

21-1 The Kingdom Fungi

In spring, if you know where to look, you can find one of the most prized of all foods—the common morel—growing wild in woodlands throughout the United States. Its ridged cap is often camouflaged by dead leaves that collect in abandoned orchards or underneath old oaks or tulip poplars. Some morels grow alone, but others grow in groups. They appear suddenly, often overnight, and live for only a few days. What are these mysterious organisms? How do they grow so quickly?

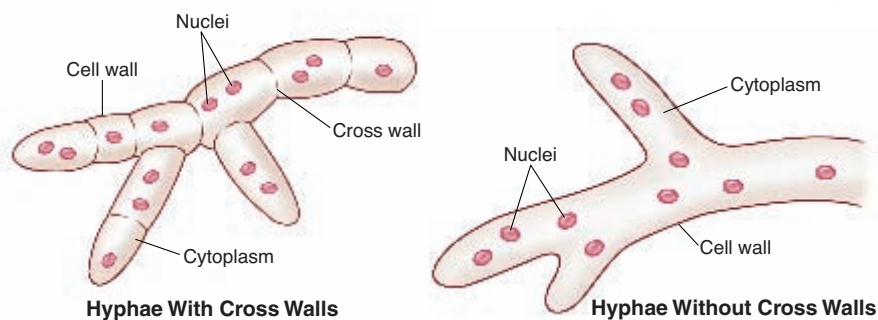
What Are Fungi?

Like mushrooms and molds, morels are fungi. The way in which many fungi grow from the ground once led scientists to classify them as nonphotosynthetic plants. But they aren't plants at all. In fact, fungi are very different from plants.

Fungi are eukaryotic heterotrophs that have cell walls. The cell walls of fungi are made up of **chitin**, a complex carbohydrate that is also found in the external skeletons of insects. Recall that heterotrophs depend on other organisms for food. Unlike animals, fungi do not ingest their food. Instead, they digest food outside of their bodies and then absorb it. Many fungi feed by absorbing nutrients from decaying matter in the soil. Others live as parasites, absorbing nutrients from the bodies of their hosts.

Structure and Function of Fungi

Except for yeasts, all fungi are multicellular. Multicellular fungi are composed of thin filaments called **hyphae** (HY-fee; singular: hypha). Each hypha is only one cell thick. In some fungi, cross walls divide the hyphae into cells containing one or two nuclei, as shown in **Figure 21-1**. In the cross walls, there are tiny openings through which the cytoplasm and nuclei can move. Other hyphae lack cross walls and contain many nuclei.



Guide for Reading

Key Concepts

- What are the defining characteristics of fungi?
- What is the internal structure of a fungus?
- How do fungi reproduce?

Vocabulary

chitin
hypha
mycelium
fruiting body
sporangium
sporangiophore

Reading Strategy: Asking Questions

Before you read, preview **Figures 21-1** and **21-2**. Make a list of questions you have about the structure of fungi. As you read, look for answers to your questions.

Figure 21-1 Fungi are eukaryotes that have cell walls made of chitin. Most fungi are made up of filaments called hyphae. In some fungi, the hyphae are divided by cross walls. In other fungi, the hyphae lack cross walls and contain many nuclei.

Section 21-1

1 FOCUS

Objectives

- 21.1.1 Identify** the defining characteristics of fungi.
- 21.1.2 Describe** the main structures of a fungus.
- 21.1.3 Explain** how fungi reproduce.

Guide for Reading

Vocabulary Preview

Ask volunteers to pronounce each Vocabulary word. Correct any mispronunciations. Survey students for their ideas of what the words mean.

Reading Strategy

Have students copy the Key Concepts into their notebooks. As they read the section, have students write supporting details for each Key Concept.

2 INSTRUCT

What Are Fungi?

Build Science Skills

Comparing and Contrasting

Have students make a compare/contrast table that compares characteristics of bacteria, protists, fungi, plants, and animals. Column headings should include *Prokaryotes/Eukaryotes*, *Autotrophs/Heterotrophs*, and *Method of Obtaining Nutrition*. To complete this table, students can draw on the knowledge gained from previous chapters in this unit, as well as on their common knowledge about plants and animals. **L2**

Structure and Function of Fungi

Build Science Skills

Using Analogies Explain that a filament is a thin, flexible, threadlike object. Then, show students a ball of yarn. Point out that the yarn when wrapped in a ball feels like a large, solid object. As students watch, unravel part of the ball. Explain that fungal hyphae are like the yarn—they can aggregate into a large object or they can be thin threads underground. **L2**



SECTION RESOURCES

Print:

- **Teaching Resources**, Lesson Plan 21-1, Adapted Section Summary 21-1, Adapted Worksheets 21-1, Section Summary 21-1, Worksheets 21-1, Section Review 21-1
- **Reading and Study Workbook A**, Section 21-1
- **Adapted Reading and Study Workbook B**, Section 21-1

Technology:

- **iText**, Section 21-1
- **Transparencies Plus**, Section 21-1

21-1 (continued)

Use Visuals

Figure 21-2 Point out that fungi have a great variety of shapes and sizes, and the fungus illustrated here is only a representative that is helpful as an introduction to fungus structure. Ask: **What is the function of the mushroom you see above-ground?** (*The mushroom, or fruiting body, is the reproductive structure of the fungus.*) **What are both the mushroom and the mycelium made of?** (*Tiny filaments called hyphae*) **What are the cell walls of these hyphae made of?** (*Chitin, a complex carbohydrate*) **L1 L2**

Build Science Skills

Inferring Have students recall that in Chapter 10 they learned about cell size and ratio of surface area to volume. Ask: **As cell volume increases, what happens to the ratio of surface area to volume?** (*It decreases.*) **Why is such a decrease a disadvantage to a cell?** (*With a smaller ratio, it becomes more difficult for a cell to bring materials into the cell and send waste materials out.*) **With this concept in mind, how does the structure of the mycelium correlate with its function for the organism?** (*The structure of the mycelium provides a large ratio of surface area to volume for the organism's cells. This large ratio correlates with the structure's function, which is absorbing nutrients from decaying matter in the soil or from the body of the host.*) **L2 L3**

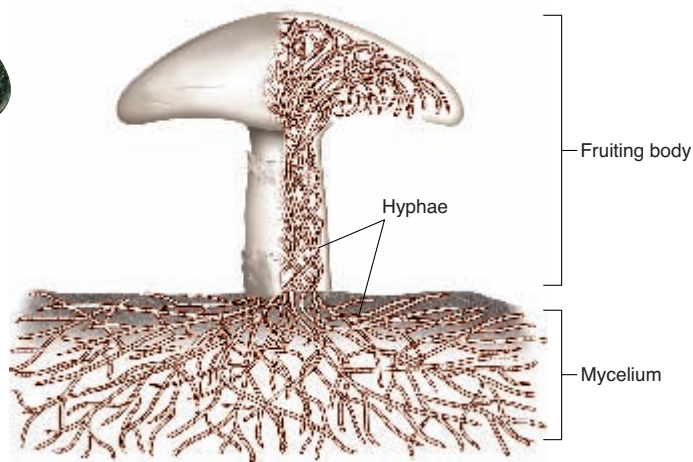
Reproduction in Fungi

Build Science Skills

Designing Experiments Ask students to investigate what causes an organism to reproduce either sexually or asexually. Students should discover that in some organisms, asexual reproduction occurs when conditions are stable and favorable to growth. Sexual reproduction, by contrast, occurs when environmental conditions are changing. Once students have researched the topic, have them collaborate in designing an experiment that tests what conditions would cause a fungus to reproduce sexually. **L3**



Figure 21-2 🌱 The body of a mushroom is part of a mycelium formed from many tangled hyphae. The major portion of the mycelium grows below ground. The visible portion of the mycelium is the reproductive structure, or fruiting body, of the mushroom.



Fungus Structure **Figure 21-2** shows the structure of a multicellular fungus. 🌱 **The bodies of multicellular fungi are composed of many hyphae tangled together into a thick mass called a mycelium.** The **mycelium** (my-SEE-lee-um; plural: mycelia) is well suited to absorb food because it permits a large surface area to come in contact with the food source through which it grows.

What you recognize as a mushroom is actually the fruiting body of a fungus. A **fruiting body** is a reproductive structure growing from the mycelium in the soil beneath it. Clusters of mushrooms are often part of the same mycelium, which means that they are part of the same organism.

Fairy Rings Some mycelia can live for many years. As time goes by, soil nutrients near the center of the mycelium become depleted. As a result, new mushrooms sprout only at the edges of the mycelium, producing a ring like the one in **Figure 21-3**. People once thought fairies dancing in circles during warm nights produced these rings, so they were called “fairy rings.” Over many years, fairy rings can become enormous—from 10 to 30 meters in diameter.

Reproduction in Fungi

🌱 **Most fungi reproduce both asexually and sexually.** Asexual reproduction takes place when cells or hyphae break off from a fungus and begin to grow on their own. Some fungi also produce spores, which can scatter and grow into new organisms. Recall that a spore is a reproductive cell that is capable of growing into a new organism by mitosis alone. In some fungi, spores are produced in structures called **sporangia** (soph-RAN-jee-uh; singular: sporangium). Sporangia are found at the tips of specialized hyphae called **sporangiophores** (soph-RAN-jee-oh-fawrfz).

▼ **Figure 21-3** This fairy ring is composed of the fruiting bodies of mushrooms that developed at the outer edges of a single mycelium. **Predicting** *How will the size of the fairy ring change in future years?*



SUPPORT FOR ENGLISH LANGUAGE LEARNERS

Vocabulary: Link to Visual

Beginning Use Figure 21-2 to help students visualize the Vocabulary terms *fruiting body*, *hyphae*, and *mycelium*. After students have examined the figure, provide an unlabeled copy of the figure and a list of the three Vocabulary terms. Ask the students to label the diagram. Check the students' work, and pronounce each term for the students. Have the

students repeat the Vocabulary terms to practice pronunciation. **L1**

Intermediate Students should do the activity described for beginning students. Then, to extend the activity, have the students provide a brief definition of each term in either oral or written form. Students who need assistance in preparing definitions should be paired with a student who is proficient in English. **L2**

Sexual reproduction in fungi usually involves two different mating types. Because gametes of both mating types are about the same size, they are not called male and female. Rather, one mating type is called “+” (plus) and the other “-” (minus). When hyphae of opposite mating types meet, they start the process of sexual reproduction by fusing, bringing plus and minus nuclei together in the same cell. After a period of growth and development, these nuclei form a diploid zygote nucleus. In most fungi, the diploid zygote then enters meiosis, completing the sexual phase of its life cycle by producing haploid spores. Like the spores produced asexually, these spores are also capable of growing, by repeated rounds of mitosis, into new organisms.

How Fungi Spread

Fungal spores are found in almost every environment. This is why molds seem to spring up in any location that has the right combination of moisture and food. Many fungi produce dry, almost weightless spores, as shown in **Figure 21-4**. These spores scatter easily in the wind. On a clear day, a few liters of fresh air may contain hundreds of spores from many species of fungi.

If these spores are to germinate, they must land in a favorable environment. There must be the proper combination of temperature, moisture, and food so that the spores can grow. Even under the best of circumstances, the probability that a spore will produce a mature organism can be less than one in a billion.

Other fungi are specialized to lure animals, which disperse fungal spores over long distances. Stinkhorns smell like rotting meat, which attracts flies. When they land on the stinkhorn, the flies ingest the sticky, smelly fluid on the surface of the fungus. The spore-containing fluid will pass unharmed out of the flies’ digestive systems, depositing spores over many kilometers.



▲ **Figure 21-4** 🌱 Most fungi reproduce both sexually and asexually. One form of asexual reproduction is spore formation. Here, an earthstar puffball (*Geastrum saccatum*) that has been struck by a raindrop expels a cloud of spores.

How Fungi Spread

Build Science Skills

Observing Shake or scrape spores from the underside of a mature mushroom cap onto a sheet of paper. Invite students to observe the spores with the naked eye, and then, transfer some of the spores to slides. Have each student observe spores under a microscope. Ask: **How would you describe these spores?** (*The spores are tiny, dry structures. The shape varies with the variety of mushroom.*)

L2

3 ASSESS

Evaluate Understanding

Have volunteers explain different parts of Figure 21-2. Ask about the structures of a typical fungus, its asexual and sexual reproductive parts, and how its spores are spread.

Reteach

Have students draw and label a typical fungus, as in Figure 21-2. Students may add other drawings to their page as they learn about the main groups of fungi in the next section.

21-1 Section Assessment

1. 🌱 **Key Concept** Identify the characteristics all fungi have in common.
2. 🌱 **Key Concept** Describe the structure of the body of a typical fungus.
3. 🌱 **Key Concept** Briefly describe asexual and sexual reproduction in fungi.
4. By what means are fungal spores spread to new locations?
5. **Critical Thinking Applying Concepts** Tissue from several mushrooms gathered near the base of a tree were tested and found to be genetically identical. How might you explain this?

Writing in Science

Writing a Proposal

A house may become uninhabitable because of the presence of mold spores. Research how to detect and identify mold allergens in the home. Assume you are a contractor. Write a proposal for how you will assess this problem in preparation for a cleanup. *Hint:* Write a draft of your proposal.

Writing in Science

Advise students to look for library books or Internet sites that address allergies to molds. Students should find that identifying molds involves collecting samples and examining spores under a microscope. Eliminating molds from buildings involves washing thoroughly with antiseptic detergents. Students may also discover that heating and cooling systems would have to be disassembled and washed to eliminate mold spores.

21-1 Section Assessment

1. Fungi are eukaryotic heterotrophs that have cell walls. Fungi do not ingest food; they digest food outside their cells and absorb it.
2. The bodies of multicellular fungi are composed of many hyphae tangled together into a thick mass called a mycelium. The visible portion of the mycelium is the reproductive structure, or fruiting body.
3. Asexual reproduction takes place when cells or hyphae break off from a fungus and begin to grow on their own. Some fungi also produce asexual spores. Sexual reproduction in fungi usually involves two different mating types, which mate to form zygote nuclei.
4. Some spores are scattered by the wind and some, by animals.
5. The genetically identical mushrooms were part of the same mycelium, which means they were part of the same organism.



If your class subscribes to the iText, use it to review the Key Concepts in Section 21-1.

Answer to . . .

Figure 21-3 *The fairy ring will become larger as the mycelium grows.*