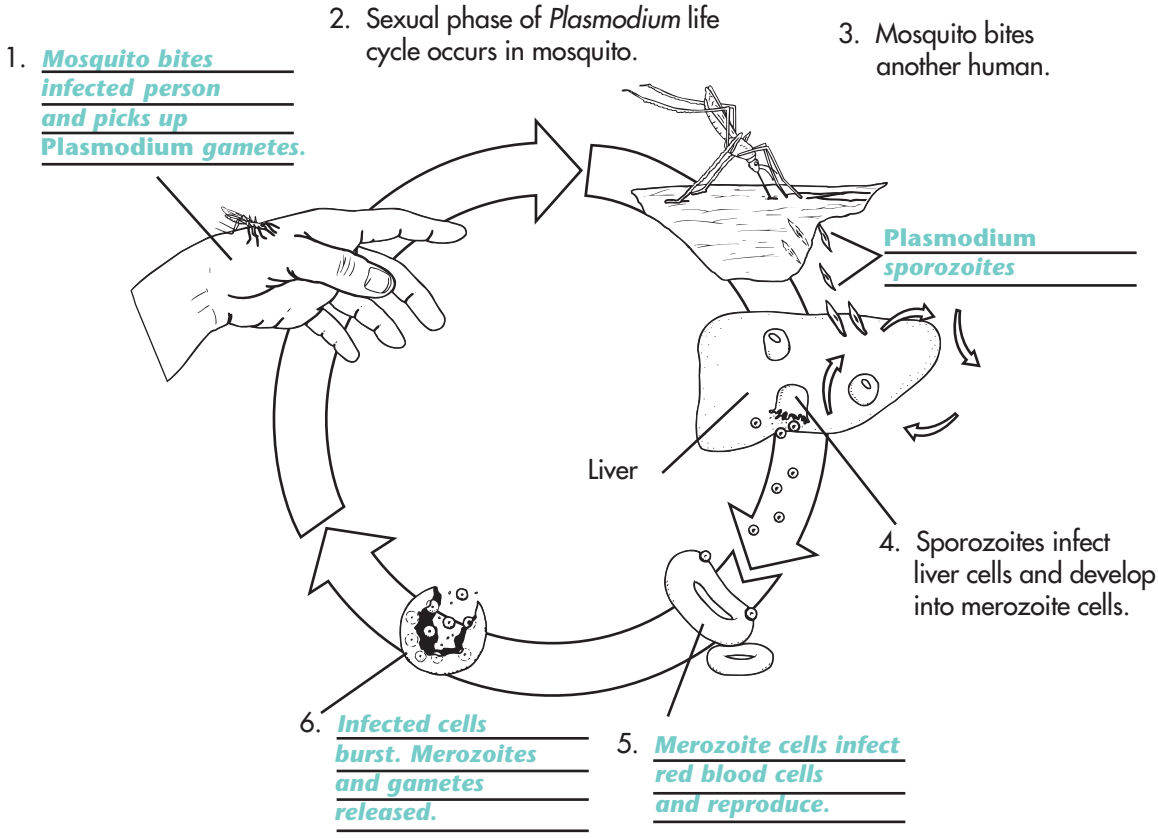
Symbiotic Protists—Mutualists and Parasites

14. How does the protist *Trichonympha* make it possible for termites to eat wood?

Termites do not have enzymes to break down the cellulose in wood. The protists in a termite's gut manufacture the enzyme cellulase, which breaks the chemical bonds in cellulose. With the help of their protist partners, then, the termites can digest wood.

15. What causes malaria? *Plasmodium*

16. Complete the flowchart showing the cycle of malarial infection.



Apply the Big idea

17. Slime molds are heterotrophic protists that thrive on decaying matter. How would they help maintain homeostasis within their ecosystems? How do they benefit an ecosystem? Why is their role so important?

SAMPLE ANSWER: *They would help decompose decaying plant and animal matter. They therefore help recycle nutrients throughout an ecosystem, which benefits any ecosystem. Without them, there would be fewer nutrients being recycled, and the ecosystem would be smothered by decaying matter.*

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21.4 Fungi

Lesson Objectives

- Identify the defining characteristics of fungi.
- Describe how fungi affect homeostasis.

Lesson Summary

What Are Fungi? Fungi are eukaryotic heterotrophs that have cell walls. The cell walls of fungi contain **chitin**, a complex carbohydrate.

- Most fungi are composed of thin filaments called **hyphae**. The **fruiting body** of a fungus—such as the above-ground part of a mushroom—is a reproductive structure that you can see. It grows from many hyphae tangled underground in a thick mass called a **mycelium**.
- Most fungi reproduce both asexually and sexually. Asexual reproduction can occur when cells or hyphae break off and begin to grow on their own. Some fungi also reproduce asexually by means of spores.
- Most fungi can also reproduce sexually. Spores are produced in structures called sporangia. Many fungi have minus (-) and plus (+) types that can reproduce sexually by fusing their nuclei when they meet.

The Ecology of Fungi Fungi do not ingest their food as animals do. Instead, fungi digest food outside their bodies and then absorb it. Many fungi feed by absorbing nutrients from decaying matter. Some fungi are parasites.

- Fungi help maintain equilibrium in nearly every ecosystem by recycling nutrients by breaking down the bodies and wastes of other organisms.
- Parasitic fungi cause serious plant and animal diseases. Fungal diseases in humans include athlete's foot, thrush, and yeast infections of the female reproductive tract.
- Some fungi form mutualistic relationships in which both partners benefit.
- **Lichens** are symbiotic associations between a fungus and a photosynthetic organism. The photosynthetic organism provides a source of energy. The fungus provides water and minerals.
- Mutualistic associations of plant roots and fungi are called **mycorrhizae**. The plant's roots are woven into a partnership with the web of fungal hyphae.

What Are Fungi?

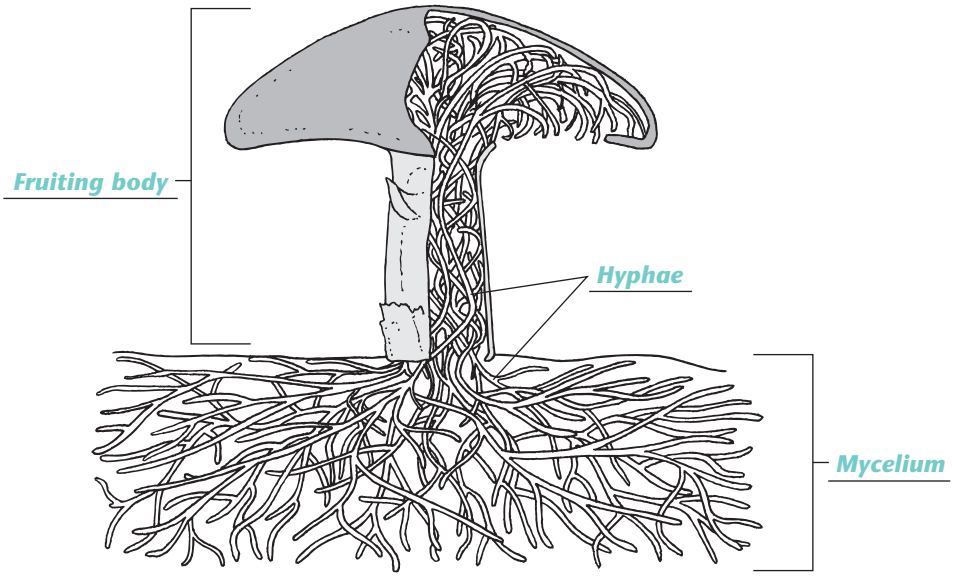
1. Why do scientists think that fungi are more closely related to animals than to plants?

The cells walls of fungi contain chitin. Similarly, insect exoskeletons contain chitin.

2. Describe two types of hyphae.

One type has cross walls that divide it into compartments like cells, and the other does not.

3. Label the parts of the fungus.



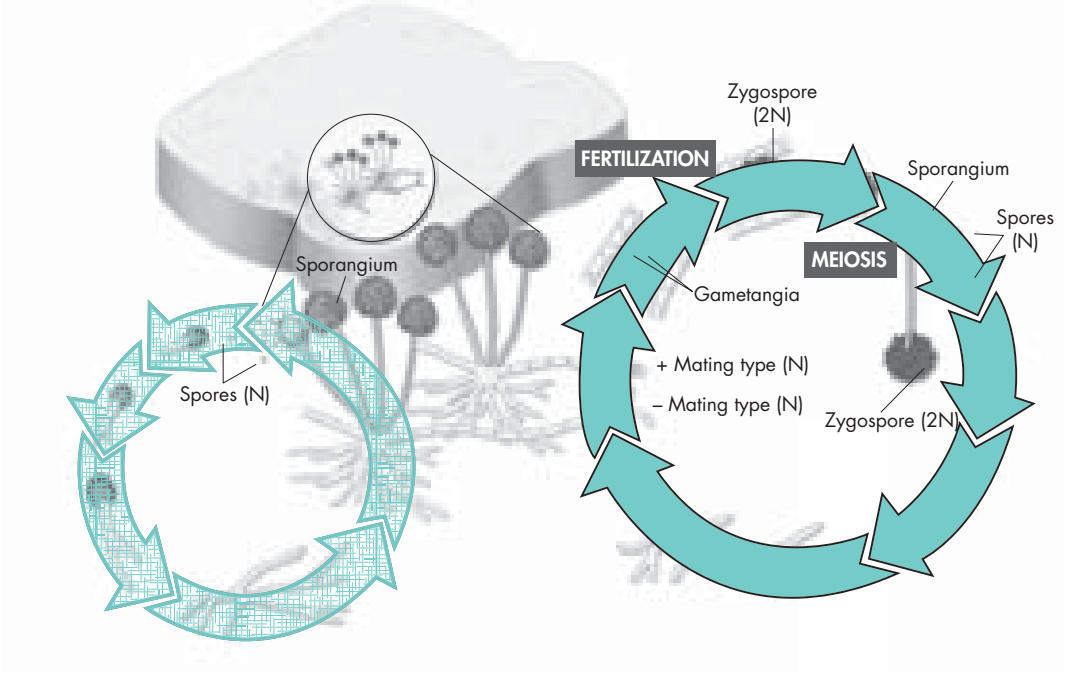
4. What is the function of a fruiting body?

It is the reproductive structure of the mushroom.

5. What is a fairy ring, and why does it form?

A fairy ring is composed of the fruiting bodies of mushrooms that developed at the outer edges of a single mycelium. It forms because as time goes by soil nutrients near the center of the mycelium become depleted and fruting bodies sprout only at the edges.

6. The diagram below shows the life cycle of *Rhizopus stolonifer* fungi. Shade the arrows that show sexual reproduction. Cross-hatch the arrows that show asexual reproduction.



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The Ecology of Fungi

7. How do fungi break down leaves, fruit, and other organic material into simple molecules?

They release digestive enzymes that speed the breakdown of these materials.

8. How can fungi disrupt the homeostasis of plants?

They can cause diseases, such as corn smut and wheat rust.

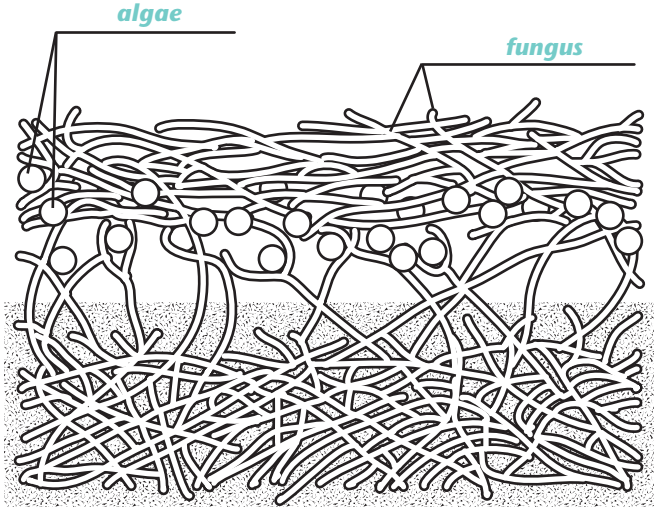
9. Lichens and mycorrhizae are both examples of what kind of symbiotic relationship?

mutualism

10. How do plants benefit from mycorrhizae? How do fungi benefit?

The fungi collect water and nutrients and bring them to the plant roots as well as freeing nutrients in the soil; the plants provide photosynthesis products to fungi.

11. THINK VISUALLY In the diagram of a lichen, label the alga and the fungus. Then, on the lines below, describe what benefits the fungus and alga each derive from their association in the lichen.



The photosynthetic organisms provide fungus with a source of energy. The fungus provides the alga with water, minerals, and protection.

Apply the Big idea

12. A fungus-killing chemical soaks into the ground and is absorbed through the roots of a plant with a fungal disease. How might this help infected plants regain homeostasis? How might it damage the homeostasis of other plants in the area?

SAMPLE ANSWER: *The chemical would kill the fungus that was harming the plants, restoring them to homeostasis. It could, however, harm other plants in the area, if it killed mycorrhizal fungi on their roots.*

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Chapter Vocabulary Review

Match the term with its definition.

Term	Definition
D 1. mycelium	A. Complex carbohydrate that makes up the cell walls of fungi
B 2. lichen	B. An example of a symbiotic association
C 3. sporangium	C. A structure that contains spores
A 4. chitin	D. Mass of tangled fungus hyphae
E 5. algal bloom	E. A rapid growth in algae in a body of water with a great deal of sewage
F 6. flagella	F. Structures that protists use for motion

Complete each statement by writing the correct word or words.

7. Multicellular fungi are composed of thin filaments called ___hyphae___.
8. A(n) ___fruiting body___ is a fungal reproductive structure growing from the mycelium.
9. Ciliates sweep food particles into their cell into a ___gullet___.
10. A small cavity in the cytoplasm that temporarily stores food is a food ___vacuole___.
11. A symbiotic association of plant roots and fungi is called a(n) ___mycorrhiza___.

Write the letter of the correct answer on the line at the left.

D 12. A life cycle that switches between haploid and diploid stages is called
- A. amoeboid movement.
- B. conjugation.
- C. meiotic binary fission.
- D. alternation of generations.

A 13. The single structure with many nuclei that is formed by a mass of amoeba-like slime molds is a(n)
- A. plasmodium.
- B. cilium.
- C. pseudopod.
- D. sporangium.

A 14. Amoebas move and feed by using their
- A. pseudopods.
- B. gullets.
- C. cilia.
- D. flagella.

B 15. Some ciliates exchange genetic material through a process called
- A. amoeboid movement.
- B. conjugation.
- C. fruiting bodies.
- D. alternation of generations.

A 16. A reproductive cell made by some protists is called a
- A. spore.
- B. cilium.
- C. sporangium.
- D. hypha.

C 17. A paramecium moves by using hairlike projections called
- A. gullets.
- B. contractile vacuoles.
- C. cilia.
- D. pseudopods.

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CHAPTER MYSTERY

"A BLIGHT OF UNUSUAL CHARACTER"

21st Century Learning

In the Chapter Mystery you investigated the water mold *Phytophthora* that led to the Irish potato famine in the 1840s. In recent years, experts have warned that the modern-day banana crop might soon face a similar threat.

A Threat to the World's Banana Crop

Juan Fernando Aguilar is a leading banana breeder at the Honduran Foundation for Agricultural Investigation (FHIA). He believes that the worldwide banana trade is currently highly vulnerable to a blight known as Fusarium wilt, or Panama disease, which is caused by the *Fusarium* fungus. As Aguilar explains, the modern-day banana, a variety known as the Cavendish, is highly susceptible to the disease, which has already destroyed plantations in Southeast Asia and now threatens crops elsewhere.

Read the fact sheet below, compiled from information from banana growers like Aguilar, to learn more about bananas and the threat they face from Fusarium wilt.

Facts About the Banana Trade and the Threat Posed by Fusarium Wilt

- The Cavendish banana, nutritious and convenient, is a monoculture. Almost all commercial banana farming relies on the Cavendish.
- As many as 100 billion Cavendish bananas are consumed worldwide each year.
- The global trade in Cavendish bananas is a $4-billion-per-year business.
- Americans eat more bananas than any other kind of fresh fruit. Average consumption in the U.S. equals 26.2 pounds of bananas per year.
- Fusarium wilt, once called Panama Disease, is caused by *Fusarium* fungi that invade young roots of the banana plant and cause its leaves to wilt and die.
- Some varieties of the fungus have proven resistant to existing fungicides and continue to thrive in surrounding soil, preventing the success of future plantings.
- Fusarium wilt wiped out the Gros Michel banana, which once was the most widely consumed banana. The Gros Michel became extinct by 1960.
- The Cavendish banana does not appear to be safe from the latest strain of Fusarium wilt which first appeared in 1992 and has spread throughout Southeast Asia. It has not reached the Western Hemisphere yet, but experts predict it will.
- Scientists have found no cure for Fusarium wilt.
- Fusarium wilt is so virulent that a single clump of dirt carried on a tire or shoe can spark an outbreak.

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21st Century Themes Science and Global Awareness, Science and Economic Literacy

1. How big is the global trade in bananas? What figures illustrate the popularity of bananas and their commercial importance?

   The global trade in bananas accounts for some $4 billion in sales annually, with 100 billion bananas consumed worldwide each year. Americans eat an average of more than 26 pounds of bananas each year, more than any other fresh fruit.

2. What characteristic of the current banana crop makes it particularly vulnerable to a blight?

   Bananas are particularly vulnerable to a blight because they are farmed as a monoculture: the Cavendish variety is virtually the only type commercially grown. The lack of diversity makes bananas particularly susceptible to widespread damage from a single strain of a disease.

3. What is Fusarium wilt? What causes it and how does it affect the banana crop?

   Fusarium wilt, or Panama disease, is caused by the **Fusarium** *fungus, which thrives in the soil and invades the young roots of banana plants, causing the plants' leaves to wilt and die.*

4. What characteristics of the current strain of Fusarium wilt make banana growers particularly worried?

   They worry especially because the latest strain infects Cavendish bananas, is resistant to fungicides, and is virulent. It can potentially be spread by a single clump of infected dirt carried on a tire or shoe.

5. Based on the facts presented, how vulnerable do you think the world's banana crop is to a widespread blight? Why or why not?

   Student viewpoints and rationale are encouraged here. Based on the facts presented, however, including the lack of diversity in the banana crop and the virulence of the disease, students should conclude that the banana crop is quite vulnerable.

21st Century Skills Investigate Fusarium Wilt

The skills used in this activity include **problem identification, formulation, and solution; information and media literacy;** and **communication skills**.

Use library and Internet resources to conduct further research about this topic. Try to find out more about the science of Fusarium wilt and expert assessment of the threat posed to the world's banana crops. How does the current situation compare to the Irish potato famine in the 1840s? Based on your research, write a newspaper article on the threat posed to the world trade in bananas and suggest what you think banana growers ought to do about it.

Evaluate students' articles by their choice of appropriate Web sites, inclusion of all the necessary facts, and a clear explanation of Fusarium wilt and the threat it presents to the banana trade. Students should draw apt comparisons with the Irish potato famine. They should also include a well-reasoned opinion of what should be done.