

Fungi

How are cheese, bread, and soy sauce related to fungi? A fungus can help make each of these foods.

Fungi (singular, *fungus*) are everywhere. The mushrooms on pizza are a type of fungus. The yeast used to make bread is a fungus. And if you've ever had athlete's foot, you can thank a fungus for that, too.

What You Will Learn

- Describe the characteristics of fungi.
- Distinguish between the four main groups of fungi.
- Explain how lichens affect their environment.

Vocabulary

fungus	spore
hypha	mold
mycelium	lichen

Characteristics of Fungi

Fungi are eukaryotic heterotrophs that have rigid cell walls and no chlorophyll. They are so different from other organisms that they are placed in their own kingdom. As you can see in **Figure 1**, fungi come in a variety of shapes, sizes, and colors.

Food for Fungi

Fungi are heterotrophs, but they cannot catch or surround food. Fungi must live on or near their food supply. Most fungi are consumers. These fungi get nutrients by secreting digestive juices onto a food source and then absorbing the dissolved food. Many fungi are decomposers, which feed on dead plant or animal matter. Other fungi are parasites.

Some fungi live in mutualism with other organisms. For example, many types of fungi grow on or in the roots of a plant. The plant provides nutrients to the fungus. The fungus helps the root absorb minerals and protects the plant from some disease-causing organisms. This relationship between a plant and a fungus is called a *mycorrhiza* (MIE koh RIE zuh).

READING STRATEGY

Paired Summarizing Read this section silently. In pairs, take turns summarizing the material. Stop to discuss ideas that seem confusing.

fungus an organism whose cells have nuclei, rigid cell walls, and no chlorophyll and that belongs to the kingdom Fungi

Figure 1 Fungi vary greatly in their appearance.

▼ Straight coral fungus



▲ Bird's nest fungus

▼ Witch's hat fungus



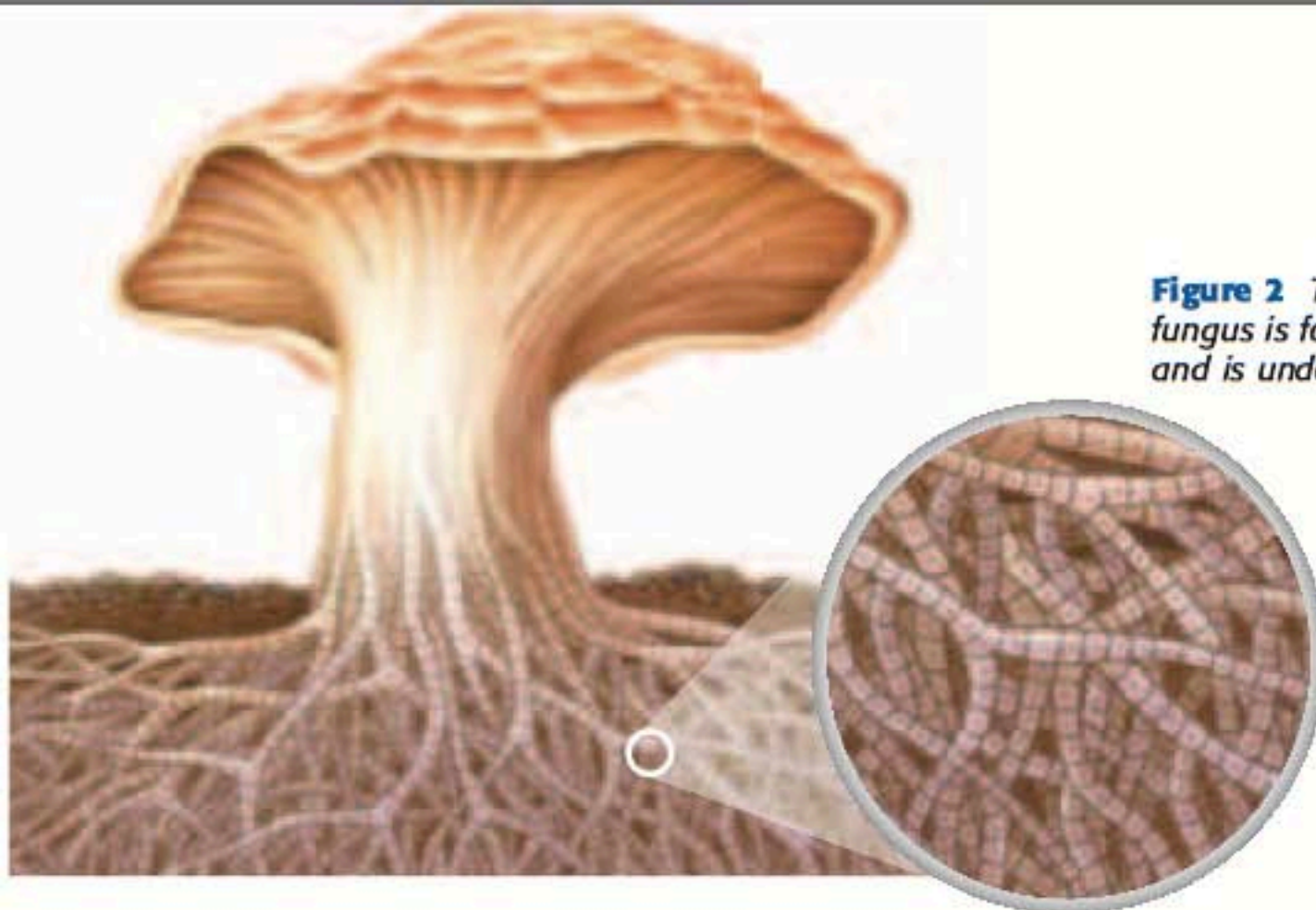


Figure 2 The mycelium of a fungus is formed by hyphae and is underground.

Hidden from View

All fungi are made of eukaryotic cells, which have nuclei. Some fungi are single celled, but most fungi are made of many cells. These many-celled fungi are made up of chains of cells called hyphae (HIE fee). **Hyphae** (singular, *hypha*) are threadlike fungal filaments. These filaments are made of cells that have openings in their cell walls. These openings allow cytoplasm to move freely between the cells.

Most of the hyphae that make up a fungus grow together to form a twisted mass called the **mycelium** (mie SEE lee uhm). The mycelium makes up the major part of the fungus. However, this mass is hidden from view underneath the ground. **Figure 2** shows the hyphae of a fungus.

Making More Fungi

Reproduction in fungi may be either asexual or sexual. Asexual reproduction in fungi occurs in two ways. In one type of asexual reproduction, the hyphae break apart, and each new piece becomes a new fungus. Asexual reproduction can also take place by the production of spores. **Spores** are small reproductive cells that are protected by a thick cell wall. Spores are light and easily spread by wind. When the growing conditions where a spore lands are right, the spore will grow into a new fungus.

Sexual reproduction in fungi happens when special structures form to make sex cells. The sex cells join to produce sexual spores that grow into a new fungus. **Figure 3** shows a fungus releasing sexual spores into the air.

✓ Reading Check What are two ways that fungi can reproduce asexually? (See the Appendix for answers to Reading Checks.)

hypha a nonreproductive filament of a fungus

mycelium the mass of fungal filaments, or hyphae, that forms the body of a fungus

spore a reproductive cell or multicellular structure that is resistant to stressful environmental conditions and that can develop into an adult without fusing with another cell



Figure 3 This puffball is releasing sexual spores that can produce new fungi.



Figure 4 Black bread mold is a soft, cottony mass that grows on bread and fruit.

mold a fungus that looks like wool or cotton

Quick Lab

Moldy Bread

1. Dampen a slice of bread with a few drops of water, and then seal it in a plastic bag for 1 week.
2. Draw a picture of the bread in the plastic bag.
3. Predict what you think will happen during the week. Will the bread get moldy?
4. After the week has passed, check on the bread in the plastic bag. Compare it with your original drawing. What happened? Were your predictions correct?
5. With a partner, discuss where you think mold spores come from and how they grow.

Kinds of Fungi

Fungi are classified based on their shape and the way that they reproduce. There are four main groups of fungi. Most species of fungi fit into one of these groups. These groups are threadlike fungi, sac fungi, club fungi, and imperfect fungi.

Threadlike Fungi

Have you ever seen fuzzy mold growing on bread? A **mold** is a shapeless, fuzzy fungus. **Figure 4** shows a black bread mold. This particular mold belongs to a group of fungi called *threadlike fungi*. Most of the fungi in this group live in the soil and are decomposers. However, some threadlike fungi are parasites.

Threadlike fungi can reproduce asexually. Parts of the hyphae grow into the air and form round spore cases at the tips. These spore cases are called *sporangia* (spoh RAN jee uh). **Figure 5** shows some magnified sporangia. When the sporangia break open, many tiny spores are released into the air. New fungi will develop from these spores if they land in an area with good growing conditions.

Threadlike fungi can also reproduce sexually. Threadlike fungi reproduce sexually when a hypha from one individual joins with a hypha from another individual. The hyphae grow into specialized sporangia that can survive times of cold or little water. When conditions improve, these specialized sporangia release spores that can grow into new fungi.

✓ Reading Check Describe two ways that threadlike fungi can reproduce.

Figure 5 Each of the round sporangia contains thousands of spores.





Figure 6 Morels are only part of a larger fungus. They are the sexual reproductive part of a fungus that lives under the soil.

Sac Fungi

Sac fungi are the largest group of fungi. Sac fungi include yeasts, powdery mildews, truffles, and morels. Some morels are shown in **Figure 6**.

Sac fungi can reproduce both asexually and sexually during their life cycles. Most of the time, they use asexual reproduction. When they reproduce sexually, they form a sac called an *ascus*. This sac gives the sac fungi their name. Sexually produced spores develop within the ascus.

Most sac fungi are made of many cells. However, *yeasts* are single-celled sac fungi. When yeasts reproduce asexually, they use a process called *budding*. In budding, a new cell pinches off from an existing cell. **Figure 7** shows a yeast that is budding. Yeasts are the only fungi that reproduce by budding.

Some sac fungi are very useful to humans. For example, yeasts are used in making bread and alcohol. Yeasts use sugar as food and produce carbon dioxide gas and alcohol as waste. Trapped bubbles of carbon dioxide cause bread dough to rise. This process is what makes bread light and fluffy. Other sac fungi are sources of antibiotics and vitamins. And some sac fungi, such as truffles and morels, are prized as human foods.

Not all sac fungi are helpful. In fact, many sac fungi are parasites. Some cause plant diseases, such as chestnut blight and Dutch elm disease. The effects of Dutch elm disease are shown in **Figure 8**.

Figure 8 Dutch elm disease is a fungal disease that has killed millions of elm trees.



Figure 7 Yeasts reproduce by budding. A round scar forms where a bud breaks off from a parent cell.

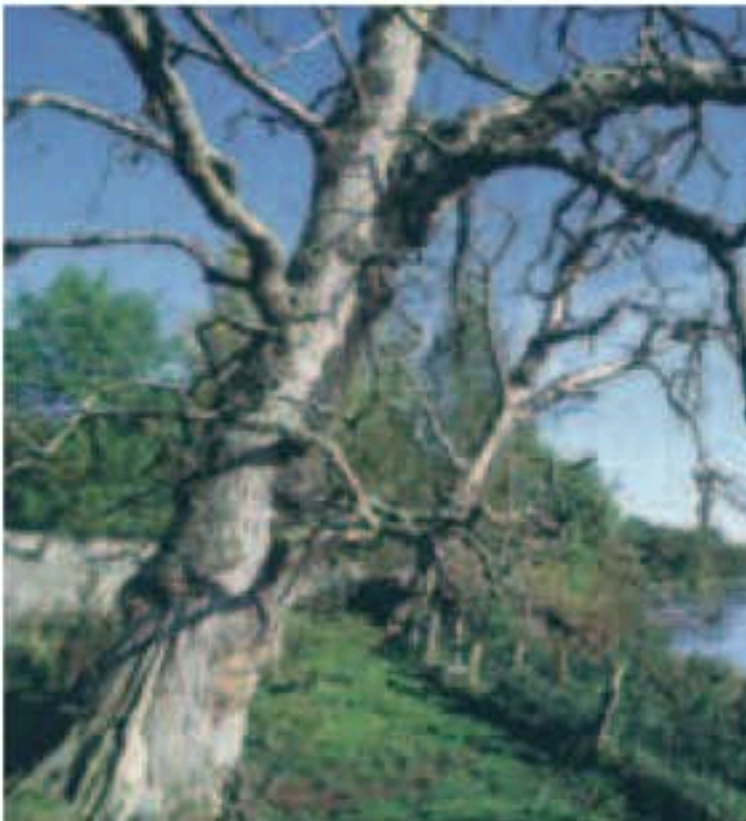




Figure 9 A ring of mushrooms can appear overnight. In European folk legends, these were known as “fairy rings.”

Quick Lab

Observe a Mushroom

1. Identify the stalk, cap, and gills on a **mushroom** that your teacher has provided.
2. Carefully twist or cut off the cap, and cut it open with a **plastic knife**. Use a **magnifying lens** to observe the gills. Look for spores.
3. Use the magnifying lens to observe the other parts of the mushroom. The mycelium begins at the bottom of the stalk. Try to find individual hyphae.
4. Sketch the mushroom, and label the parts.

Club Fungi

The umbrella-shaped mushrooms are the most familiar fungi. Mushrooms belong to a group of fungi called *club fungi*. This group gets its name from structures that the fungi grow during reproduction. Club fungi reproduce sexually. During reproduction, they grow special hyphae that form clublike structures. These structures are called *basidia* (buh SID ee uh), the Greek word for “clubs.” Sexual spores develop on the basidia.

When you think of a mushroom, you probably picture only the spore-producing, above-ground part of the organism. But most of the organism is underground. The mass of hyphae from which mushrooms are produced may grow 35 m across. That’s about as long as 18 adults lying head to toe! Mushrooms usually grow at the edges of the mass of hyphae. As a result, mushrooms often appear in circles, as shown in **Figure 9**.

The most familiar mushrooms are known as *gill fungi*. The basidia of these mushrooms develop in structures called *gills*, under the mushroom cap. Some varieties are grown commercially and sold in supermarkets. However, not all gill fungi are edible. For example, the white destroying angel is a very poisonous fungus. Simply a taste of this mushroom can be fatal. See if you can pick out the poisonous fungus in **Figure 10**.

✓ Reading Check What part of a club fungus grows above the ground?



Figure 10 Many poisonous mushrooms look just like edible ones. Never eat a mushroom from the wild unless a professional identifies it in person.



Figure 11 Bracket fungi look like shelves on trees. The underside of the bracket contains spores.

Nonmushroom Club Fungi

Mushrooms are not the only club fungi. Bracket fungi, puffballs, smuts, and rusts are also club fungi. Bracket fungi grow outward from wood and form small shelves or brackets, as shown in **Figure 11**. Smuts and rusts are common plant parasites. They often attack crops such as corn and wheat. The corn in **Figure 12** has been infected with a smut.

Imperfect Fungi

The *imperfect fungi* group includes all of the species of fungi that do not quite fit in the other groups. These fungi do not reproduce sexually. Most are parasites that cause diseases in plants and animals. One common human disease caused by these fungi is athlete's foot, a skin disease. Another fungus from this group produces a poison called *aflatoxin* (AF luh TAHKS in), which can cause cancer.

Some imperfect fungi are useful. *Penicillium*, shown in **Figure 13**, is the source of the antibiotic penicillin. Other imperfect fungi are also used to produce medicines. Some imperfect fungi are used to produce cheeses, soy sauce, and the citric acid used in cola drinks.



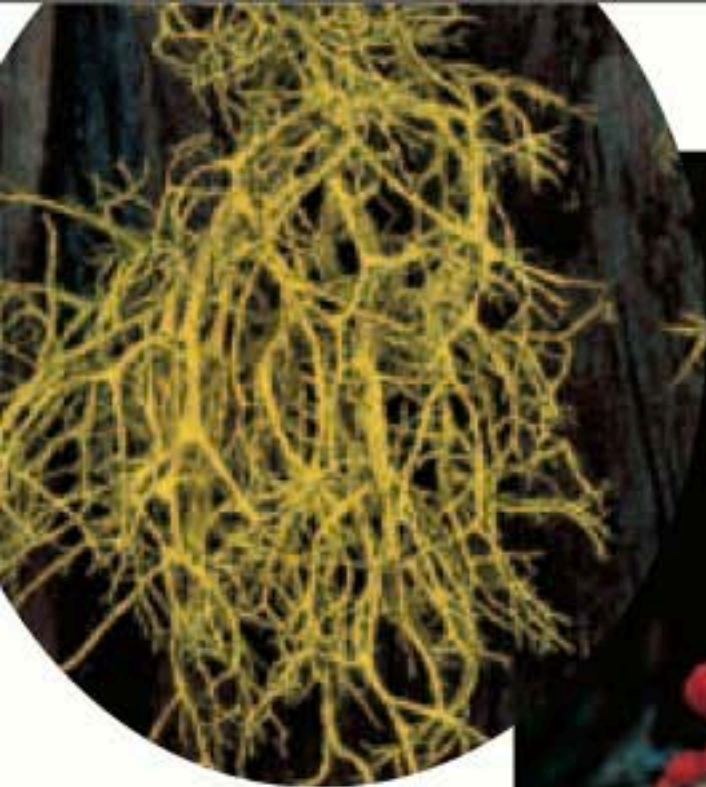
Figure 12 This corn is infected with a club fungus called smut.



Figure 13 The fungus *Penicillium* produces a substance that kills certain bacteria.

CONNECTION TO Language Arts

Beatrix Potter Beatrix Potter (1866–1943) is best known for writing children's stories, such as *The Tale of Peter Rabbit* and *The Tale of Two Bad Mice*. Potter lived and worked in England and had a scholarly interest in fungi. She was a shy person, and she was not taken seriously by fungi scholars of her time. But today, she is widely respected as a mycologist (a scientist who studies fungi). She wrote many valuable papers about fungi and made detailed drawings of more than 270 fungi. Research Potter's life, and present a report to your class.



▲ Wolf lichen

British soldier
lichen ▶



▼ Christmas lichen



Figure 14 These are some of the many types of lichens.

Lichens

A **lichen** (LIE kuhn) is a combination of a fungus and an alga that grow together. The alga actually lives inside the protective walls of the fungus. The resulting organism is different from either organism growing alone. The lichen is a result of a mutualistic relationship. But the merging of the two organisms to form a lichen is so complete that scientists give lichens their own scientific names. **Figure 14** shows some examples of lichens.

Unlike fungi, lichens are producers. The algae in the lichens produce food through photosynthesis. And unlike algae, lichens can keep from drying out. The protective walls of the fungi keep water inside the lichens. Lichens are found in almost every type of land environment. They can even grow in dry environments, such as deserts, and cold environments, such as the Arctic.

Because lichens need only air, light, and minerals to grow, they can grow on rocks. As lichens grow, the changes that they make to their surroundings allow other organisms to live there, too. For example, lichens make acids that break down rocks and cause cracks. When bits of rock and dead lichens fill the cracks, soil is made. Other organisms then grow in this soil.

Lichens absorb water and minerals from the air. As a result, lichens are easily affected by air pollution. So, the presence or absence of lichens can be a good measure of air quality in an area.

lichen a mass of fungal and algal cells that grow together in a symbiotic relationship and that are usually found on rocks or trees

SECTION Review

Summary

- Fungi can be consumers, decomposers, or parasites, or they can live in mutualistic relationships with other organisms.
- Most fungi are made up of chains of cells called *hyphae*. Many hyphae join together to form a mycelium.
- The four main groups of fungi are threadlike fungi, sac fungi, club fungi, and imperfect fungi.
- Threadlike fungi are primarily decomposers that form sporangia containing spores.
- During sexual reproduction, sac fungi form little sacs in which sexual spores develop.
- Club fungi form structures called *basidia* during sexual reproduction.
- The imperfect fungi include all of the species that do not quite fit in the other groups. Many are parasites that reproduce only by asexual reproduction.
- A lichen is a combination of a specific fungus and a specific alga. The lichen is different from either organism growing alone.

Using Key Terms

1. In your own words, write a definition for each of the following terms: *spore* and *mold*.

For each pair of terms, explain how the meanings of the terms differ.

2. *fungus* and *lichen*
3. *hyphae* and *mycelium*

Understanding Key Ideas

4. Which of the following statements about fungi is true?
 - a. All fungi are eukaryotic.
 - b. All fungi are decomposers.
 - c. All fungi reproduce by sexual reproduction.
 - d. All fungi are producers.
5. What are the four main groups of fungi? Give a characteristic of each group.
6. How are fungi able to withstand periods of cold or drought?

Critical Thinking

7. **Analyzing Processes** Many fungi are decomposers. Imagine what would happen to the natural world if decomposers no longer existed. Write a description of how a lack of decomposers might affect the processes of nature.
8. **Identifying Relationships** Explain how two organisms make up a lichen.

Interpreting Graphics

Use the photo below to answer the questions that follow.



9. To which group of fungi does this organism belong? How can you be sure?
10. What part of the organism is shown in this photo? What part is not shown? Explain.

SCILINKS

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