Section 3 Fungi

Objectives

After completing the lesson, students will be able to

A.3.3.1 Name the characteristics fungi share.

A.3.3.2 Explain how fungi reproduce.

A.3.3.3 Describe the roles fungi play in nature.

Target Reading Skill

Asking Questions Explain that changing a head into a question helps students anticipate the ideas, facts, and events they are about to read.

Answers

Possible questions and answers are:
What are fungi? *(Fungi are eukaryotes that have cell walls, are heterotrophs that feed by absorbing their food, and use spores to reproduce.)* **How do fungi reproduce?** *(Fungi usually reproduce by making spores.)* **What is the role of fungi in nature?** *(Fungi are important decomposers and recyclers.)*

All in One Teaching Resources

- Transparency A24

Preteach

Build Background Knowledge

L2

Considering Mushroom Habitat

Ask students to describe what they know about how mushrooms grow. Some students may have seen mushrooms growing in the woods, while others may have seen cultivated mushrooms. Encourage students to think about how mushrooms are similar to plants.

Section 3 Fungi

Reading Preview

Key Concepts

- What characteristics do fungi share?
- How do fungi reproduce?
- What roles do fungi play in nature?

Key Terms

- fungi • hyphae
- fruiting body • budding
- lichen

Target Reading Skill

Asking Questions Before you read, preview the red headings. In a graphic organizer like the one below, ask a *what* or *how* question for each heading. As you read, write answers to your questions.

Fungi

Question	Answer
What are fungi?	Fungi are . . .

Lab zone Discover Activity

Do All Molds Look Alike?

1. Your teacher will give you two sealed, clear plastic bags—one containing moldy bread and another containing moldy fruit. **CAUTION:** *Do not open the sealed bags at any time.*
2. In your notebook, describe what you see.
3. Next, use a hand lens to examine each mold. Sketch each mold in your notebook and list its characteristics.
4. Return the sealed bags to your teacher. Wash your hands.

Think It Over

Observing How are the molds similar? How do they differ?

Unnoticed, a speck of dust lands on a cricket's back. But this is no ordinary dust—it is alive! Tiny glistening threads emerge from the dust and begin to grow into the cricket's moist body. As they grow, the threads release chemicals that slowly dissolve the cricket's tissues. Within a few days, the cricket's body is little more than a hollow shell filled with a tangle of the deadly threads. Then the threads begin to grow up and out of the dead cricket. They produce long stalks with knobs at their tips. When one of the knobs breaks open, it will release thousands of dustlike specks, which the wind can carry to new victims.

What Are Fungi?

The strange cricket-killing organism is a member of the fungi kingdom. Although you may not have heard of a cricket-killing fungus before, you are probably familiar with other kinds of fungi. For example, the molds that grow on stale bread and the mushrooms that sprout in yards are all fungi.

A bush cricket attacked by a killer fungus. ▶

Lab zone Discover Activity

Skills Focus Observing L1

Materials Self-seal bags, tape, hand lens, old bread, fruit

Time 15 minutes

Tips At least one week before the activity, place pieces of moist bread and fruit in separate self-seal bags. Seal the bags, then make an extra seal with tape. Keep bags in a dark place at room temperature. Make sure students do not open the bags. Dispose of the sealed bags and all other materials according to proper procedures; check your district's and state's guidelines for proper disposal.

Expected Outcome Observations will depend on the kinds of fungi that grow.

Think It Over The molds will probably have similar threadlike appearances and fruiting bodies but will probably be of different colors.

Most **fungi** share several important characteristics. **Fungi are eukaryotes that have cell walls, are heterotrophs that feed by absorbing their food, and use spores to reproduce.** In addition, fungi need moist, warm places in which to grow. They thrive on moist foods, damp tree barks, lawns coated with dew, damp forest floors, and even wet bathroom tiles.

Cell Structure Fungi range in size from tiny unicellular yeasts to large multicellular fungi. The largest known organism on Earth is actually an underground fungus that covers an area as large as a thousand football fields!

The cells of all fungi are surrounded by cell walls. Except for the simplest fungi, such as unicellular yeasts, the cells of most fungi are arranged in structures called hyphae. **Hyphae** (HY fee) (singular hypha) are the branching, thread-like tubes that make up the bodies of multicellular fungi. The hyphae of some fungi are continuous threads of cytoplasm that contain many nuclei. Substances move quickly and freely through the hyphae.

What a fungus looks like depends on how its hyphae are arranged. In some fungi, the threadlike hyphae are loosely tangled. Fuzzy-looking molds that grow on old foods have loosely tangled hyphae. In other fungi, hyphae are packed tightly together. For example, the stalks and caps of the mushrooms shown in Figure 15 are made of hyphae packed so tightly that they appear solid. Underground, however, a mushroom's hyphae form a loose, threadlike maze in the soil.

Reading Checkpoint **What do the bodies of multicellular fungi consist of?**

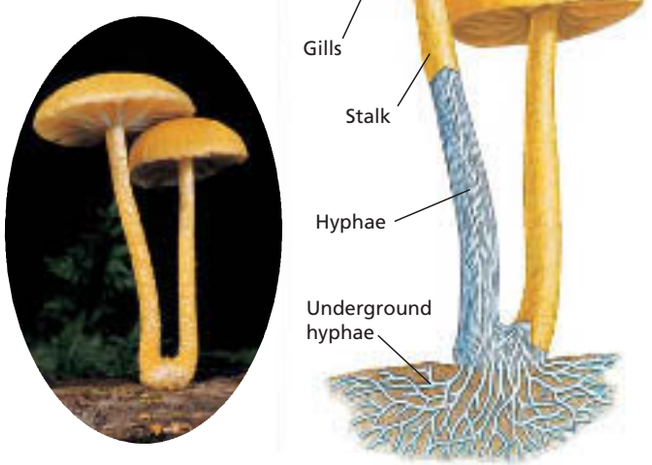


FIGURE 15
Structure of a Mushroom
The hyphae in the stalk and cap of a mushroom are packed tightly to form very firm structures. Underground hyphae, are arranged loosely.
Inferring *What function might the underground hyphae perform?*

Differentiated Instruction

English Learners/Beginning L1
Vocabulary: Science Glossary
Pronounce and define aloud for students the Key Terms for this section. Suggest that students start a personal glossary of vocabulary terms, with each term and its definition in English on one side of an index card and in the student's primary language on the other side. To help remember the meanings of the words, students might draw and label diagrams. **learning modality: verbal**

Less Proficient Readers L1
Vocabulary: Science Glossary Have students copy section Key Terms, then find and write the definitions as they read the section. Provide an unlabeled copy of Figure 15, and encourage students to add the labels. **learning modality: visual**

Protists and Fungi

Show the Video Field Trip to help students understand the relationships that fungi have with other organisms. Discussion question: **How do leaf cutter ants build a fungus garden?** *(By crushing pieces of leaves and mixing them with digestive juices, creating a paste. The fungi grow and feed on the paste.)*

Instruct

What are Fungi?

Teach Key Concepts L2

Identifying Fungi

Focus Ask students what bread mold has in common with the killer fungus shown attacking the bush cricket. *(Possible answer: Both grow on other organisms.)*

Teach Ask: **Which traits are shared by all fungi?** *(Eukaryotic, with cell walls; heterotrophs with similar means of feeding; spores for reproduction)* **Which fungi are unicellular?** *(Yeasts)* **What are hyphae?** *(Branching, threadlike tubes that form the body of multicellular fungi)*

Apply Explain that in most fungi, cytoplasm flows freely through the hyphae because the walls separating cells have a "hole" in them. Ask: **How do hyphae help a fungus in its life processes?** *(By allowing essential materials to move quickly throughout the fungus)* **learning modality: verbal**

All in One Teaching Resources
- Transparency A25

Independent Practice L2

All in One Teaching Resources
- Guided Reading and Study Worksheet: *Fungi*

Student Edition on Audio CD

Monitor Progress L2

Answers
Figure 15 Anchoring; absorbing materials
Reading Checkpoint Hyphae

Reproduction in Fungi

Teach Key Concepts L2

Exploring How Fungi Reproduce

Focus Have students examine Figure 17.

Teach Ask: **What type of asexual reproduction occurs in yeasts?** *(Budding)* **What type of reproduction produces fungi that differ genetically from the parents?** *(Sexual reproduction)* **What are fruiting bodies?** *(The reproductive structure of a fungus that contains or produces spores.)* **Under what conditions do most fungi reproduce asexually?** *(Adequate food and moisture)*

Apply Ask: **How are fungal spores similar to plant seeds?** *(They have protective coverings and are transported easily by air or water.)* **learning modality: logical/mathematical**

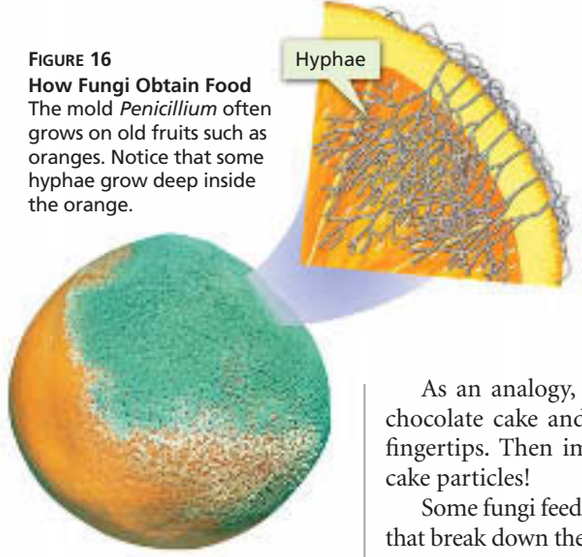


FIGURE 16
How Fungi Obtain Food
The mold *Penicillium* often grows on old fruits such as oranges. Notice that some hyphae grow deep inside the orange.

Obtaining Food Although fungi are heterotrophs, they do not take food into their bodies as you do. Instead, fungi absorb food through hyphae that grow into the food source. Figure 16 shows a mold feeding on an orange.

First, the fungus grows hyphae into a food source. Then digestive chemicals ooze from the hyphae into the food. The chemicals break down the food into small substances that can be absorbed by the hyphae.

As an analogy, imagine sinking your fingers down into a chocolate cake and dripping digestive chemicals out of your fingertips. Then imagine your fingers absorbing the digested cake particles!

Some fungi feed on dead organisms. Other fungi are parasites that break down the chemicals in living organisms.

Reproduction in Fungi

Like it or not, fungi are everywhere. The way they reproduce guarantees their survival and spread. **Fungi usually reproduce by making spores. The lightweight spores are surrounded by a protective covering and can be carried easily through air or water to new sites.** Fungi produce millions of spores, more than can ever survive. Only a few spores will fall where conditions are right for them to grow.

Fungi produce spores in reproductive structures called **fruiting bodies.** The appearances of fruiting bodies vary from one type of fungus to another. For some fungi, such as mushrooms and puffballs, the part of the fungus that you see is the fruiting body. In other fungi, such as bread molds, the fruiting bodies are tiny, stalklike hyphae that grow upward from the rest of the hyphae. A knoblike spore case at the tip of each stalk contains the spores.

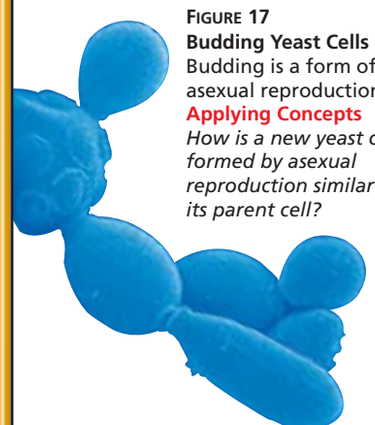


FIGURE 17
Budding Yeast Cells
Budding is a form of asexual reproduction.
Applying Concepts
How is a new yeast cell formed by asexual reproduction similar to its parent cell?

Asexual Reproduction Most fungi reproduce both asexually and sexually. When there is adequate moisture and food, the fungi make spores asexually. Cells at the tips of their hyphae divide to form spores. The spores grow into fungi that are genetically identical to the parent.

Unicellular yeast cells undergo a form of asexual reproduction called **budding.** In budding, no spores are produced. Instead, a small yeast cell grows from the body of a parent cell somewhat similar to the way a bud forms on a tree branch. The new cell then breaks away and lives on its own.

Sexual Reproduction Most fungi can also reproduce sexually, especially when growing conditions become unfavorable. In sexual reproduction, the hyphae of two fungi grow together and genetic material is exchanged. Eventually, a new reproductive structure grows from the joined hyphae and produces spores. The spores develop into fungi that differ genetically from either parent.

Classification of Fungi Figure 18 shows three major groups of fungi. The groups are named for the appearance of their reproductive structures. Additional groups include water species that produce spores with flagella and those that form tight associations with plant roots.

Reading Checkpoint **What is budding?**

FIGURE 18
Classification of Fungi
Three major groups of fungi include sac fungi, club fungi, and zygote fungi.
Comparing and Contrasting *How do the spore-producing structures of sac fungi and club fungi compare?*

Sac Fungi ▶
Sac fungi produce spores in structures that look like long sacs, such as those at the tips of these hyphae. This group is the largest group of fungi and includes yeasts, morels, truffles, and some fungi that cause plant diseases. Sac fungi also include fungi that make up lichens.

Club Fungi ▲
Club fungi produce spores in microscopic structures that look like clubs. This group includes mushrooms, bracket fungi, and rusts. Club fungi also include puffballs such as these, one of which is releasing its spores. The most poisonous fungi are club fungi.

Zygote Fungi ▲
Zygote fungi produce very resistant spores that can survive harsh environmental conditions. This group contains many common fruit and bread molds, such as this *Rhizopus*, and molds that attack and kill insects.

Differentiated Instruction

Special Needs L1
Observing Fungi Group students to allow those with differing proficiencies to work together. Give groups a selection of mushrooms from the grocery store, and a hand lens to use to observe them. Challenge students to identify mushroom structures. Have students gently twist off the cap of one mushroom and break open the stalk from end to end. Ask: **Can you pull threadlike structures from the stalk?** *(Answers may vary depending on the mushroom.)* Tell students that these structures are hyphae. Make sure students wash their hands immediately after the activity. **learning modality: kinesthetic**

Lab zone **Build Inquiry** L2

Observing Mushroom Spores

Materials mushroom spores in water, eyedropper, microscope, slide, cover slip
Time 15 minutes

Focus Remind students that spores result from reproduction.

Teach Have students use a dropper to place a drop of water with spores on a microscope slide, and cover it with a cover slip. Students can observe the spores under a microscope, and sketch their observations, including the color and shape of the spores.

Apply Ask: **How will the fungi that grow from spores produced sexually differ from the parent plants that produced them?** *(They will be genetically different.)* **learning modality: visual**

Use Visuals: Figure 18 L1
Classification of Fungi

Focus Have students look at the photos as a volunteer reads each caption.

Teach Students may be confused when they look at the puffball, because it does not resemble a club. Inform them that the club-shaped spore cases are microscopic and located inside the puffball. **learning modality: logical/mathematical**

Monitor Progress L2

Writing Have students explain how fungi reproduce sexually and asexually.

Answers
Figure 17 It is genetically identical to its parent.
Figure 18 Sac fungi produce spores in saclike structures; club fungi produce spores on structures that look like clubs.
Reading Checkpoint A form of asexual reproduction; it does not produce spores.

The Role of Fungi in Nature

Teach Key Concepts

Examining the Diverse Roles of Fungi

Focus Tell students that fungi play many important roles in nature, both helpful and harmful.

Teach Ask: **How are fungi recyclers?** *(They are decomposers, breaking down chemicals in dead organisms and returning them to the soil.)* **How are they eaten as food?** *(Yeasts are used for making breads and wine, molds for making cheeses; many mushrooms are edible, truffles are delicacies.)* **Which types of fungi cause diseases?** *(Parasites in crop plants; athlete's foot and ringworm in humans)* **Which are disease fighters?** *(Those that produce antibiotics, such as* Penicillium*)* **How do fungi live associated with other organisms?** *(In mutualistic relationships with plant roots, or, in lichens, with an alga or bacterium)*

Apply Ask: **Fungi most often share their roles as decomposers, disease agents, and disease fighters with which organisms?** *(Bacteria)* **learning modality: logical/mathematical**

Help Students Read

Reciprocal Teaching Have students read the section with a partner. One partner reads a paragraph aloud. Then the other partner summarizes the paragraph's contents and explains the main concepts. The partners continue to switch roles with each new paragraph until they have finished the section.

FIGURE 19
Truffles
Pigs are often used to hunt for truffles, a highly prized delicacy. Truffles (inset) are the round fruiting bodies of fungi that grow underground among the roots of certain trees. Some truffles are quite rare and can sell for several thousand dollars per kilogram!

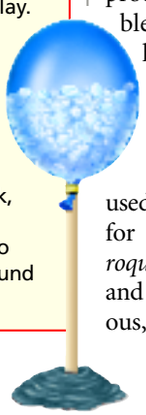
Lab zone Try This Activity

Spreading Spores

In this activity, you will make a model of a fruiting body.

1. Break a cotton ball into five equal pieces. Roll each piece into a tiny ball.
2. Insert the cotton balls into a balloon.
3. Repeat Steps 1 and 2 until the balloon is almost full.
4. Inflate the balloon. Tie a knot in its neck. Tape the knotted end of the balloon to a stick.
5. Stand the stick upright in a mound of modeling clay.
6. Pop the balloon with a pin. Observe what happens.

Making Models Draw a diagram of the model you made. Label the stalk, the spore case, and the spores. Use your model to explain why fungi are found just about everywhere.



The Role of Fungi in Nature

Fungi affect humans and other organisms in many ways. **Fungi play important roles as decomposers and recyclers on Earth. Many fungi provide foods for people. Some fungi cause disease while others fight disease. Still other fungi live in symbiosis with other organisms.**

Environmental Recycling Like bacteria, many fungi are decomposers—organisms that break down the chemicals in dead organisms. For example, many fungi live in the soil and break down the chemicals in dead plant matter. This process returns important nutrients to the soil. Without fungi and bacteria, Earth would be buried under dead plants and animals!

Food and Fungi When you eat a slice of bread, you benefit from the work of yeast. Bakers add yeast to bread dough to make it rise. Yeast cells use the sugar in the dough for food and produce carbon dioxide gas as they feed. The gas forms bubbles, which cause the dough to rise. You see these bubbles as holes in a slice of bread. Without yeast, bread would be flat and solid. Yeast is also used to make wine from grapes. Yeast cells feed on the sugar in the grapes and produce carbon dioxide and alcohol.

Other fungi are also important sources of foods. Molds are used in the production of foods. The blue streaks in blue cheese, for example, are actually growths of the mold *Penicillium roqueforti*. People enjoy eating mushrooms in salads and soups and on pizza. Because some mushrooms are extremely poisonous, however, you should never pick or eat wild mushrooms.

Lab zone Try This Activity

Skills Focus Making models

Materials round balloon, cotton balls, tape, stick or ruler about 30 cm long, modeling clay, pin

Time 25 minutes

Tips If possible, blow up the balloons with a pump or compressed air so that the cotton balls do not get wet. Suggest L2 students make the cotton balls as small as possible.

Expected Outcome The "spores" should fly out from the balloons and land in many directions, fairly far from the balloons. Students should explain that, just as air scattered the cotton balls, air currents catch and carry spores far and wide.

learning modality: kinesthetic

Disease-Fighting Fungi In 1928, a Scottish biologist named Alexander Fleming was examining petri dishes in which he was growing bacteria. To his surprise, Fleming noticed a spot of a bluish-green mold growing in one dish. Curiously, no bacteria were growing near the mold. Fleming hypothesized that the mold, a fungus named *Penicillium*, produced a substance that killed the bacteria near it.

Fleming's work contributed to the development of the first antibiotic, penicillin. It has saved the lives of millions of people with bacterial infections. Since the discovery of penicillin, many additional antibiotics have been isolated from both fungi and bacteria.

Disease-Causing Fungi Many fungi are parasites that cause serious diseases in plants. The sac fungus that causes Dutch elm disease is responsible for killing millions of elm trees in North America and Europe. Corn smut and wheat rust are two club fungi that cause diseases in important food crops. Fungal plant diseases also affect other crops, including rice, cotton, and soybeans, resulting in huge crop losses every year.

Some fungi cause diseases in humans as well. Athlete's foot causes an itchy irritation in the damp places between toes. Ringworm, another fungal disease, causes an itchy, circular rash on the skin. Because the fungi that cause these diseases produce spores at the site of infection, the diseases can spread easily from person to person. Both diseases can be treated with antifungal medications.

Reading Checkpoint **What is one way fungi help fight diseases?**

FIGURE 20
Penicillin
A *Penicillium* mold grows in the center of this petri dish. The mold produces the antibiotic penicillin, which prevents the tiny white colonies of bacteria from growing in the area around it.

FIGURE 21
Athlete's Foot
Athlete's foot is a disease caused by the fungus *Trichophyton mentagrophytes* (inset). The fungus thrives in the damp places between toes. **Relating Cause and Effect** *Why is the spread of fungal diseases difficult to control?*

Lab zone Teacher Demo L1

Considering Fungi as Decomposers

Materials components of a compost pile (leaves, manure, soil, weeds, grass clippings, vegetable and fruit wastes), small container, compost from a garden store or mature compost pile

Time 20 minutes

Focus Review the importance of decomposers to ecosystems.

Teach Ask: **Does anyone you know have a compost pile?** Explain that compost piles are made by alternating layers of soil, animal manure, and vegetable materials such as weeds, grass clippings, leaves, and food waste. Layer the sample components in the container. Explain further that after several months, the material in a compost pile becomes a rich mixture that can be used to supply nutrients necessary for garden plants to grow. Display for students the mature compost, allowing them a close view.

Apply Ask: **How do fungi help to produce compost?** *(Fungi are decomposers. They live in the soil in the compost pile and break down the chemicals in the dead plant matter.)* **learning modality: visual**

Integrating Health L1

Identifying a Fungal Disease

Encourage students to share what they know about athlete's foot. Ask: **How do you get athlete's foot?** *(Spores fall off infected feet and are picked up by your feet.)* **Where does this usually occur?** *(Public showers, gyms, etc.)* **What can you do to avoid getting athlete's foot?** *(Dry between toes; wear shoes in public areas.)* **How would you treat this fungus if you got it?** *(With a fungicide)* **learning modality: verbal**

Differentiated Instruction

Gifted and Talented L3
Designing Experiments Challenge small groups of students to design experiments that show how yeast reacts with other ingredients to make bread. Suggest that students find simple bread recipes and vary the ingredients for their experiments. Students can make predictions about how different quantities of ingredients will affect the outcome of the baked bread. Bring a bread machine into class so students can try out their recipes. **learning modality: logical/mathematical**

Less Proficient Readers L1
Identifying Roles Have students write down the various roles of fungi, as noted on the paragraph headings, then listen to the *Student Edition on Audio* CD and record notes on the importance of each role. **learning modality: verbal**

Monitor Progress L2

Skills Check Have students list ways that fungi affect humans and identify each as beneficial or harmful.

Answer
Figure 21 Fungi spores are resistant and can survive many unfavorable conditions.
Reading Checkpoint Fungi produce antibiotics that can kill bacteria.

Math Analyzing Data

Math Skill Interpreting graphs

Focus Have students study the graph. Ask: **What does this graph show?** *(The effect of root-associated fungi on the height of trees)* **What information do the two colors of bars represent?** *(One represents trees with root-associated fungi; the other represents trees without root-associated fungi.)*

Teach Ask: **Which group of trees is the control group?** *(Those grown without fungi)*

Answers

1. By measuring average height in meters
2. Those grown with root-associated fungi
3. About 5 meters; about 1.5 meters
4. Root-associated fungi improve or enhance tree growth.

Integrating Earth Science L1

Examining Lichens

Provide students with hand lenses and samples of lichens on rocks or tree bark. As students observe the lichens, challenge them to infer why lichens are sensitive to environmental pollution. *(Lichens rapidly absorb substances directly from rainwater, so they are very susceptible to airborne pollutants.)* **learning modality: visual**

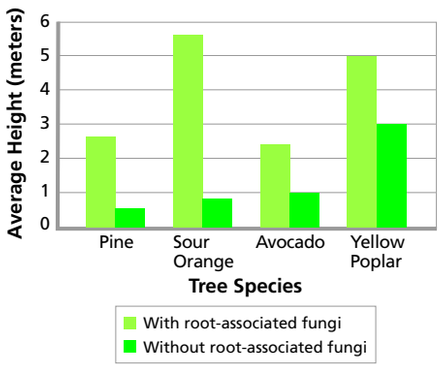
Math Analyzing Data

Fungi and Trees

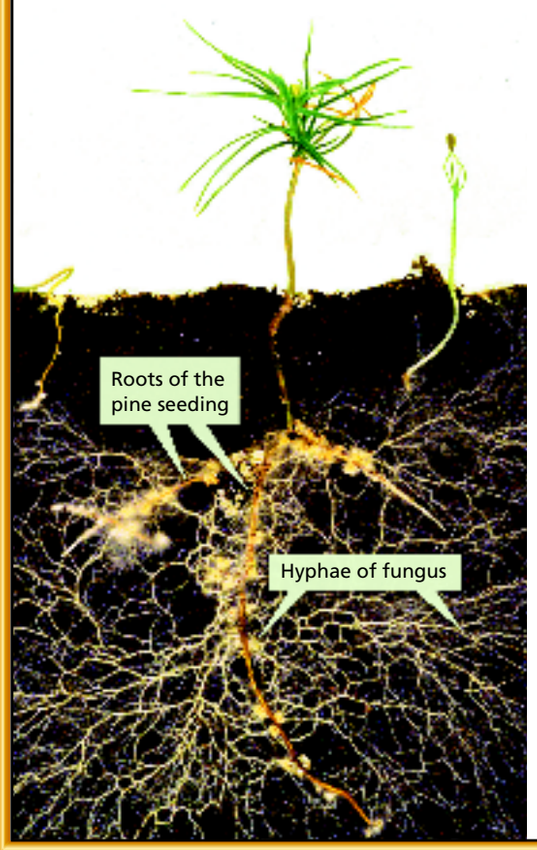
A biologist conducted an experiment to see how root-associated fungi affect the growth of four different tree species. Each species was divided into two groups—trees grown with root-associated fungi and trees grown without the fungi.

1. **Reading Graphs** How did the biologist measure tree growth?
2. **Interpreting Data** For each species, which group of trees showed more growth?
3. **Calculating** What is the average height difference between sour orange trees that grew with root-associated fungi and those that grew without fungi? What is the height difference between avocado trees with and without the fungi?

Effect of Root-Associated Fungi on Tree Growth



4. **Drawing Conclusions** Based on this experiment, how do root-associated fungi affect tree growth?



Fungus–Plant Root Associations Some fungi help plants grow larger and healthier when their hyphae grow into, or on, the plant's roots. The hyphae spread out underground and absorb water and nutrients from the soil for the plant. With more water and nutrients, the plant grows larger than it would have grown without its fungal partner. The plant is not the only partner that benefits. The fungi get to feed on the extra food that the plant makes and stores. You can see the partnership between a fungus and a pine seedling in Figure 22.

Most plants have fungal partners. Many plants are so dependent on the fungi that they cannot survive without them. For example, orchid seeds cannot develop without their fungal partners.

Reading Checkpoint **How do fungi help plants grow?**

FIGURE 22
Fungus–Plant Root Associations
An extensive system of fungal hyphae has grown in association with the roots of the pine seedling in the middle.
Classifying *What type of symbiosis do these two organisms exhibit?*

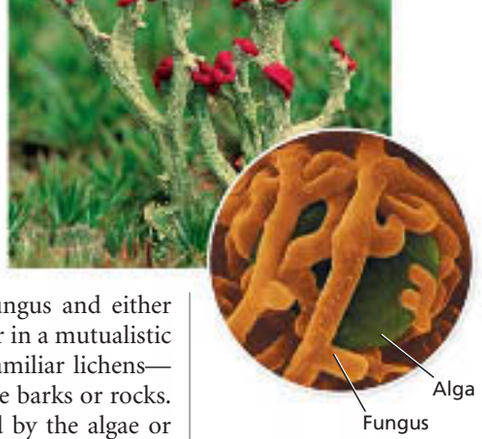


FIGURE 23
Lichens
The British soldier lichen consists of a fungus and an alga. The inset shows how entwined the alga is among the fungus's hyphae.

Lichens A **lichen** (LY kun) consists of a fungus and either algae or autotrophic bacteria that live together in a mutualistic relationship. You have probably seen some familiar lichens—irregular, flat, crusty patches that grow on tree barks or rocks. The fungus benefits from the food produced by the algae or bacteria. The algae or bacteria, in turn, obtain shelter, water, and minerals from the fungus.

Lichens are often called "pioneer" organisms because they are the first organisms to appear on the bare rocks in an area after a volcanic eruption, fire, or rock slide has occurred. Over time, the lichens break down the rock into soil in which other organisms can grow. Lichens are also useful as indicators of air pollution. Many species of lichens are very sensitive to pollutants and die when pollution levels rise. By monitoring the growth of lichens, scientists can assess the air quality in an area.

Reading Checkpoint **What two organisms make up a lichen?**

Go Online NSTA SCILINKS
For: Links on fungi
Visit: www.SciLinks.org
Web Code: scn-0133

Section 3 Assessment

Target Reading Skill **Asking Questions** Use the answers to the questions you wrote about the headings to help you answer the questions below.

Reviewing Key Concepts

1. a. **Listing** List three characteristics that a bread mold shares with a mushroom.
   b. **Comparing and Contrasting** How are the cells of a bread mold arranged? How are the cells of a mushroom arranged?
   c. **Summarizing** How does the cell structure of a fungus help it obtain food?
2. a. **Reviewing** What role do spores play in the reproduction of fungi?
   b. **Sequencing** Outline the steps by which fungi produce spores by sexual reproduction.
   c. **Inferring** Why is it advantageous to a fungus to produce millions of spores?
3. a. **Identifying** Name six roles that fungi play in nature.
   b. **Predicting** Suppose all the fungi in a forest disappeared. What do you think the forest would be like without fungi?

Writing in Science

Wanted Poster Design a "Wanted" poster for a mold that has been ruining food in your kitchen. Present the mold as a "criminal of the kitchen." Include detailed descriptions of the mold's physical characteristics, what it needs to grow, how it grows, and any other details that will help your family identify this mold. Propose ways to prevent new molds from growing in your kitchen.

Monitor Progress L2

Answers

Figure 22 A partnership in which both organisms benefit—mutualism

Reading Checkpoint Fungus; alga or bacterium

Go Online NSTA SCILINKS
For: Links on fungi
Visit: www.SciLinks.org
Web Code: scn-0133
Download a worksheet that will guide students' review of Internet resources on fungi.

Assess

Reviewing Key Concepts

1. a. Any three of the following: eukaryotes, have cell walls, reproduce through spores, heterotrophs that feed in a similar way, live in warm, moist places. **b.** Fungal cells are arranged in hyphae. Bread mold hyphae are loosely tangled; mushroom hyphae are tightly packed. **c.** Threadlike hyphae grow into a food source, then release chemicals that break it down.

2. a. Spores are reproductive cells that develop into new fungi. **b.** Hyphae of two fungi join and exchange genetic material; a reproductive eventually grows from the joined hyphae and produces spores; spores develop into new fungi. **c.** It increases the chance that more spores will survive to become new fungi.

3. a. Recycler, food source, disease agent, disease fighter, organism living in association with plant roots, one of the pair of organisms in a lichen. **b.** It would be filled with dead plants and animals.

Reteach L1

As a class, make a chart presenting fungal characteristics and roles in nature.

Performance Assessment L2

Oral Presentation Have small groups make presentations on the structure of fungi, how they obtain food, their reproduction, types of fungi, or how fungi interact in nature.

All in One Teaching Resources

- Section Summary: *Fungi*
- Review and Reinforce: *Fungi*
- Enrich: *Fungi*

Lab zone Chapter Project

Keep Students on Track Students will need help drawing conclusions about their results. As you review students' sketches, point out questions that are not addressed by the poster. If necessary, list some ideas for information students should include on their posters before they make their sketches.

Writing in Science

Writing Mode Description

Scoring Rubric

4 Includes detailed, accurate descriptions; writing and art are engaging
3 Includes all criteria; writing and art not engaging
2 Minimally meets criteria
1 Includes inaccurate or incomplete information

What's for Lunch?

L2

Prepare for Inquiry

Key Concept
The activity of yeast varies, depending on the amount of available food.

Skills Objectives
After this lab, students will be able to
- draw conclusions about whether sugar and salt act as food sources for yeast.

Prep Time 20 minutes
Class Time 45 minutes

Advance Planning
Before the lab, check a sample of yeast that is dissolved in warm water with sugar for 20 minutes, to make sure the yeasts are alive.

Safety
Students should wear safety goggles in case a balloon pops off a bottle or a bottle is accidentally dropped. Review the safety guidelines in Appendix A.

All in One Teaching Resources
- Lab Worksheet: *What's for Lunch?*

Guide Inquiry

Invitation
Tell students that yeasts produce carbon dioxide when they break down food. Carbon dioxide production can be measured to determine whether yeasts are feeding. Have students explain how carbon dioxide production will be measured in this lab.

Introduce the Procedure
Help students understand that when carbon dioxide gas forms in water, much of it will escape from the water's surface.

Lab zone Skills Lab

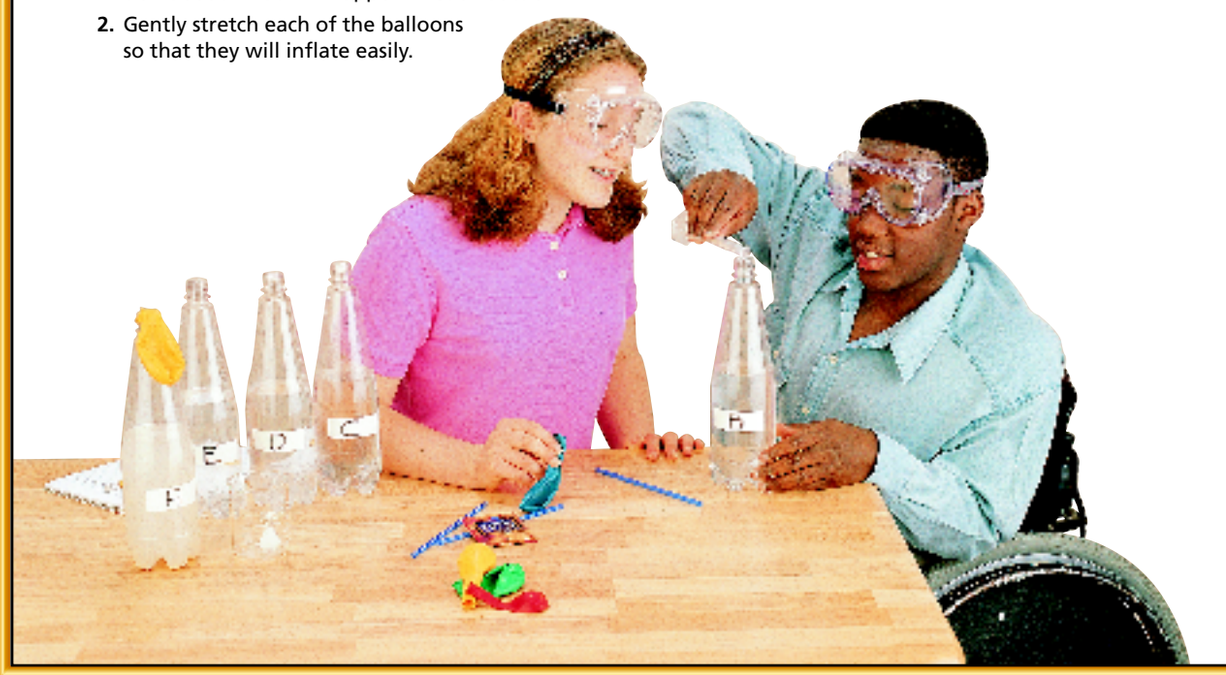
What's for Lunch?

Problem
How does the presence of sugar or salt affect the activity of yeast?

Skills Focus
measuring, inferring, drawing conclusions

Materials
- 5 small plastic narrow-necked bottles
- 5 round balloons • 5 plastic straws
- dry powdered yeast • sugar • salt
- warm water (40°–45°C) • marking pen
- beaker • graduated cylinder • metric ruler
- string

Procedure
1. Copy the data table into your notebook. Then read over the entire procedure to see how you will test the activity of the yeast cells in bottles A through E. Write a prediction about what will happen in each bottle.
2. Gently stretch each of the balloons so that they will inflate easily.
3. Using the marking pen, label the bottles *A, B, C, D,* and *E.*
4. Use a beaker to fill each bottle with the same amount of warm water. **CAUTION:** *Glass is fragile. Handle the beaker gently to avoid breakage. Do not touch broken glass.*
5. Put 25 mL of salt into bottle B.
6. Put 25 mL of sugar into bottles C and E.
7. Put 50 mL of sugar into bottle D.
8. Put 6 mL of powdered yeast into bottle A, and stir the mixture with a clean straw. Remove the straw and discard it.
9. Immediately place a balloon over the opening of bottle A. Make sure that the balloon opening fits very tightly around the neck of the bottle.
10. Repeat Steps 8 and 9 for bottle B, bottle C, and bottle D.

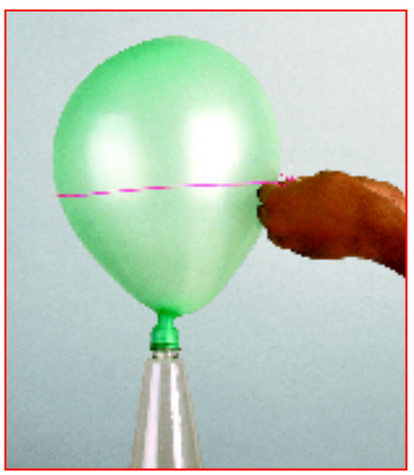


Troubleshooting the Experiment
- Do not let students overfill the bottles.
- Balloons may pop off the bottles during the lab.
- Caution students to use a fresh straw for each mixing. This is particularly important when mixing bottle E, because students must not introduce yeast by accident.

Expected Outcome
Balloon D should inflate the most. Balloon C should also inflate but noticeably less than balloon D. Balloons A, B, and E should not inflate.

Data Table						
Bottle	Prediction	Observations	Circumference			
			10 min	20 min	30 min	40 min
A (Yeast alone)						
B (Yeast and 25 mL of salt)						
C (Yeast and 25 mL of sugar)						
D (Yeast and 50 mL of sugar)						
E (No yeast and 25 mL of sugar)						

11. Place a balloon over bottle E without adding yeast to the bottle.
12. Place the five bottles in a warm spot away from drafts. Every ten minutes for 40 minutes, measure the circumference of each balloon by placing a string around the balloon at its widest point. Include your measurements in the data table.



Analyze and Conclude

1. **Measuring** Which balloons changed in size during this lab? How did they change?
2. **Inferring** Explain why the balloon changed size in some bottles and not in others. What caused that change in size?
3. **Interpreting Data** What did the results from bottle C show, compared with the results from bottle D? Why was it important to include bottle E in this investigation?
4. **Drawing Conclusions** Do yeast use salt or sugar as a food source? How do you know?
5. **Communicating** In a paragraph, summarize what you learned about yeast from this investigation. Be sure to support each of your conclusions with the evidence you gathered.

Design an Experiment

Develop a hypothesis about whether temperature affects the activity of yeast cells. Then design an experiment to test your hypothesis. *Obtain your teacher's permission before carrying out your investigation.*

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Analyze and Conclude

1. Balloons C and D changed during the lab. Balloon C filled up a little, and balloon D filled up a lot.

2. Some balloons were inflated by carbon dioxide gas. Other balloons remained unchanged because no carbon dioxide gas was produced by the yeast.

3. The balloon on bottle C did not inflate as much as the balloon on bottle D. When less sugar was available to the yeast (25 mL in bottle C versus 50 mL in bottle D), the yeast gave off less carbon dioxide. Without bottle E, there would be no way of knowing whether the gas was being produced by the sugar alone as it dissolved in the water.

4. They use sugar. Bottle B, which contained salt, produced no gas, indicating that the yeast was not active.

5. Student answers should explain that yeast cells use sugar as a food source, and they produce carbon dioxide as they break down food. Their feeding and production of carbon dioxide were proven by the inflation of balloons in bottles containing sugar, particularly in the bottle with the most sugar.

Extend Inquiry

Design an Experiment Students could prepare another bottle D and place it in a refrigerator. They would find that yeasts require warm environments to carry out their basic life processes.

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Students can review data sharing in an online interactivity.