

Plants, Fungi, and the Colonization of Land 17

Many people tend to take plants for granted. It is fun to run barefoot across a cool lawn or to kick through colorful leaves on a chilly autumn day. It is enjoyable to eat a crisp salad or a juicy red apple. In each of these instances, we appreciate plants for their textures, colors, and flavors. We seldom think of them from a biological point of view—growing, reproducing, adapting, evolving. But if plants are ignored, most of the time fungi are absolutely reviled. Fungi are all around us, but most of the time we fail to notice them, unless a piece of bread tastes a little strange, or an orange turns blue, or athlete's foot makes our toes itch. Aside from an occasional pretty mushroom, most people regard fungi with a sort of wary disgust. But fungi have their own way of living and reproducing, and they are important to us in several ways. This chapter examines plants and fungi in detail.

Organizing Your Knowledge

Exercise 1 (Modules 17.1 – 17.2)

Web/CD Activity 17A *Terrestrial Adaptations of Plants*

Plants probably evolved from multicellular green algae, so the two kinds of organisms share many characteristics. But plants have unique adaptations for life on land that make them different from green algae. Complete the chart below by listing the differences between plants and green algae. Consider such things as support, nutrition, transport, and reproduction. An example is done for you. On the next page, list the similarities between plants and green algae.

Differences

<i>Green Algae</i>	<i>Plants</i>
1. Supported by water	1. Leaves and stems contain rigid supporting elements
2.	2.
3.	3.
4.	4.
5.	5.
6.	6.
7.	7.
8.	8.
9.	9.
10.	10.

Similarities

1.

2.

3.

4.

Exercise 2 (Module 17.3)Web/CD Activity 17B *Highlights of Plant Evolution*

This module summarizes the four major steps in plant evolution that gave rise to four major modern groups of plants. Each of the statements below describes one of those steps. Number the steps in order, and fill in the names of the plant groups.

- ____ A. The first plants that produced seeds arose. The modern seed plants are _____ and _____.
- ____ B. Plants evolved from ancestral green algae ; one lineage gave rise to the _____ a group that included the mosses.
- ____ C. The first flowering plants (_____) appeared.
- ____ D. Vascular plants evolved that had roots and strong stems supported by rigid vascular tissues, unlike the _____. Their modern-day representatives are the _____ and the seed plants.

Exercise 3 (Modules 17.4 – 17.5)Web/CD Activity 17C *Moss Life Cycle*

Study the diagrams in these modules to review alternation of generations in the plant life cycle. Then fill in the blanks below to complete the description of the moss life cycle.

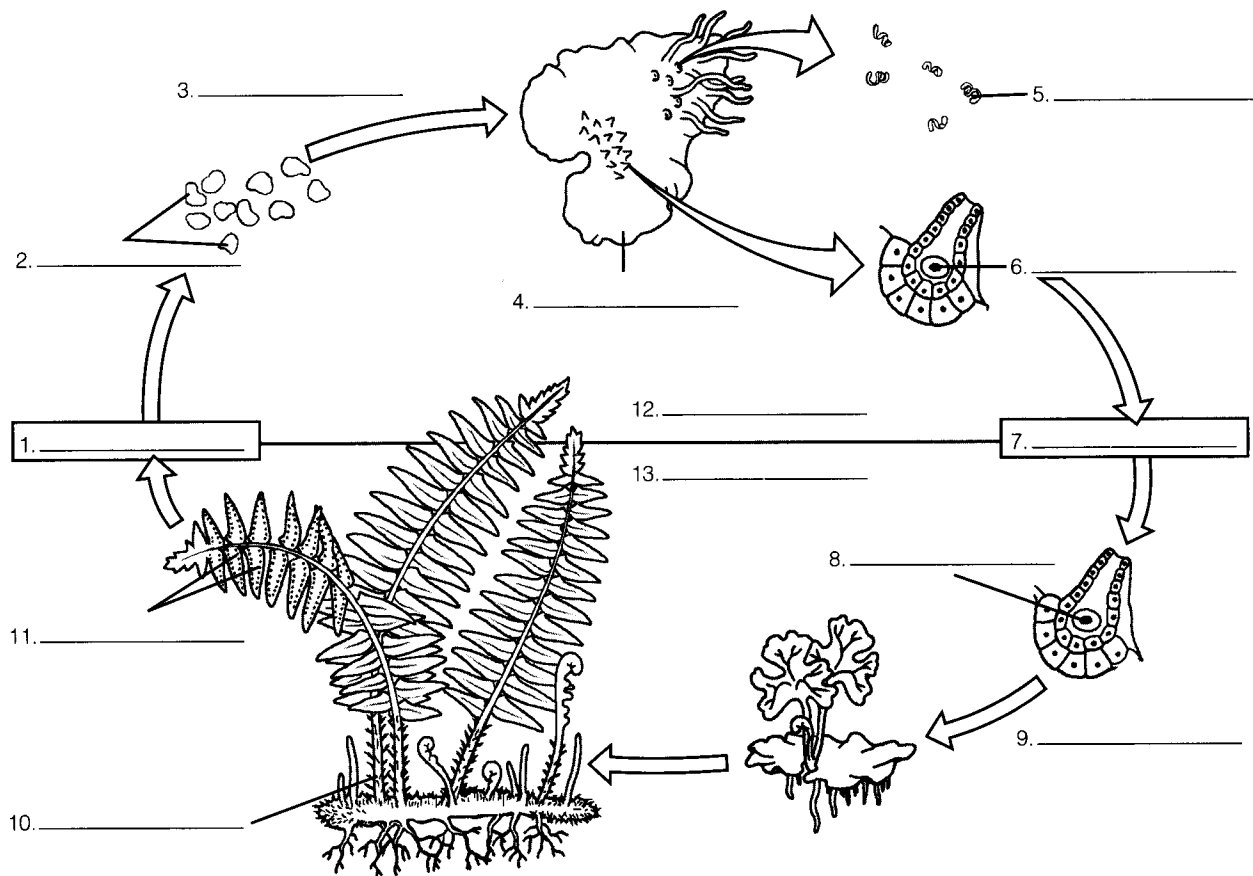
The moss life cycle, like that of all plants, is characterized by alternation of generations. Diploid individuals called ¹_____ produce ²_____ plants called gametophytes, which in turn produce ³_____ sporophytes. Since it's a cycle, we could start at any point, but let's start with a spore. A haploid moss spore grows into the haploid ⁴_____ plant, the green, cushiony growth we see on rocks or logs in a forest or bog. ⁵_____ (eggs and sperm) develop in the protection of special organs called ⁶_____ that are part of the gametophytes. Moss ⁷_____ have ⁸_____ that enable them to swim to the eggs, given a film of moisture produced by dew or raindrops. ⁹_____ the fusion of egg and sperm, produces a diploid ¹⁰_____, which remains protected in the female gametophyte. The zygote divides by mitosis and develops into the sporophyte, which consists of a ¹¹_____ attached to the gametophyte

by a slender stalk. Within the sporangium, haploid ¹² _____ are produced by the process of ¹³ _____. When these spores are mature, the sporangium opens and they scatter in the wind, to begin the cycle anew.

Exercise 4 (Module 17.6)

Web/CD Activity 17D Fern Life Cycle

Identify the stages of the fern life cycle by labeling this diagram. Include the following: **haploid phase**, **diploid phase**, **sporophyte**, **gametophyte**, **zygote**, **sporangia**, **spores**, **sperm**, **egg**, **meiosis**, **fertilization**, and **mitosis and development**. One answer is used twice. Color the haploid part of the life cycle yellow and the diploid part of the life cycle gray.



Exercise 5 (Modules 17.7 – 17.8)

Web/CD Activity 17E Pine Life Cycle

Complete the following sentences with a structure or stage in the pine life cycle. Select your answers from this list: **seed, pine tree, ovule(s), sperm, egg(s), pollen grain(s), male cone(s), female cone(s), embryo, seed coat, and zygote**. Some answers are used more than once.

1. A _____ is the diploid sporophyte generation of the pine life cycle.
2. The haploid gametophyte generation develops within the _____ and _____.
3. The small, soft _____ contain many sporangia. Meiosis occurs in the sporangia, producing many spores that develop into _____. These are male gametophytes.
4. Each scale in the larger, woody _____ bears two _____. Each of these develops as a sporangium covered by a tough integument.
5. The wind carries pollen grains to the female cones. Pollination occurs when a pollen grain lands on and enters an _____.
6. After pollination, meiosis occurs in the _____, producing a haploid spore that develops into the female gametophyte.
7. Over a period of months _____ are produced by the female gametophyte in the ovule. At the same time, the male gametophyte (the pollen grain) produces _____.
8. A tiny tube grows out of the _____, releasing a _____ to fertilize the _____.
9. A diploid fertilized egg, or _____, develops into a sporophyte _____. The whole ovule becomes a _____.
10. The _____ consists of the _____ and a food supply made from the remains of the female gametophyte, covered by a seed coat made from the ovule's integument.
11. The seed falls on the ground. When conditions are right, the seed germinates, and the embryo, over decades, grows into a _____, the adult sporophyte. It then produces cones, and the cycle begins again.

Exercise 6 (Module 17.9)

Flowers are responsible for the diversity and success of angiosperms—the flowering plants. Review the flower by matching each flower part with its function.

- | | | |
|-----------|-------|--|
| A. Petal | _____ | 1. Eggs develop in this chamber |
| B. Anther | _____ | 2. Male reproductive structure |
| C. Sepal | _____ | 3. Produces pollen |
| D. Ovary | _____ | 4. Attracts pollinators |
| E. Stamen | _____ | 5. Female structure with ovary at its base |
| F. Carpel | _____ | 6. Protects the flower before it opens |
| G. Stigma | _____ | 7. Sticky tip that traps pollen |

Exercise 9 (Modules 17.3 – 17.14)

Review your knowledge of the structure, life cycles, evolution, and uses of the major plant groups. Match each statement with a group (or groups) of plants. Some statements require more than one answer.

- | | | |
|----------------|-------|---|
| M. Mosses | _____ | 1. Flowering plants |
| F. Ferns | _____ | 2. Two types of plants that produce seeds |
| G. Gymnosperms | _____ | 3. These plants and their relatives formed coal deposits |
| A. Angiosperms | _____ | 4. The simplest vascular plants |
| | _____ | 5. Pines, firs, spruces, and cedars |
| | _____ | 6. A type of plant in which the gametophyte stage is dominant |
| | _____ | 7. Plants that produce fruits |
| | _____ | 8. Nonvascular plants |
| | _____ | 9. Two types of plants with flagellated swimming sperm |
| | _____ | 10. Conifers |
| | _____ | 11. Roses, apples, maples, and daisies |
| | _____ | 12. Plants with horizontal stems and leaves bearing sporangia |
| | _____ | 13. Plants with the shortest gametophyte and longest sporophyte stages |
| | _____ | 14. Two types of plants whose spores develop into pollen and ovules |
| | _____ | 15. The group that first developed good roots and rigid stems |
| | _____ | 16. Source of most lumber and paper |
| | _____ | 17. The simplest plants |
| | _____ | 18. Plants that produce seeds but not fruits |
| | _____ | 19. The majority of modern plants |
| | _____ | 20. Two types of plants without seeds |
| | _____ | 21. Source of most of our food |
| | _____ | 22. Many of these plants depend on animals for pollination and seed dispersal |

Exercise 10 (Module 17.14)

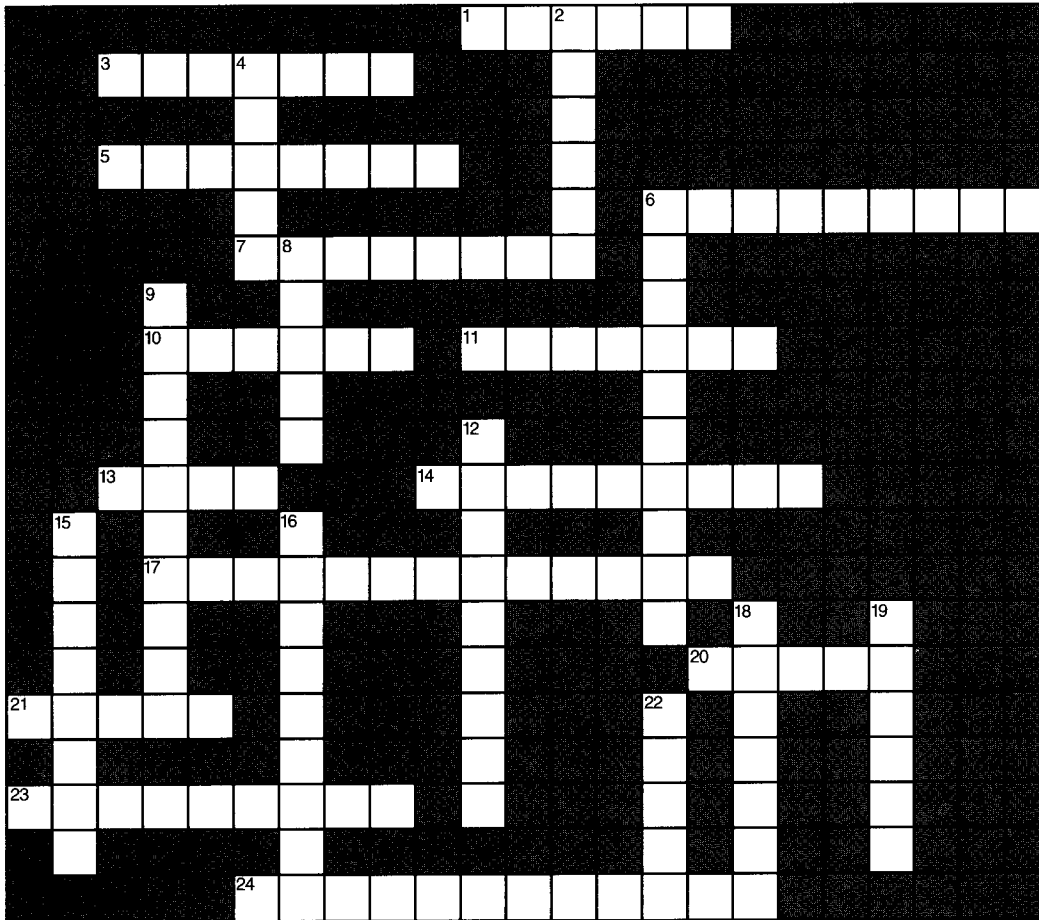
Web/CD Activity 17G *Connection: Madagascar and the Biodiversity Crisis*

This module presents some sobering statistics concerning the human threat to world plant diversity. Write in the number that completes each statement.

- About _____ million acres of forest land are cleared every year.
- About _____ percent of the world's forests are found in the tropics.
- About _____ percent of tropical forests were destroyed in the last third of the twentieth century.
- The forests of North America have shrunk by almost _____ percent over the last two centuries.
- More than _____ percent of prescription drugs are extracted from plants.
- Only about _____ plant species have been investigated as sources of medicines.
- The All Species Foundation wants to catalogue every species within the next _____ years.

Exercise 11 (Modules 17.15 – 17.20)Web/CD Activity 17H *Fungal Reproduction and Nutrition*Web/CD Activity 17I *Fungal Life Cycles*

These modules introduce fungi and describe their characteristics and importance. After reading the modules, test your knowledge of fungi by completing this crossword puzzle.

**Across**

1. A fungus consists of filaments called ____.
3. Fungi are responsible for the flavors of many ____.
5. ____ is caused by a human fungal parasite.
6. Lichens are very sensitive to air ____.
7. ____ are the most highly prized edible fungi.
10. ____ are unicellular fungi.
11. Yeasts are used in baking and ____.
13. Fungi cannot move, but they ____ rapidly.
14. The word ____ describes the relationship between fungus and algae in a lichen.
17. Fungi are ____ eukaryotes.
20. A parasitic fungus causes ____ elm disease.
21. A lichen consists of a fungus and green ____ or cyanobacteria.
23. Molds and ____ are typical fungi.
24. A mushroom is a fungal ____ structure.

Down

2. Fungi probably moved onto land at the same time as ____.
4. People have been poisoned by ____-infested grain.
6. Fungi produce ____ and other antibiotics.
8. Parasitic fungi called smuts and ____ attack crops.
9. A root and fungus can form a ____, a mutually beneficial partnership.
12. A mycorrhizal fungus helps a plant obtain ____.
15. A network of fungal hyphae make up a ____.
16. Some fungi are parasites, some are mutualists, and some ____ organic matter.
18. Fungi digest their food ____ their bodies.
19. Fungal cell walls are made of ____.
22. Fungi are classified in their own kingdom—Kingdom ____.

Exercise 12 (Module 17.17)Web/CD Activity 171 *Fungal Life Cycles*

Fill in the blanks to complete this paragraph about the fungus life cycle.

The life cycle of a fungus consists of ¹ _____ distinct phases. Under suitable conditions, haploid ² _____ germinate and produce long filaments called ³ _____. These strands make up a network called a ⁴ _____. The haploid mycelium grows through the substrate, secreting enzymes, digesting organic matter, and absorbing nutrient molecules. There are different kinds of mycelia, called ⁵ _____. If compatible mating types come into contact, their hyphae fuse, and the hybrid hyphae form their own mycelium. The ⁶ _____ within these hybrids do not fuse, however. This begins the ⁷ _____ phase of the fungus life cycle. Each cell in this mycelium contains two genetically distinct nuclei. Eventually, the dikaryotic mycelium forms a ⁸ _____—the familiar mushroom. Under the mushroom's cap, haploid nuclei finally fuse, forming ⁹ _____ cells. Without undergoing mitosis, each of these cells undergoes ¹⁰ _____, forming haploid spores. These spores, produced by the billions, are dispersed by wind, water, and animals to places where they can germinate and grow into new hyphae.

Testing Your Knowledge**Multiple Choice**

- Which of the following is *not* a difference between algae and plants?
 - Plant cells have rigid cellulose walls, and algae cells do not.
 - Plant zygotes and embryos are protected in moist chambers, and those of algae are not.
 - Algae lack discrete organs—leaves, stems, roots—characteristic of plants.
 - Plants have xylem and phloem, and algae do not.
 - Plants have a waxy, waterproof cuticle, and algae do not.
- Bryophytes such as mosses differ from all other plants in that most bryophytes
 - do not produce flowers.
 - have cones but no seeds.
 - have flagellated sperm.
 - lack vascular tissues.
 - produce spores.
- The gametophyte stage of the plant life cycle is most conspicuous in
 - ferns.
 - mosses.
 - angiosperms.
 - gymnosperms.
 - seed plants.
- Ferns and mosses are mostly limited to moist environments because
 - their pollen is carried by water.
 - they lack a cuticle and stomata.
 - they lack vascular tissues.
 - they have swimming sperm.
 - their seeds do not store much water.
- The diploid generation of the plant life cycle always
 - produces spores.
 - is called the gametophyte.
 - is larger and more conspicuous than the haploid stage.
 - develops from a spore.
 - produces eggs and sperm.
- During the Carboniferous period, forests consisting mainly of _____ produced vast quantities of organic matter, which was buried and later turned into coal.
 - early angiosperms
 - ferns and other seedless plants
 - giant mosses
 - gymnosperms
 - gymnosperms and early angiosperms

7. Which of the following best describes how fertilization occurs in a conifer?
 - a. A sperm cell swims through a film of moisture to fertilize the egg.
 - b. A pollen grain carried by wind fertilizes the egg.
 - c. A pollen grain carried by wind produces a sperm that fertilizes the egg.
 - d. A sperm cell carried by wind fertilizes the egg.
 - e. A pollen grain swims through a film of moisture to fertilize the egg.
8. Most species of plants are
 - a. non-seed-bearing plants.
 - b. angiosperms.
 - c. gymnosperms.
 - d. plants other than angiosperms.
 - e. nonvascular plants.
9. When you look at a pine or maple tree, the plant you see is
 - a. a haploid sporophyte.
 - b. a diploid sporophyte.
 - c. a haploid gametophyte.
 - d. a diploid gametophyte.
 - e. none of the above.
10. In a flowering plant, meiosis occurs in the _____, producing a spore that develops into a female gametophyte.
 - a. fruit
 - b. seed
 - c. stamen
 - d. anther
 - e. ovary
11. A fruit is a ripened
 - a. seed.
 - b. pollen grain.
 - c. bud.
 - d. ovary.
 - e. anther.
12. Fungi cannot make their own food, and they cannot move. How do they "find" things to eat?
 - a. They produce huge numbers of tiny spores.
 - b. They grow rapidly.
 - c. They poison anything nearby.
 - d. They do all of the above.
 - e. They do a and b only.
13. The body of a fungus consists of threadlike _____, which form a network called a _____.
 - a. mycelia . . . dikaryon
 - b. hyphae . . . gametophyte
 - c. mycelia . . . hypha
 - d. hyphae . . . mycelium
 - e. sporangia . . . dikaryon
14. Where and when does fertilization occur in the mushroom life cycle?
 - a. underground, as a mycelium begins to spread
 - b. on the surface of the ground, when a spore germinates
 - c. in a mushroom, when nuclei of a dikaryotic cell fuse
 - d. underground, when hyphae of different mating types fuse
 - e. in a mushroom, when eggs and sperm meet
15. Which of the following kinds of fungi would be considered the least useful or beneficial?
 - a. mycorrhizal fungus
 - b. yeast
 - c. rust
 - d. truffle
 - e. decomposer

Essay

1. Compare a plant with a multicellular green alga, paying particular attention to plant adaptations to life on land.
2. Most nonbiologists consider seaweeds and fungi to be plants. Why? Why are seaweeds, fungi, and plants placed in separate kingdoms?
3. What are the seed plants? What adaptations have made them so successful?
4. What kinds of products do we obtain from forests? What kinds of trees supply most of our forest product needs? How can we obtain the forest products we need and still preserve our forests?
5. Sketch a flower, name its major parts, and describe their functions.
6. How do animals assist in angiosperm reproduction? How have the structures of angiosperms adapted to reflect this relationship with animals?
7. How do fungi obtain their food?
8. What two components make up a lichen? What are their roles?

Applying Your Knowledge

Multiple Choice

- An explorer found a plant that had roots, stems, and leaves. It had no flowers but produced seeds. This plant sounds like a(n)
 - fern.
 - bryophyte.
 - angiosperm.
 - moss.
 - gymnosperm.
- Which of the following stages in the life cycle of a maple tree corresponds to the leafy, spongy plant in the moss life cycle?
 - egg and sperm
 - adult tree
 - flower
 - pollen grain and ovule
 - zygote
- Deep in the tropical rain forest, a botanist discovered an unusual plant with vascular tissues, stomata, a cuticle, flagellated sperm, conelike reproductive structures bearing seeds, and an alternation-of-generations life cycle. He was very excited about this discovery because it would be rather unusual for a plant to have both
 - a cuticle and flagellated sperm.
 - vascular tissues and alternation of generations.
 - seeds and flagellated sperm.
 - alternation of generations and seeds.
 - cones and vascular tissues.
- The pinyon pine lives in near-desert areas in western North America. This habitat is a bit unusual for gymnosperms because they
 - have a long life cycle for such harsh growing conditions.
 - possess flagellated sperm that must swim to the egg.
 - produce extremely small quantities of pollen.
 - lack vascular tissues and are unable to transport much water.
 - produce cones rather than drought-resistant seeds.
- Unlike most angiosperms, grasses are pollinated by wind. As a consequence, some "unnecessary" parts of grass flowers have almost disappeared. Which of the following parts would you expect to be most reduced in a grass flower?
 - ovaries
 - petals
 - anthers
 - carpels
 - stamens
- Fuchsia flowers are generally reddish, they hang downward, and their nectar is located deep in floral tubes. Fuchsias are typically pollinated by
 - bees.
 - flies.
 - bats.
 - butterflies.
 - birds.
- Some scum was found growing near the edge of a pond. Under a microscope, each of its cells were found to contain two nuclei. This means the scum must be
 - some kind of alga.
 - a fungus.
 - a plant gametophyte.
 - a liverwort.
 - a plant sporophyte.
- Strolling through the woods, you would be least likely to notice which of the following?
 - a moss gametophyte
 - a fern gametophyte
 - an angiosperm sporophyte
 - a fern sporophyte
 - the dikaryotic stage of a fungus
- The diploid phase of the life cycle is shortest in which of the following?
 - moss
 - angiosperm
 - fungus
 - fern
 - gymnosperm
- Which of the following is a difference between plants and fungi?
 - Plants have diploid and haploid phases.
 - Fungi have cell walls.
 - Fungi are autotrophic.
 - In fungi, zygotes undergo meiosis to produce spores.
 - Plants undergo sexual reproduction.

Essay

1. What characteristics does a fern share with the seed plants that evolved later? In what ways are ferns similar to mosses?
2. What kinds of plants are dispersed to new habitats by spores? By seeds? What are the advantages and disadvantages of each means of dispersal?
3. When his orchard was attacked by parasitic fungi, a farmer sprayed the trees with a powerful fungicide. The next season, most of the trees were free of the parasite, but they grew poorly and produced even less fruit than they had when they were infected. What might account for this change?
4. If you have ever had athlete's foot, you are probably aware that fungal infections are rather difficult to get rid of. What do you know about the structure and lifestyle of fungi that might make them particularly persistent pests?
5. Biologists give each species a Latin name, such as *Homo sapiens* for humans and *Acer macrophyllum* for the big-leaf maple. Why do you suppose this might be difficult for lichens?

Extending Your Knowledge

1. You might enjoy taking a walk through a nearby garden, park, campus, forested area, or even a backyard, and looking for examples of some of the plants and fungi, and their structures, mentioned in this chapter. For example, look for mosses (gametophytes and sporophytes), mushrooms (fruiting bodies, spores, and mycelia), ferns (sporophytes, sporangia, and spores), conifers (male and female cones, pollen, and seeds), and angiosperms (flowers and their parts, pollen, seeds, and fruits).
2. Are there any rare or endangered species of plants in your area? The Nature Conservancy buys property to set aside as preserves for endangered species. Your state probably has a native plant society concerned with preserving native plants and their habitats. If you would like to learn more about plant conservation or see some of these plants, you can contact local or state offices of these organizations. Find the Nature Conservancy on the Web at www.nature.org.