Plants, Fungi, and the Colonization of Land 17

Focus on the Concepts

The colonization of land by plants was a major event in the history of life. Even the earliest plants were accompanied by fungi, and the destinies of plants and fungi continue to be intertwined. In studying this chapter, focus on these concepts:

- Plants are eukaryotic multicellular autotrophs that evolved from green algae. A set of derived characters sets plants apart from algae: Alternation of haploid and diploid generations, walled spores produced in sporangia, male and female gametangia, and multicellular, dependent embryos. Plants produce nearly all food for life on land and many important products for humans.
- Many plant characteristics are adaptations to life on land. Most plants have a waxy cuticle that prevents water loss. Gas exchange occurs through pores called stomata. Aboveground, leaves capture gases and sunlight. Belowground, roots absorb water and minerals. These structures are connected by rigid stems with vascular tissues that support the plant. Leaves and roots develop from apical meristems. Plant gametes and embryos are protected in gametangia. All plants produce spores, which some plants use for dispersal. Other plants disperse seeds.
- Plant evolution occurred in four major stages: (1) After plants split from algae, early diversification led to seedless nonvascular plants, such as mosses, lacking vascular tissues and true roots, stems, and leaves. (2) Vascular plants such as ferns came next. They have well-developed roots, rigid stems, and leaves, with vascular tissues. (3) Vascular plants with seeds were the next big step. In gymnosperms—conifers and their relatives—male gametophytes are protected in pollen grains and embryos are protected and dispersed by seeds. (4) Most modern plants are angiosperms—flowering plants. Flowers facilitate pollination, and seeds are protected and dispersed by fruits.
- Haploid and diploid generations alternate in plant life cycles. Haploid gametophytes produce eggs and sperm. Fertilized eggs develop into diploid sporophytes, which produce spores, which develop into gametophytes. In mosses the gametophyte is dominant. The sporophyte is dominant in ferns. Both mosses and ferns have swimming sperm and are dispersed by spores. Gymnosperms and angiosperms are seed plants. In cones or flowers on the sporophyte, spores develop into gametophytes called ovules and pollen grains. Pollen delivers sperm. Embryos develop in cones or flowers and are dispersed in seeds. Angiosperm seeds are enclosed in fruits.

- Fungi are heterotrophic eukaryotes that digest food outside their bodies and absorb the nutrient molecules. A fungus consists of threadlike hyphae with chitin cell walls that form a feeding network called a mycelium. Fungi spread as spores and grow rapidly through their food. They are found nearly everywhere and are important decomposers. Parasitic fungi cause most plant diseases, and a few are human parasites. Some fungi produce food and antibiotics. Most plants have beneficial mycorrhizal fungi associated with their roots.
- Most fungi reproduce sexually via a three-phase life cycle: Spores germinate and haploid hyphae develop. When mycelia of different mating types meet, hyphae fuse but their nuclei do not, producing heterokaryotic cells with two haploid nuclei. Later, the hertokaryotic mycelium forms a reproductive structure, such as a mushroom. In certain cells, nuclei fuse, producing a diploid cells that immediately undergo meiosis, producing spores. There are five groups of fungi, classified on the basis of sexual reproductive structures.
- Many fungi typically reproduce asexually. A mold is any rapidly growing fungus that produces spores asexually. A yeast is any single-celled fungus that reproduces by fission or budding.

Review the Concepts

Work through the following exercises to review the concepts in this chapter. For additional review, check out the activities at www.mybiology.com. The website offers a pre-test that will help you plan your studies.

Exercise 1 (Module 17.1)

Structural, biochemical, and genetic evidence suggests that plants and green algae called charophytes probably evolved from a common algal ancestor. Land plants make up a clade with a set of derived characters that set them apart from algae. Most of these characters are adaptations to life on land. Complete the chart below by listing the major problems plants have to contend with and the adaptations that set plants apart from green algae. (Use a pine tree or rose bush as your plant example; in some ways simple plants such as mosses are "in between" algae and plants.) Also, note (*) which plant characteristics are the shared derived characters of the plant clade.

Differences Between Green Algae and Plants

Green algae	*Pine tree or rose bush*
1. Surrounded by water, unlikely to dry out	1.
2. Exchange gases through body surface	2.
3. Obtain water, gases, nutrients all from one location	3.
4. Floats in water	4.
5. Gamete-producing cells exposed to water	5.
6. Sperm swim and eggs fertilized in water	6.
7. Embryos develop in water	7.
8. No protected cells or embryos for dispersal	8.

Exercise 2 (Module 17.2)

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 pollen and seeds evolved. 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, liverworts, and hornworts.

____ C. The first flowering plants, or _____, appeared.

____ D. Vascular plants evolved that had roots and strong stems supported by lignin-hardened vascular tissues, unlike the _____. Their modern-day representatives are the _____ and the seed plants.

Exercise 3 (Modules 17.3–17.4)

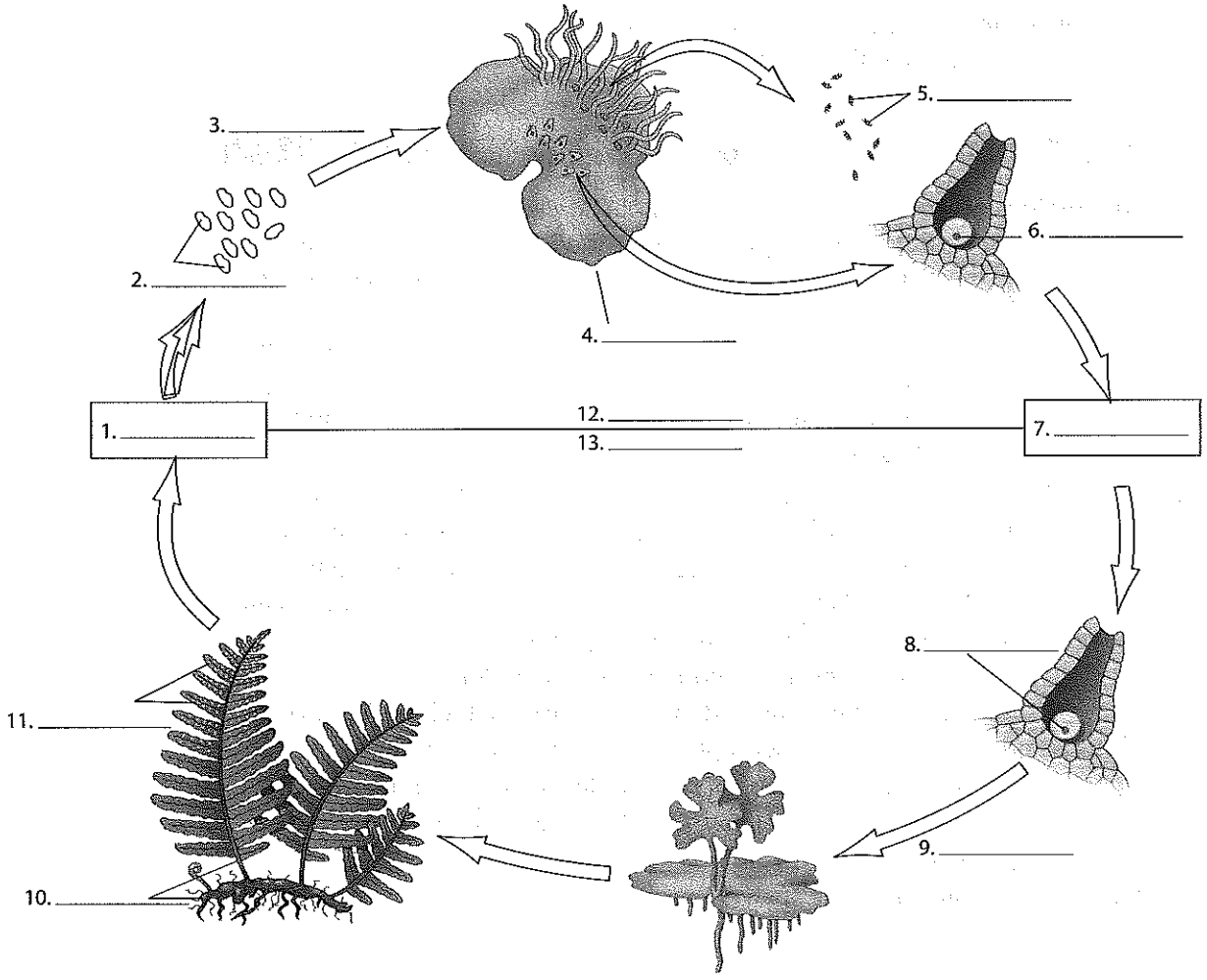
Haploid and diploid generations alternate in all plant life cycles. This is one of the defining characteristics of plants. Study the diagrams in these modules to review alternation of generations. Then fill in the blanks below to complete the description of the moss life cycle.

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, beginning the cycle anew.

Exercise 4 (Modules 17.5–17.6)

Ferns and lycophytes have vascular tissues, but do not produce seeds; they are often called "seedless vascular plants."

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 blue.



Exercise 5 (Module 17.7)

In seed plants, a specialized structure within the sporophyte houses all reproductive stages—spores, eggs, sperm, zygotes, and embryos. In gymnosperms such as pine trees, this special structure is the cone. Two significant plant adaptations are seen in gymnosperms—pollen and seeds. 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), pollen (male) cone(s), ovulate (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 ovulate 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 an _____.
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.

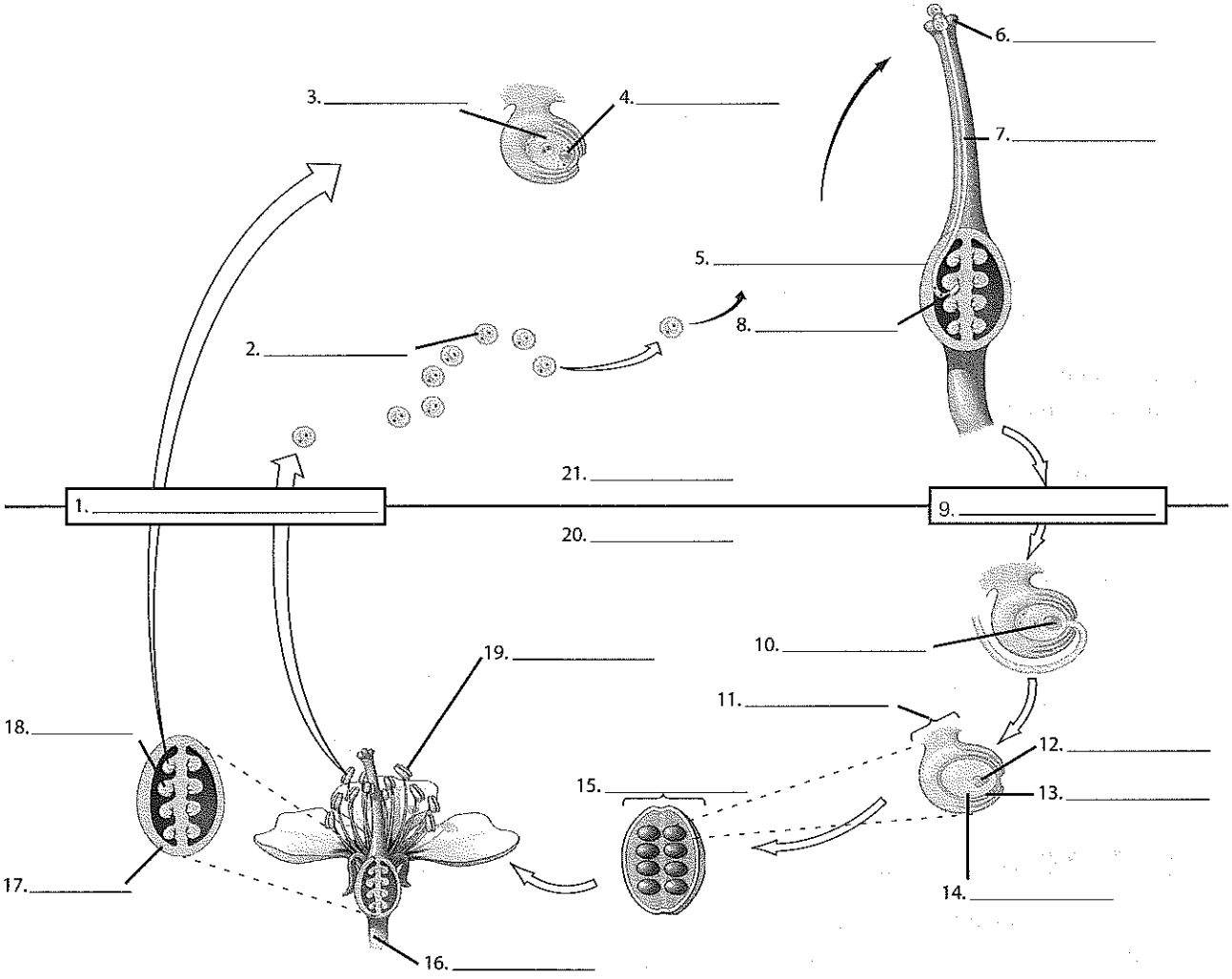
Exercise 6 (Module 17.8)

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

_____ 1. Ovules contained in this chamber	A. Petal
_____ 2. Consists of filament and anther	B. Style
_____ 3. Produces pollen	C. Sepal
_____ 4. Attracts pollinators	D. Ovary
_____ 5. Female structure with ovary at its base	E. Stamen
_____ 6. Protects the flower before it opens	F. Carpel
_____ 7. Sticky tip that traps pollen	G. Stigma
_____ 8. Stalk that supports anther	H. Filament
_____ 9. Between stigma and ovary	I. Anther

Exercise 7 (Module 17.9)

Identify the stages in the life cycle of an angiosperm—a flowering plant—by labeling the diagram below. Include **haploid phase, diploid phase, sporophyte, anther, meiosis, ovary, ovule, female gametophyte, pollen grain (male gametophyte), egg, stigma, pollen tube, sperm, zygote, seed, seed coat, fertilization, embryo, fruit, food supply,** and **pollination.** Then color the haploid part of the life cycle yellow and the diploid part blue.



Exercise 8 (Modules 17.7–17.9)

The life cycles of gymnosperms and angiosperms are similar, but angiosperms have added their own tricks of pollination and seed dispersal. Compare gymnosperms (conifers) and angiosperms in the chart below.

Characteristic	*Gymnosperms (Conifers)*	*Angiosperms*
Characteristic reproductive structures	1.	2.
Mode of pollination (wind, insects, etc.)	3.	4.
Interval between pollination and fertilization	5.	6.
Time required to produce seeds (pollination to seed dispersal)	7.	8.
Seed protection and dispersal	9.	10.

Exercise 9 (Modules 17.2–17.12)

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
F. Ferns
G. Gymnosperms
A. Angiosperms

_____ 1. Flowering plants
_____ 2. Two types of plants that produce seeds
_____ 3. These plants and their relatives formed coal deposits.
_____ 4. Represent simple 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. Plants with protected gametes and embryos
_____ 18. Plants that produce seeds but not fruits
_____ 19. Most species 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.
_____ 23. Have walled spores protected in sporangia
_____ 24. The simplest plants

Exercise 10 (Module 17.13)

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

1. More than _____ square miles of forest land are cleared every year.
2. About ____ % of the world's forests are found in the tropics.
3. About ____ % of tropical forests were destroyed in the last third of the twentieth century.
4. The forests of North America have shrunk by almost ____ % over the last two centuries.
5. More than ____ % of prescription drugs are extracted from plants.
6. Fewer than _____ of the worlds' _____ known plant species have been investigated as sources of medicines.
7. The All Species Foundation wants to catalogue every species within the next ____ years.

Exercise 11 (Modules 17.14–17.20)

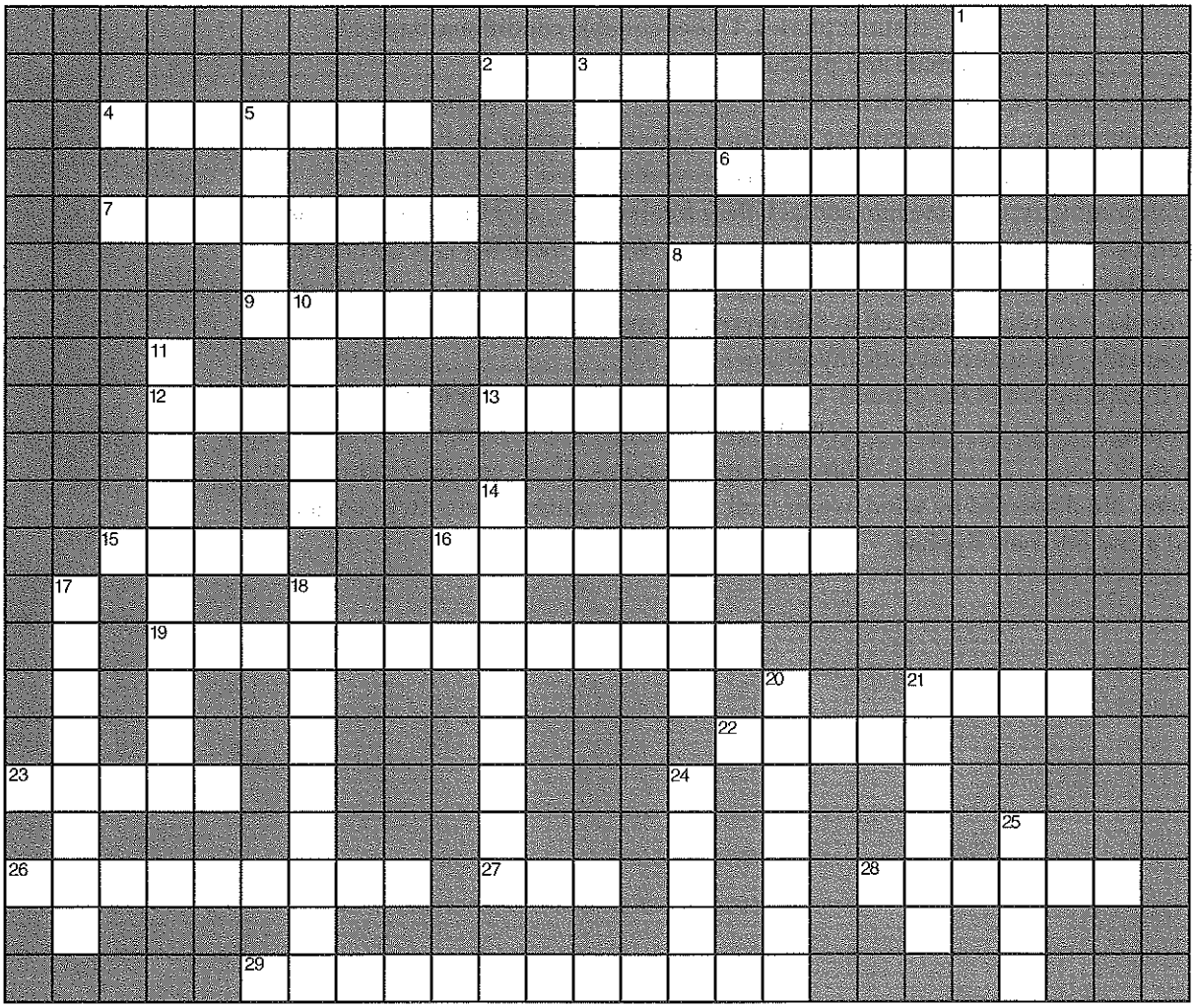
Fungi are strange beasts, but as you get to know them, they will grow on you! These modules introduce some of the structures, roles, and types of fungi. We will review the fungus life cycle in the next exercise, but for now, review fungus vocabulary by matching each fungal phrase with the correct term.

_____ 1. Disperse fungi over great distances
_____ 2. Fungal infection
_____ 3. Hard-to-classify fungi with no known sexual stages
_____ 4. Threadlike fungal filament
_____ 5. Fungi named for their clublike spore-producing structures
_____ 6. A branching feeding network of fungal hyphae
_____ 7. The material of fungal cell walls
_____ 8. A mutually helpful association between plant roots and fungus
_____ 9. Systemic mycosis that affects the lungs
_____ 10. Single-celled fungus that usually lives in liquid or moist habitats
_____ 11. Phase of fungus life cycle where cells have two nuclei
_____ 12. Mutualistic relationship between fungus and photosynthetic organisms
_____ 13. Ants (and most other animals) can't break this down, but fungi can.
_____ 14. Chemicals from this fungus used to make medicines and LSD
_____ 15. About 90% of plants have partnerships with these fungi.
_____ 16. The closest relatives of fungi
_____ 17. A fast-growing furry mycelium on bread or fruit
_____ 18. Fungal pathogen of corn
_____ 19. Their hyphae fuse to start heterokaryotic phase.
_____ 20. Aboveground reproductive structure of a sac or club fungus
_____ 21. A group of fungi that produce spores in saclike structures
_____ 22. The earliest line of fungi; they have flagellated spores
_____ 23. Fungus that attacks wheat crops
_____ 24. The scientific study of fungi
_____ 25. How fungi get their food
_____ 26. Black bread mold is one of these zygote fungi.

A. Chytrids
B. Fruiting body
C. Mycelium
D. Cellulose
E. Mycosis
F. Lichen
G. Absorption
H. Zygomycetes
I. Mating types
J. Spores
K. Ergot
L. Mycology
M. Basidiomycetes
N. Rust
O. Mold
P. Imperfect fungi
Q. Hypha
R. Ascomycetes
S. Heterokaryotic
T. Chitin
U. Yeast
V. Glomeromycetes
W. Mycorrhiza
X. Smut
Y. Animals
Z. Coccidiomycosis

Exercise 13 (Modules 17.14–17.21)

The last few modules in this chapter discuss types of fungi, their ecological roles, and their importance to humans. After reading the modules, review your knowledge of fungi by completing this crossword puzzle.



Across

2. A fungus consists of filaments called ____.
4. Fungi are responsible for the flavors of many ____.
6. A____ is a biologist who studies fungi.
7. ____ is caused by a human fungal parasite.
8. Lichens are very sensitive to air ____.
9. ____ are the most highly prized edible fungi.
12. ____ are unicellular fungi.
13. Yeasts are used in baking and ____.
15. Fungi cannot move, but they ____ rapidly.
16. The word ____ describes the relationship between fungus and algae in a lichen.
19. Unlike plants, which are autotrophic, fungi are ____ eukaryotes.
21. Common mushrooms are ____ fungi, or basidiomycetes.
22. A parasitic fungus causes ____ elm disease.
23. A lichen consists of a fungus and green ___ or cyanobacteria.
26. Molds and ____ are typical fungi.
27. Yeasts, cup fungi, and molds are ____ fungi, or ascomycetes.
28. Club fungi can break down tough ____ in wood.
29. A mushroom is a fungal ____ structure.

Down

1. Athlete's foot is a human fungal disease, or ____.
3. Mycorrhizal fungi help many ____ absorb nutrients.
5. People have been poisoned by ____-infested grain.
8. Fungi produce ____ and other antibiotics.
10. Parasitic fungi called smuts and ____ attack crops.
11. A root and fungus can form a ____, a mutually beneficial partnership.
14. A mycorrhizal fungus helps a plant obtain ____.
17. A network of fungal hyphae make up a ____.
18. Some fungi are parasites, some are mutualists, and some ____ organic matter.
20. Fungi digest their food ___ their bodies.
21. Fungal cell walls are made of ____.
24. Fungi are classified in their own kingdom—Kingdom ____.
25. Leaf-cutting ____ grow fungi for food.

Test Your Knowledge

Multiple Choice

1. Which of the following is *not* a difference between algae and plants?
   a. Plant cells have rigid cellulose walls, and algae cells do not.
   b. Plant zygotes and embryos are protected in moist chambers, and those of algae are not.
   c. Algae lack discrete organs—leaves, stems, roots—characteristic of plants.
   d. Plants have xylem and phloem, and algae do not.
   e. Plants have a waxy, waterproof cuticle, and algae do not.
2. Bryophytes (such as mosses) differ from all other plants in that most bryophytes
   a. do not produce flowers.
   b. have cones but no seeds.
   c. have flagellated sperm.
   d. lack vascular tissues.
   e. produce spores.
3. The gametophyte stage of the plant life cycle is most conspicuous in
   a. ferns.
   b. mosses.
   c. angiosperms.
   d. gymnosperms.
   e. seed plants.
4. Ferns and mosses are mostly limited to moist environments because
   a. their pollen is carried by water.
   b. they lack a cuticle and stomata.
   c. they lack vascular tissues.
   d. they have swimming sperm.
   e. their seeds do not store much water.
5. The diploid generation of the plant life cycle always
   a. produces spores.
   b. is called the gametophyte.
   c. is larger and more conspicuous than the haploid stage.
   d. develops from a spore.
   e. produces eggs and sperm.

6. During the Carboniferous period, forests consisting mainly of ____ produced vast quantities of organic matter, which was buried and later turned into coal.
   a. early angiosperms
   b. seedless vascular plants
   c. giant mosses
   d. gymnosperms
   e. 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. nonvascular plants.
   c. gymnosperms.
   d. plants other than angiosperms.
   e. angiosperms

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. How do fungi "find" things to eat?
    a. They produce huge numbers of tiny spores.
    b. They grow rapidly.
    c. They make their own food.
    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 . . . sporangium
    b. hyphae . . . gametophyte
    c. mycelia . . . hypha
    d. hyphae . . . mycelium
    e. sporangia . . . fruiting body

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 heterokaryotic 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?

Apply the Concepts

Multiple Choice

1. An explorer found a plant that had roots, stems, and leaves. It had no flowers but produced seeds. This plant sounds like a(n)
   a. fern.
   b. bryophyte.
   c. angiosperm.
   d. moss.
   e. gymnosperm.
2. Which of the following stages in the life cycle of a maple tree corresponds to the leafy, spongy plant in the moss life cycle?
   a. egg and sperm
   b. adult tree
   c. flower
   d. pollen grain and ovule
   e. zygote
3. 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 is unheard of for a plant to have both
   a. a cuticle and flagellated sperm.
   b. vascular tissues and alternation of generations.
   c. seeds and flagellated sperm.
   d. alternation of generations and seeds.
   e. cones and vascular tissues.
4. The pinyon pine lives in near-desert areas in western North America. This habitat is a bit unusual for gymnosperms because they
   a. have a long life cycle for such harsh growing conditions.
   b. possess flagellated sperm that must swim to the egg.
   c. produce extremely small quantities of pollen.
   d. lack vascular tissues and are unable to transport much water.
   e. produce cones rather than drought-resistant seeds.
5. 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?
   a. ovaries
   b. petals
   c. anthers
   d. carpels
   e. stamens
6. Fuchsia flowers are generally reddish, they hang downward, and their nectar is located deep in floral tubes. It sounds like fuchsias are typically pollinated by
   a. bees.
   b. flies.
   c. bats.
   d. butterflies.
   e. birds.
7. Some scum was found growing near the edge of a pond. Under a microscope, each of its cells was found to contain two nuclei. This means the scum must be
   a. some kind of alga.
   b. a fungus.
   c. a plant gametophyte.
   d. a liverwort.
   e. a plant sporophyte.
8. Strolling through the woods, you would be least likely to notice which of the following?
   a. a moss gametophyte
   b. a fern gametophyte
   c. an angiosperm sporophyte
   d. a fern sporophyte
   e. the heterokaryotic stage of a fungus
9. The diploid phase of the life cycle is shortest and smallest in which of the following?
   a. moss
   b. angiosperm
   c. fungus
   d. fern
   e. gymnosperm
10. Which of the following is a difference between plants and fungi?
    a. Plants have diploid and haploid phases.
    b. Fungi have cell walls.
    c. Fungi are autotrophic.
    d. In fungi, zygotes undergo meiosis to produce spores.
    e. 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?

Put Words to Work

Correctly use as many of the following words as possible when reading, talking, and writing about biology:

absorption, alternation of generations, angiosperm, anther, apical meristem, ascomycete, basidiomycete, bryophyte, carpel, club fungus, fossil fuel, fruit, Fungi, fungus (plural, *fungi*), *gametangium* (plural, *gametangia*), *gametophyte, gymnosperm, heterokaryotic stage, hypha* (plural, *hyphae*), *imperfect fungus, lichen, lignin, mold, mycelium* (plural, *mycelia*), *mycorrhiza* (plural, *mycorrhizae*), *ovary, parasite, petal, phloem, pollen, pollen grain, pollination, sac fungus, seed, seed coat, seedless vascular plants, sepal, sporangium* (plural, *sporangia*), *spore, sporophyte, stamen, vascular plant, vascular tissue, xylem , yeast, zygomycete, zygote fungus*

Use the Web

There is more on plants and fungi at www.mybiology.com.

phylogenetic tree, so they do not reflect ancestry. For example, diatoms, brown algae, and water molds are now all thought to be related. Diatoms and brown algae are photosynthetic, but water molds apparently lost their chloroplast and are more fungus-like. Thus they are related, but they don't share the same nutritional mode. But that doesn't mean that water molds are closely related to slime molds, which are related to amoebas! Euglenozoans and green algae are both green, but euglenozoans appear to be related not to green algae, but to the very simplest protists, which are not photosynthetic. Euglenozoans are green because their chloroplasts were green algae taken up by ancestors of the euglenozoans in a process of secondary endosymbiosis. Protist genealogy can be confusing!

Chapter 17

Review the Concepts

Exercise 1: 1. On dry land, plants could dry out. They are covered by a waxy cuticle that prevents water loss. 2. A Cuticle prevents drying, but can interfere with gas exchange. Gasses diffuse through pores called stomata. 3. On land, light and gases are above ground, but water and minerals in the soil. Specialized leaves obtain light from the sun and carbon dioxide from the air, while underground roots absorb water and minerals. A vascular tissue transport system connect roots and leaves via the stem. Plants also have specialized growth regions called apical meristems at the tips of stems and roots. 4. Because a plant is not buoyant in air, it must be able to support itself against the pull of gravity. Cell walls of some plant tissues are thickened and reinforced with lignin for rigidity. 5. Plant gametes are protected in male and female *gametangia. 6. Some plants have swimming sperm, but in most, sperm-producing cells are carried through the air by pollen grains. 7. In plants, eggs are fertilized and embryos *develop in and depend on protective gametangia. 8. All plant life cycles involve *alternation of a haploid generation that produces gametes with a diploid generation that produces *spores, which sometime disperse to new locations. Pines and roses have spores, but their embryos are dispersed in seeds.

Exercise 2: A. 3, gymnosperms, angiosperms B. 1, bryophytes C. 4, angiosperms D. 2, bryophytes, seedless vascular plants (club mosses and ferns)

Exercise 3: 1. sporophytes 2. haploid 3. diploid 4. gametophyte 5. gametes 6. gametangia 7. sperm 8. flagella 9. fertilization 10. zygote 11. sporangium 12. spores 13. meiosis

Exercise 4: 1. meiosis 2. spores 3. mitosis and development 4. gametophyte 5. sperm 6. egg 7. fertilization 8. zygote 9. mitosis and development 10. sporophyte 11. sporangia 12. haploid phase 13. diploid phase

Exercise 5: 1. pine tree 2. pollen cones, ovulate cones 3. pollen cones, pollen grains 4. ovulate cones, ovules 5. ovule 6. ovule 7. eggs, sperm 8. pollen grain, sperm, egg 9. zygote, embryo, seed 10. seed, embryo 11. pine tree

Exercise 6: 1. D 2. E 3. I 4. A 5. F 6. C 7. G 8. H 9. B

Exercise 7: 1. meiosis 2. pollen grain (male gametophyte) 3. female gametophyte 4. egg 5. pollination 6. stigma 7. pollen tube 8. sperm 9. fertilization 10. zygote 11. seed 12. embryo 13. seed coat 14. food supply 15. fruit 16. sporophyte 17. ovary 18. ovule 19. anther 20. diploid phase 21. haploid phase

Exercise 8: 1. cones 2. flowers 3. wind 4. insects, and so on 5. a year or more 6. 12 hours or so 7. more than a year 8. days or weeks 9. seeds unprotected 10. seeds protected and dispersed by fruit

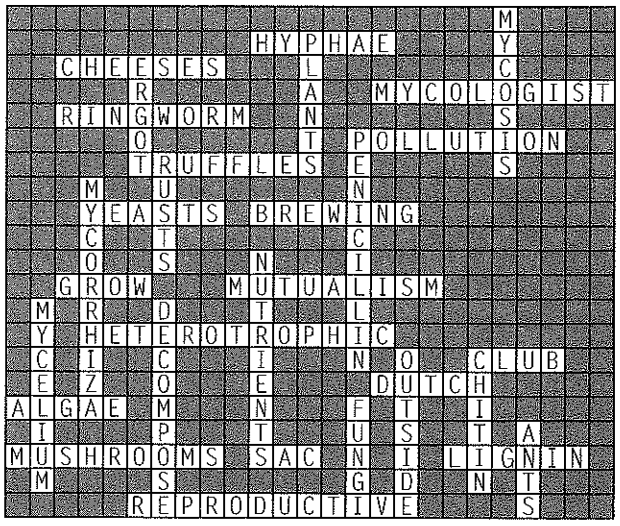
Exercise 9: 1. A 2. G, A 3. F 4. F 5. G 6. M 7. A 8. M 9. M, F 10. G 11. A 12. F 13. A 14. G, A 15. F 16. G 17. M, F, G, A 18. G 19. A 20. M, F 21. A 22. A 23. M, F, G, A 24. M

Exercise 10: 1. 50,000 2. 50 3. 20 4. 40 5. 25 6. 5,000, 290,000 7. 25

Exercise 11: 1. J 2. E 3. P 4. Q 5. M 6. C 7. T 8. W 9. Z 10. U 11. S 12. F 13. D 14. K 15. V 16. Y 17. O 18. X 19. I 20. B 21. R 22. A 23. N 24. L 25. G 26. H

Exercise 12: 1. three 2. spores 3. hyphae 4. mycelium 5. mating types 6. nuclei 7. heterokaryotic 8. fruiting body 9. diploid 10. meiosis

Exercise 13:



Test Your Knowledge

Multiple Choice: 1. a 2. d 3. b 4. d 5. a 6. b 7. c 8. e 9. b 10. e 11. d 12. e 13. d 14. c 15. c

Essay: 1. Algae are supported by water, and they lack supporting tissues. The leaves and stems of plants contain rigid supporting elements. The whole body of an alga is exposed to water, light, and minerals, while only aboveground parts of the plant are exposed to light and only the roots are in contact with a reliable supply of nutrients and water. Plants have discrete organs—roots, stems, and leaves, and specialized growing regions at the tips of stems and roots—while algae do not have true organs with specialized functions. Plants have mycorrhizae, but algae do not. Plants are covered by a cuticle that prevents drying, pierced by stomata for gas exchange, but algae have no need for such a covering or stomata. Plants have vascular tissues that transport nutrients and water, but algae do not. In plants, zygotes and embryos develop within the female gametangium.

2. Many people think all are plants because they are rigid, "rooted" in one spot, and cannot move. Seaweeds lack many of the specialized interdependent tissues and organs seen in plants, such as leaves, stems, roots, and vascular tissues, and the gametes and embryos of seaweeds are unprotected. Fungi are heterotrophic, while plants and seaweeds are autotrophic—capable of making their own food via photosynthesis.

3. Gymnosperms and angiosperms—the cone-bearing and flowering plants—both produce seeds. Seed plants do not require water for fertilization. Instead of sperm that swim to the eggs, seed plants produce pollen grains that protect male gametophytes and carry them through the air to the female parts of the plant. The seed is a survival packet for the embryo—a protective coat and a food supply that enable the embryo to get a good start.

4. Gymnosperms—conifers such as pines and firs—supply most lumber for construction, wood pulp for making paper, and most other forest products. Forests are also important for wildlife habitat, watersheds, and recreation. We can reduce the cutting of forests by recycling lumber and paper, and by cutting trees no faster than they can be replanted.

5. See Figure 17.8B in the text.

6. Animals assist angiosperms by carrying pollen from anthers to carpels and by dispersing seeds. Flowers produce nectar and pollen, which are attractive to animals, and advertise their presence with showy shapes, colors, and scents. Fruits sometimes cling to the fur of animals or attract animals to eat them and thereby disperse seeds in their droppings.

7. The threadlike hyphae of fungi grow through their food and secrete enzymes that digest the food outside their bodies. The fungal cells then absorb the digested nutrient molecules through their cell membranes.

8. A lichen consists of a fungus growing in a mutualistic relationship with green algae or cyanobacteria. Their exact roles are not completely understood, but it is known that the fungus receives food from the algae or cyanobacteria, and the photosynthetic cells receive protection, water, and certain minerals from the fungus.

Apply the Concepts

Multiple Choice: 1. e 2. d 3. c 4. a 5. b 6. e 7. b 8. b 9. c 10. d

Essay: 1. Like seed plants, ferns have true roots, stems, and leaves; vascular tissues that transport water and nutrients; and a life cycle in which the sporophyte stage predominates. Like mosses, ferns have flagellated sperm that swim to the egg.

2. Mosses and ferns are dispersed in the form of spores. Gymnosperms and angiosperms are dispersed in the form of seeds. Spores are very small and can be carried by the wind for long distances, but they are relatively vulnerable and short-lived. Seeds are bigger and cannot travel as far as fast (at least without help from animals), but they are protected by a seed coat and carry their own food supply that the embryo can draw on for a good start.

3. What probably happened is that the farmer killed beneficial mycorrhizal fungi along with the harmful parasites. Without the help of the mycorrhizae, the trees are not able to absorb water and soil minerals effectively.

4. Fungi can actually grow into other cells, where they are protected. They grow very rapidly, which enables them to come back quickly if not completely killed off. (Also, since they are eukaryotes, their metabolism is more like our own cells than is the metabolism of pathogenic bacteria. This makes them harder to kill than bacteria, because chemicals that injure fungi might injure human cells as well.)

5. Naming a lichen is tricky because the lichen consists of two organisms—a fungus and an alga or cyanobacterium. Does the lichen get one name or two?

Chapter 18

Review the Concepts

Exercise 1: The black line goes between prokaryotes and protists; prokaryotes have simple cells