Mr. PIERRO

SECTION 1

The Plant Kingdom

DISCOVER ACTIVITY

What Do Leaves Reveal About Plants?

1. Your teacher will give you two leaves from plants that grow in two very different environments: a desert and an area with average rainfall.
2. Carefully observe the color, size, shape, and texture of the leaves. Touch the surfaces of each leaf. Examine each leaf with a hand lens. Record your observations in your notebook.
3. When you have finished, wash your hands thoroughly with soap and water.

Think It Over

Inferring Use your observations to determine which plant lives in the desert and which does not. Give at least one reason to support your inference.

GUIDE FOR READING

- What characteristics do all plants share?
- What do plants need to live successfully on land?

Reading Tip Before you read, list the boldfaced vocabulary words in your notebook. Leave space to add notes as you read.

Imagine a forest where a thick growth of fungi, mosses, and ferns carpets the floor. Because there is no bare soil, seedlings start their lives on fallen logs. Ferns hang like curtains from the limbs of giant hemlock trees. Douglas fir trees grow taller than 20-story buildings. Other plants with strange names—vanilla leaf, self-heal, and licorice fern—also grow in the forest.

Such a forest exists on the western slopes of the Olympic Mountains in Washington State. Native Americans named the forest *Hoh*, which means "fast white water," after a river there. In some areas of the forest, over 300 centimeters of rain fall each year, which makes the area a rain forest.

What Is a Plant?

You would probably recognize many of the plants that grow in the Hoh rain forest. You encounter other familiar plants when you pick flowers, run across freshly cut grass, or eat vegetables such as peas.

▼ The Hoh rain forest

$H_2O + CO_2 \rightarrow glucose + O_2$

Members of the plant kingdom share some important characteristics. **All plants are eukaryotes that contain many cells. In addition, plants are autotrophs, which produce their own food.**

In Chapter 2, you learned that plants carry out the process called photosynthesis to make their food. During photosynthesis, a plant uses carbon dioxide gas and water to make food and oxygen. Sunlight provides the energy that powers the entire process.

Living on Land

Unlike algae, most plants live on land. How is living on land different from living in water? Imagine multicellular green algae floating in the ocean. Their bodies are held up toward the sunlight by the water around them. The algae obtain water and other materials directly from their watery surroundings. When algae reproduce, sperm cells swim to egg cells through the water.

On land, plants are not surrounded by water. **For plants to survive on land, they must have ways to obtain water and other materials from their surroundings, retain water, transport materials throughout the plant, support their bodies, and reproduce successfully.** In *Exploring Plant Adaptations* on the next page, you can see some of the ways in which plants are adapted to live on land.

Obtaining Water and Other Materials Recall that all organisms need water to survive. Obtaining water is easy for algae because water surrounds them. To live on land, though, plants need adaptations for obtaining water from the soil. Plants must also have ways of obtaining other nutrients from the soil.

Retaining Water Have you ever noticed that a puddle of rainwater gradually shrinks and then disappears after the rain stops? This happens because there is more water in the puddle than in the air. As a result, the water evaporates into the air. The same principle explains why a plant on land can dry out. Because there is more water in plant cells than in air, water evaporates into the air. Plants need adaptations to reduce water loss to the air. One common adaptation is a waxy, waterproof layer called the **cuticle** that covers the leaves of most plants.

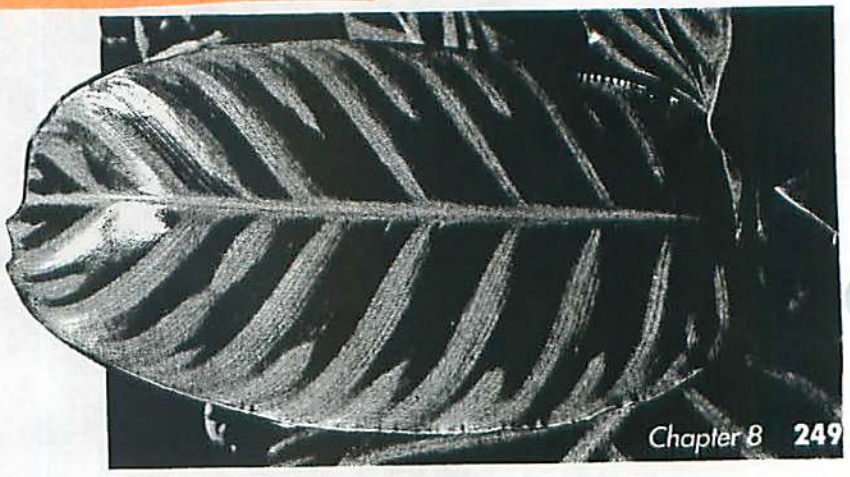


Figure 1 Plants have adaptations that help them retain water. The shiny, waterproof cuticle on this leaf slows down evaporation.

Sharpen your Skills

Interpreting Data

ACTIVITY

The table shows how much water a certain plant loses during the hours listed.

Time	Water Loss (grams)
7 to 8 AM	190
9 to 10 AM	209
11 to Noon	221
1 to 2 PM	233
3 to 4 PM	227
5 to 6 PM	213
7 to 8 PM	190
9 to 10 PM	100
11 to Midnight	90

When does the plant lose the most water? The least water? How could you account for the pattern you see?

Plants
/ \
Vascular Non vascular

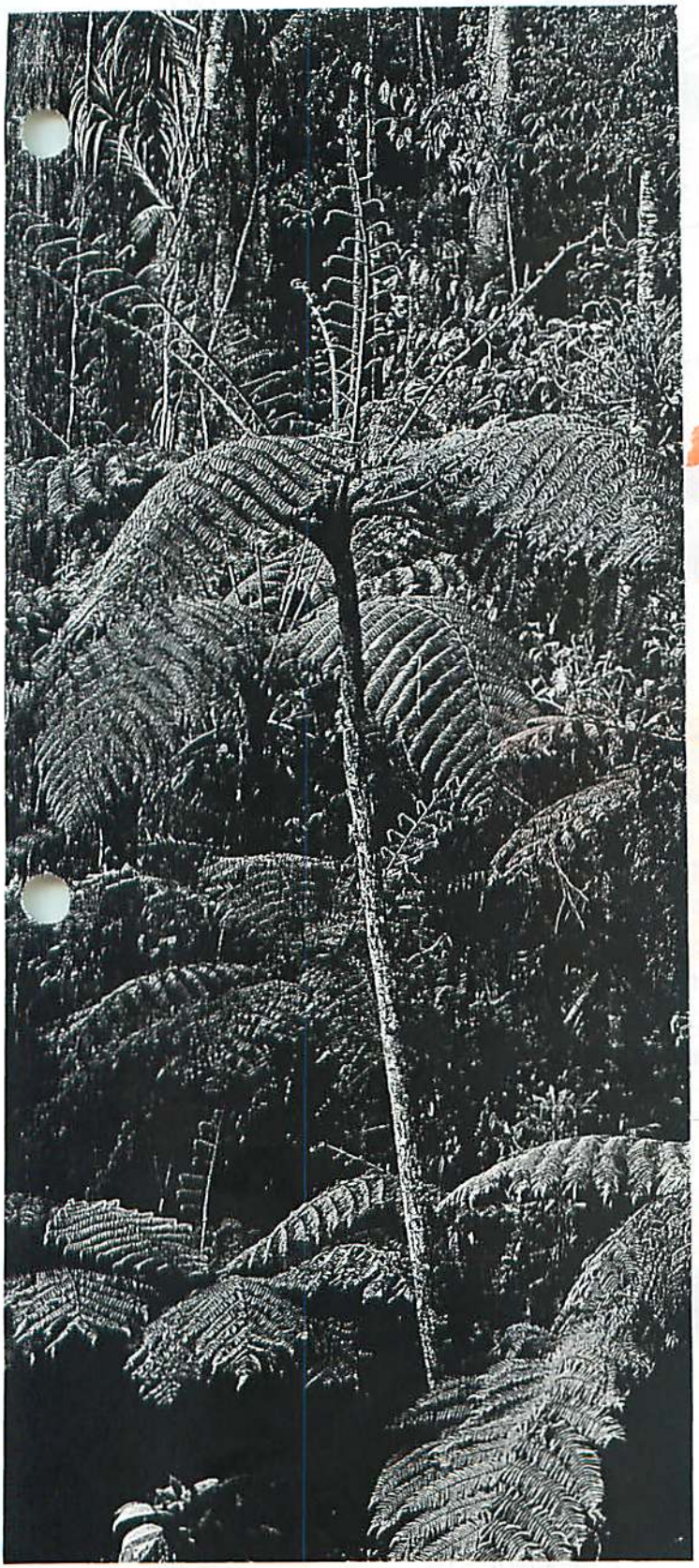


Figure 2 The vascular tissue in these tree ferns transports water and nutrients inside the plants. *Inferring What additional function might vascular tissue have in these tree ferns?*

Transporting Materials A plant needs to transport food, water, minerals, and other materials from one part of its body to another. In general, water and minerals are taken up by the bottom part of the plant. Food is made in the top part. But all the plant's cells need water, minerals, and food. To supply all cells with the materials they need, water and minerals must be transported up to the top of the plant. Then food must be transported throughout the plant.

Most plants that live on land have tissues that transport materials throughout their bodies. **Tissues** are groups of similar cells that perform a specific function in an organism. Some plants have transporting tissue called **vascular tissue.** Vascular tissue is an internal system of tubelike structures through which water and food move inside the plant. Plants that have vascular tissue are called vascular plants. Vascular plants can grow quite tall because they have an effective way of transporting substances to distant cells.

Support While algae are supported by the surrounding water, a plant on land must support its own body. Because plants need sunlight for photosynthesis, the food-making parts of the plant must be exposed to as much sunlight as possible. In vascular plants, vascular tissue strengthens and supports the large bodies of the plants.

Reproduction All plants undergo sexual reproduction that involves fertilization. **Fertilization** occurs when a sperm cell unites with an egg cell. The fertilized egg is called a **zygote.** For algae and some plants, fertilization can occur only if there is water in the environment. This is because sperm cells swim through the water to egg cells. Other plants, however, have an adaptation that make it possible for fertilization to occur in dry environments. You will learn more about this adaptation in the next chapter.

☑ *Checkpoint Why do plants need adaptations to prevent water loss?*

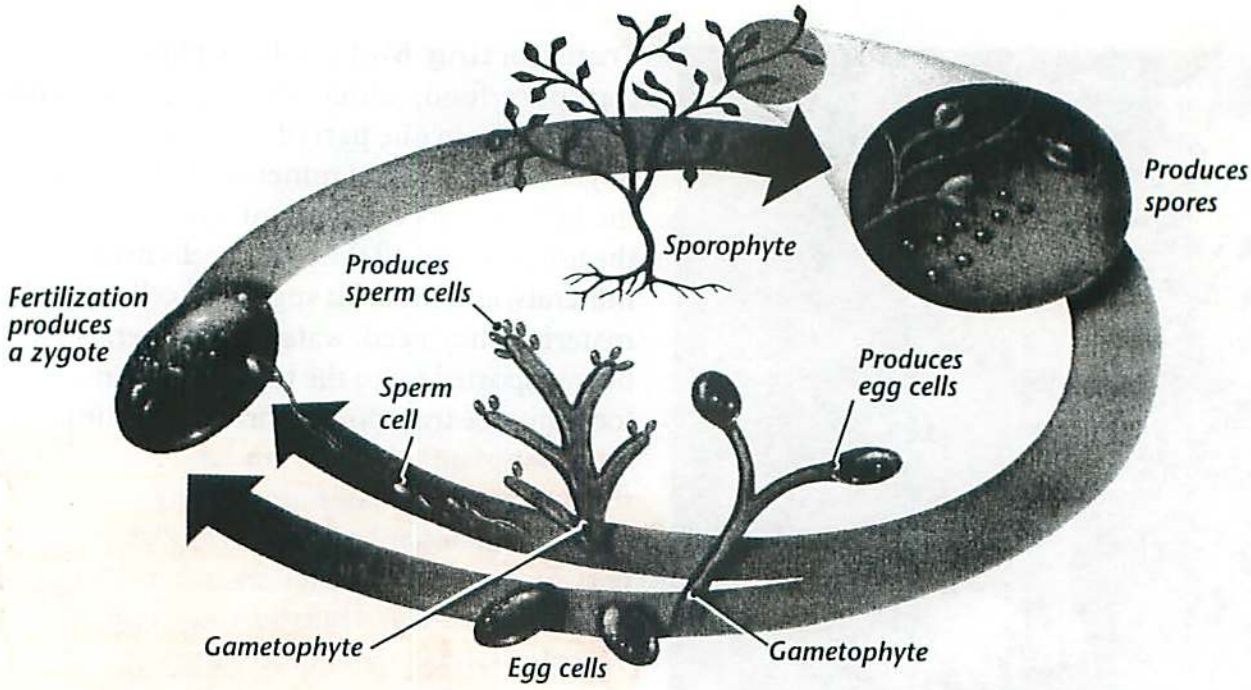


Figure 3 Plants have complex life cycles that consist of two stages—the sporophyte stage and the gametophyte stage. *Interpreting Diagrams During which stage are sperm and egg cells produced?*

Complex Life Cycles

Unlike most animals, plants have complex life cycles that are made up of two different stages, or generations. In one stage, called the **sporophyte** (SPAWR uh fyt), the plant produces spores, the tiny cells that can grow into new organisms. A spore develops into the plant's other stage, called the gametophyte. In the **gametophyte** (guh MEE tuh fyt) stage, the plant produces two kinds of sex cells, or **gametes**—sperm cells and egg cells.

Figure 3 shows a typical plant life cycle. A sperm cell and egg cell join to form a zygote. The zygote then develops into a sporophyte. The sporophyte produces spores, which develop into the gameophyte. Then the gameophyte produces sperm cells and egg cells and the cycle starts again. The sporophyte of a plant usually looks quite different from the gametophyte.

Section 1 Review

1. List three characteristics that all plants share.
2. What are five adaptations that plants need to survive on land?
3. Distinguish between a sporophyte and a gametophyte.
4. **Thinking Critically Classifying** Suppose you found a tall plant living in the desert. Do you think it would be a vascular plant? Explain.

Science at Home

State Flowers Choose any state in the United States. With a family member, find out the name of the state's official plant. Research why that plant was chosen to represent the state. Then gather information about the plant. Make an illustrated poster to display in your school that includes the information you gather.

SECTION 2

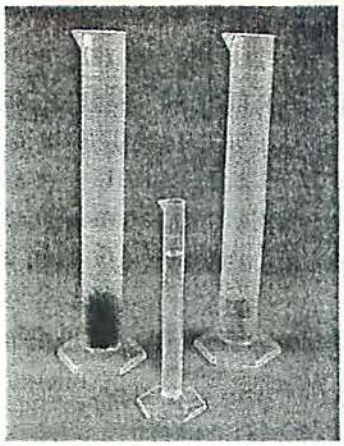
Mosses, Liverworts, and Hornworts

DISCOVER

ACTIVITY

Will Mosses Absorb Water?

1. Place 20 milliliters (mL) of sand into a plastic graduated cylinder. Place 20 mL of peat moss into a second plastic graduated cylinder.
2. Predict what would happen if you were to slowly pour 10 mL of water into each of the two graduated cylinders and then wait five minutes.



3. To test your prediction, use a third graduated cylinder to slowly add 10 mL of water to the sand. Then add 10 mL of water to the moss. After 5 minutes, record your observations.

Think It Over

Predicting How did your prediction compare with your results? What did you learn about moss from this investigation?

GUIDE FOR READING

- What characteristics do nonvascular plants share?

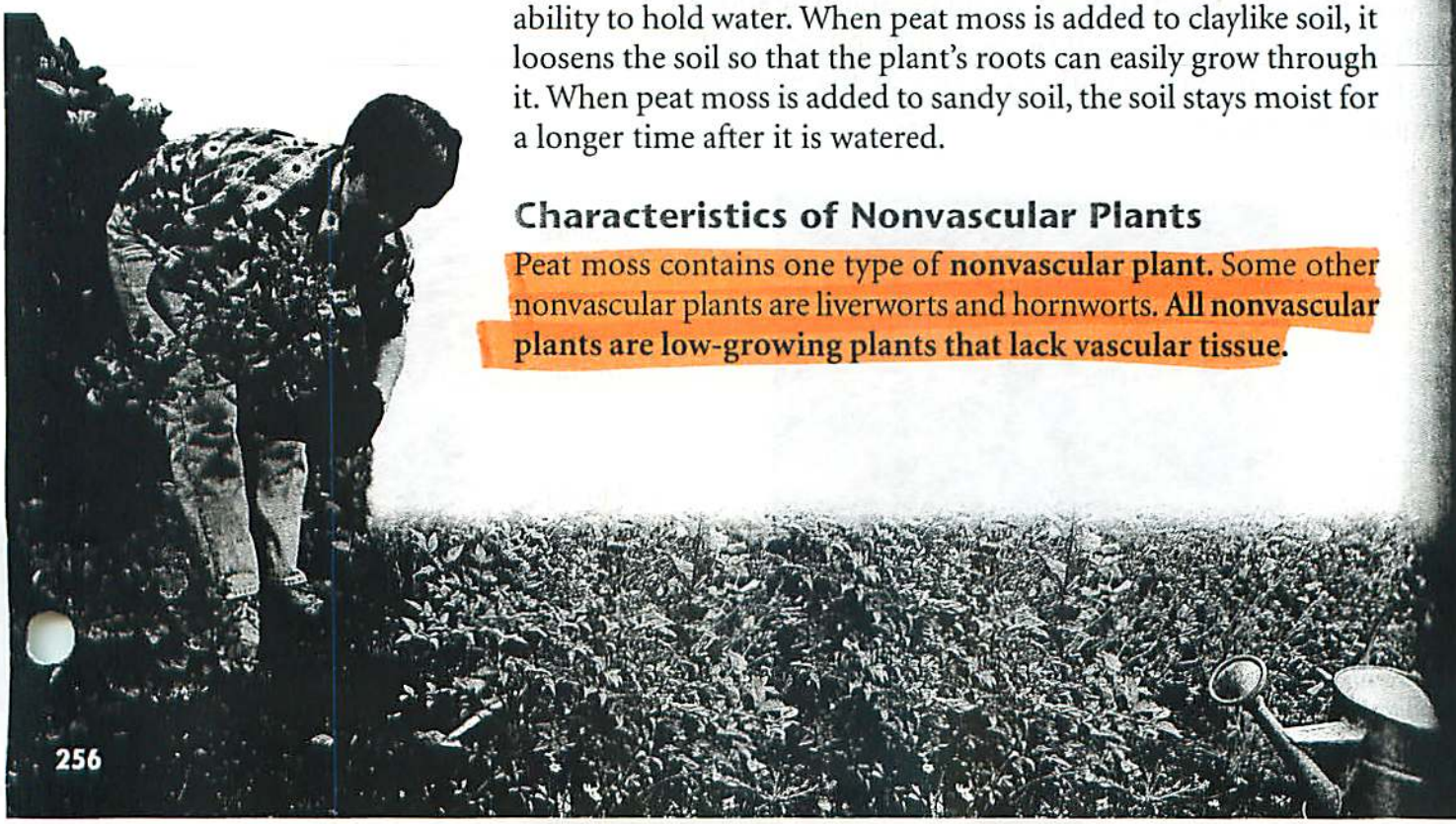
Reading Tip As you read, make a table comparing and contrasting mosses, liverworts, and hornworts.

If you enjoy gardening, you know that a garden requires time, effort, and knowledge. Before you start to plant your garden, you need to know how much water and sun your plants will need. You also need to know whether the soil in your garden can supply the plants with the water and nutrients they need.

Many gardeners add peat moss to the soil in their gardens. Peat moss improves the texture of soil and increases the soil's ability to hold water. When peat moss is added to claylike soil, it loosens the soil so that the plant's roots can easily grow through it. When peat moss is added to sandy soil, the soil stays moist for a longer time after it is watered.

Characteristics of Nonvascular Plants

Peat moss contains one type of **nonvascular plant.** Some other nonvascular plants are liverworts and hornworts. **All nonvascular plants are low-growing plants that lack vascular tissue.**



Nonvascular plants do not have vascular tissue—a system of tubelike structures that transport water and other materials. Nonvascular plants can only pass materials from one cell to the next. That means that the materials do not travel very far or very quickly. Also, these plants have only their rigid cell walls to provide support. With this type of structure, these plants cannot grow very wide or tall. As a result, nonvascular plants are small and grow low to the ground.

Like all plants, nonvascular plants require water to survive. These plants lack roots, but they can obtain water and minerals directly from their surroundings. Many nonvascular plants live where water is plentiful. But even nonvascular plants that live in drier areas need enough water to let the sperm cells swim to the egg cells during reproduction.

Mosses

Have you ever seen mosses growing in the crack of a sidewalk, on a tree trunk, or on rocks that are misted by waterfalls? With over 10,000 species, mosses are by far the most diverse group of nonvascular plants.

The Structure of a Moss If you were to look closely at a moss, you would see a plant that looks something like the one in Figure 4. The familiar green fuzzy moss is the gametophyte generation of the plant. Structures that look like tiny leaves grow off a small stemlike structure. Thin rootlike structures called **rhizoids** anchor the moss and absorb water and nutrients from the soil. The sporophyte generation grows out of the gametophyte. It consists of a slender stalk with a capsule at the end. The capsule contains spores.

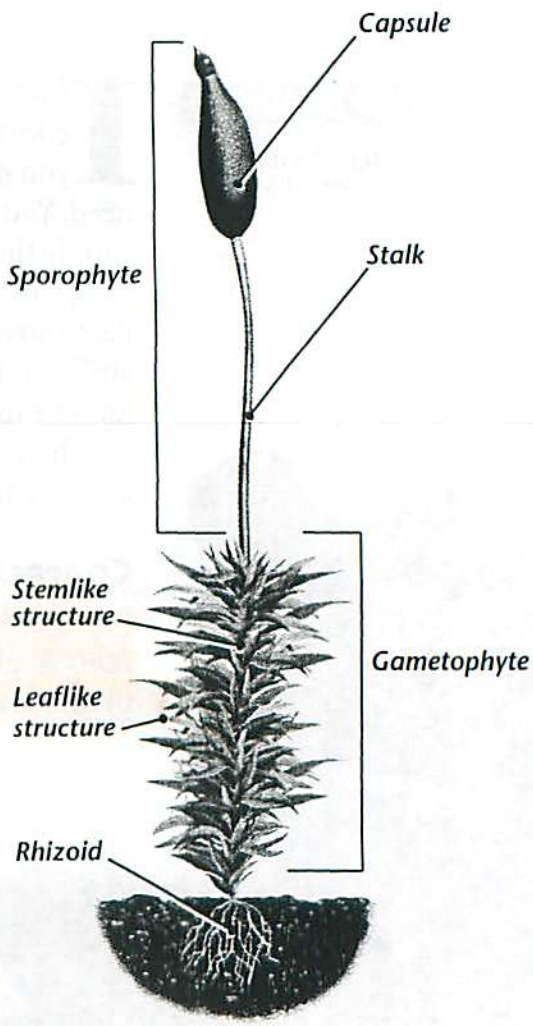


Figure 4 A moss gametophyte is low-growing and has structures that look like roots, stems, and leaves. The stalklike sporophyte generation remains attached to the gametophyte. *Interpreting Diagrams What structure anchors the gametophyte in the soil?*

Social Studies CONNECTION

Historians have found many items preserved in the acidic water of peat bogs. Weapons more than 1,600 years old have been recovered from bogs in northern Europe. In addition, about 700 human bodies have been found in bogs. Most of the bodies are as well preserved as the one that you see in the photo. This man, who lived 2,000 years ago, was found in a bog in Denmark.

In Your Journal

Imagine that you have just recovered an old wooden tool from a bog. Write a letter to a natural history museum explaining why the tool is so well preserved.

The Importance of Mosses Many people use peat moss in agriculture and gardening. The peat moss that gardeners use contains sphagnum (SFAG num) moss. Sphagnum moss grows in a type of wetland called a **bog.** The still water in a bog is so acidic that decomposing organisms cannot live in the water. Thus when the plants die, they do not decay. Instead, the dead plants accumulate at the bottom of the bog. Over time, the mosses become compressed into layers and form a blackish-brown material called **peat.** Large deposits of peat exist in North America, Europe, and Asia. In Europe and Asia, people use peat as a fuel to heat homes and to cook food.

INTEGRATING EARTH SCIENCE Like the lichens you learned about in Chapter 7, many mosses are pioneer plants. They are among the first organisms to grow in areas destroyed by volcanoes or in burnt-out forests. Like lichens, mosses trap wind-blown soil. Over time, enough soil accumulates to support the growth of other plants whose spores or seeds are blown there.

☑ *Checkpoint What does a moss sporophyte look like?*

Figure 5 The sphagnum moss that grew in this bog is being harvested as peat.

Figure 6 Like mosses, hornworts and liverworts are nonvascular plants. **A.** Hornworts grow only in soil and are often found growing among grasses. **B.** Liverworts grow flat along the ground on moist soil and rocks.

Liverworts and Hornworts

Figure 6 shows examples of two other groups of nonvascular plants—liverworts and hornworts. There are more than 8,000 species of liverworts. This group of plants is named for the shape of the plant's body, which looks somewhat like a human liver. *Wort* is an old English word for "plant." Liverworts are often found growing as a thick crust on moist rocks or soil along the sides of a stream. Unlike mosses, most liverworts grow flat along the ground. In Figure 6, you can see the gametophyte generation of one type of liverwort.

There are fewer than 100 species of hornworts. At first glance, these plants resemble liverworts. But if you look closely, you can see slender, curved structures that look like horns growing out of the gametophytes. These hornlike structures, which give these plants their names, are the sporophytes. Unlike mosses or liverworts, hornworts are seldom found on rocks or tree trunks. Instead, hornworts live in moist soil, often mixed in with grass plants.

Section 2 Review

1. Describe two characteristics that nonvascular plants share. Explain how the two characteristics are related.
2. Describe the structure of a moss plant.
3. How does peat form?
4. **Thinking Critically Comparing and Contrasting** In what ways are mosses, liverworts, and hornworts similar? How do they differ?

Check Your Progress

At this point, your plan for creating a terrarium should be complete. On a sheet of paper, list the conditions that will affect moss growth. Explain how you'll provide those conditions in your terrarium. (*Hint:* Use a sketch to show what your bottle terrarium will look like.)

SECTION 3

Ferns and Their Relatives

DISCOVER ACTIVITY

How Quickly Can Water Move Upward?

1. Put on your goggles. Your teacher will give you a plastic petri dish as well as a narrow glass tube that is open at both ends.
2. Fill the petri dish half full of water. Add a drop of food coloring to the water.
3. Stand the tube on end in the water and hold it upright. Observe what happens. Record your observations.

Think It Over

Inferring Why might it be an advantage for the transporting cells of plants to be arranged in a tubelike way?

GUIDE FOR READING

- **What are the main characteristics of seedless vascular plants?**

Reading Tip **As you read, create a table comparing ferns, club mosses, and horsetails.**

The time is 340 million years ago—long before the dinosaurs lived. The place is somewhere in the forests that covered most of Earth's land. If you could have walked through one of these ancient forests, it would have looked very strange to you.

You might have recognized the mosses and liverworts that carpeted the moist soil. But overhead you would have seen odd-looking trees, some towering as high as 25 meters above the ground. Among the trees were ancient ferns—huge versions of the ferns you find in today's florist shops. Other trees resembled giant stick figures with leaves up to one meter long. The huge leaves hugged the branches, looking something like the scales that cover a fish.

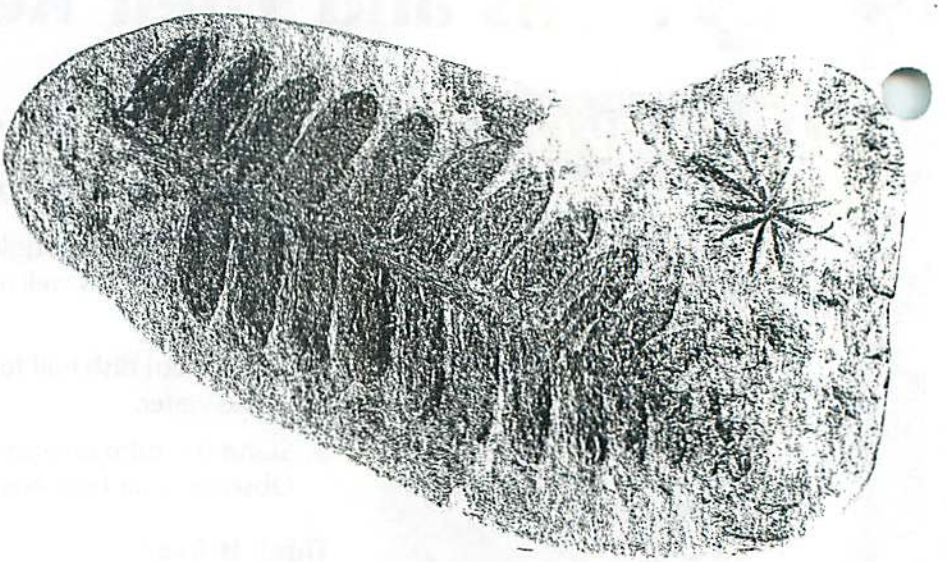


Figure 7 These fossils are from two plants that lived about 300 million years ago. The larger fossil is of a fern's leaf. The small star-shaped fossil is of a plant called a horsetail.

ACTIVITY

1. Your teacher will give you a fern plant to observe.
2. Draw a diagram of the plant and label the structures that you see.
3. Use a hand lens to observe the top and lower surfaces of the leaf. Run a finger over both surfaces.
4. With a plastic dropper, add a few drops of water to the top surface of the leaf. Note what happens.

Inferring Use your observations to explain how ferns are adapted to life on land.

INTEGRATING As the trees and other plants died, they formed thick layers and partially decomposed. Over millions of years, the layers became compressed under the weight of the layers above them. Eventually these layers became the coal deposits that we use for fuel today.

* Ferns, club mosses, horsetails: examples

The odd-looking plants in the ancient forests were the ancestors of three groups of plants that are alive today—ferns, club mosses, and horsetails. **Ferns and their relatives share two characteristics. They have vascular tissue and use spores to reproduce.**

Vascular Tissue What adaptations allowed plants to grow very tall? Unlike the mosses, the ancient trees were **vascular plants**—plants that have vascular tissue. Vascular plants are better suited to life on land than are nonvascular plants. This is because vascular tissue solves the problems of support and transportation. Vascular tissue transports water quickly and efficiently throughout the plant's body. It also transports the food produced in the leaves to other parts of the plant, including the roots.

In addition, vascular tissue strengthens the plant's body. Imagine a handful of drinking straws bundled together with rubber bands. The bundle of straws would be stronger and more

stable than a single straw would be. In a similar way, vascular tissue provides strength and stability to a plant.

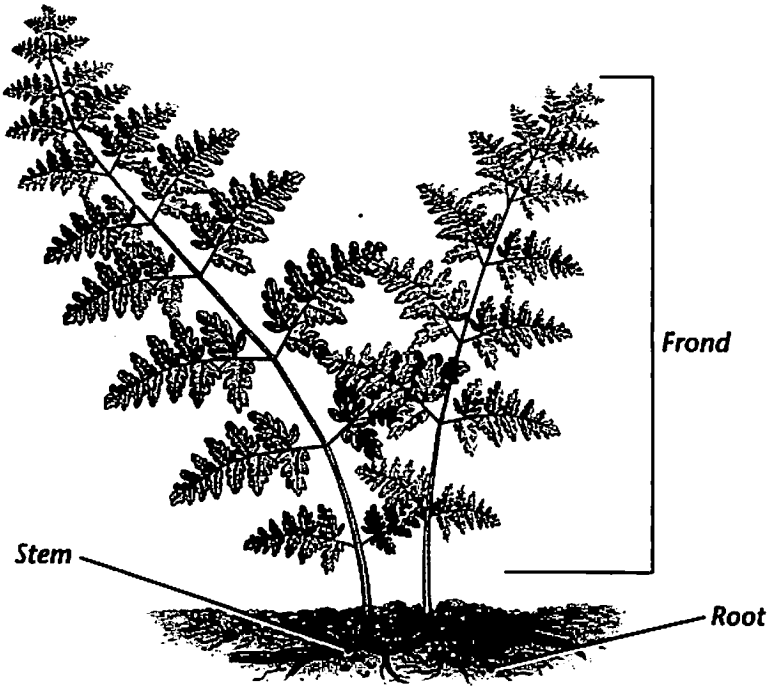
Spores for Reproduction Ferns, club mosses, and horsetails still need to grow in moist surroundings. This is because the plants release spores into their surroundings, where they grow into gametophytes. When the gametophytes produce egg cells and sperm cells, there must be enough water available for fertilization to occur.

☑ ***Checkpoint*** *What adaptation allowed plants to grow tall?*

Ferns

Fossil records indicate that ferns first appeared on land about 400 million years ago. There are over 12,000 species of ferns alive today. They range in size from tiny plants about the size of this letter "M" to large tree ferns that grow up to 5 meters tall in moist, tropical areas.

The Structure of Ferns Like other vascular plants, ferns have true stems, roots, and leaves. The stems of most ferns are underground. Leaves grow upward from the top side of the stems, and roots grow downward from the bottom of the stems. Roots are structures that anchor the fern to the ground and absorb water and nutrients from the soil. These substances enter the root's vascular tissue and travel through the tissue into the stems and leaves. In Figure 8 you can see the fern's structure.



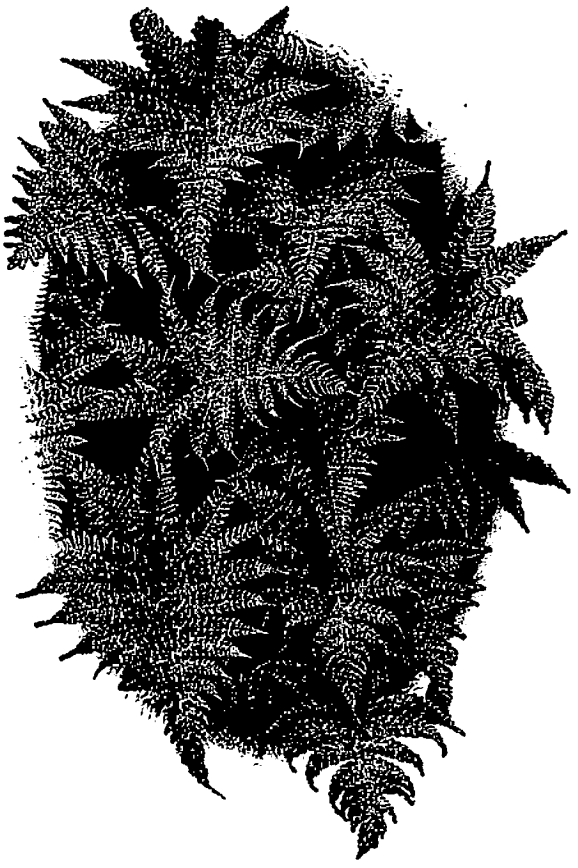


Figure 8 Most ferns have underground stems in addition to underground roots. The leaves, or fronds, grow above ground.

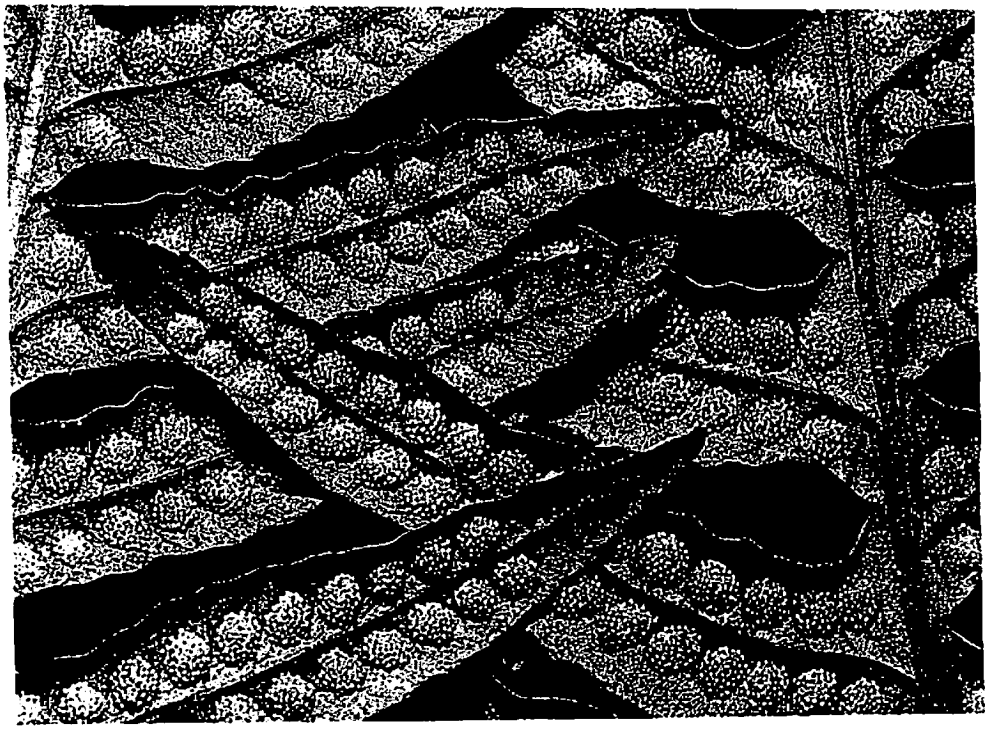


Figure 9 Spores are produced on the undersides of mature fronds. *Applying Concepts What happens to spores that are released?*

Look closely at the fern's leaves, or **fronds.** Notice that the frond is divided into many smaller parts that look like small leaves. Many other ferns have a similar divided-leaf structure. The upper surface of each frond is coated with a cuticle that helps the plant retain water. In many types of ferns, the developing leaves are coiled at first. Because they resemble the top of a violin, these young leaves are often called fiddleheads. As they mature, the fiddleheads uncurl.

Reproduction in Ferns The familiar fern with its visible fronds is the sporophyte stage of the plant. On the underside of mature fronds, spores develop in tiny spore cases. When the spores are released, wind and water can carry them great distances. If a spore lands in moist, shaded soil, it develops into a gametophyte. Fern gametophytes are tiny plants that grow low to the ground.

Figure 10 Fiddleheads are the developing leaves of a fern.

The Importance of Ferns Ferns are useful to people in many ways. They are popular houseplants because they are attractive and easy to grow. Ferns are also used to grow other kinds of houseplants. For example, orchids are often grown on the tangled masses of fern roots.

People eat some ferns. During the spring, fiddleheads are sold in supermarkets and farm stands. Fiddleheads make a nutritious vegetable dish. But because some ferns are not safe to eat, you should never gather wild fiddleheads for food.

In Southeast Asia, farmers grow a small aquatic fern alongside rice plants in their rice fields. Tiny pockets in the fern's leaves provide a home for some bacteria. The bacteria produce a natural fertilizer that helps the rice plants grow.

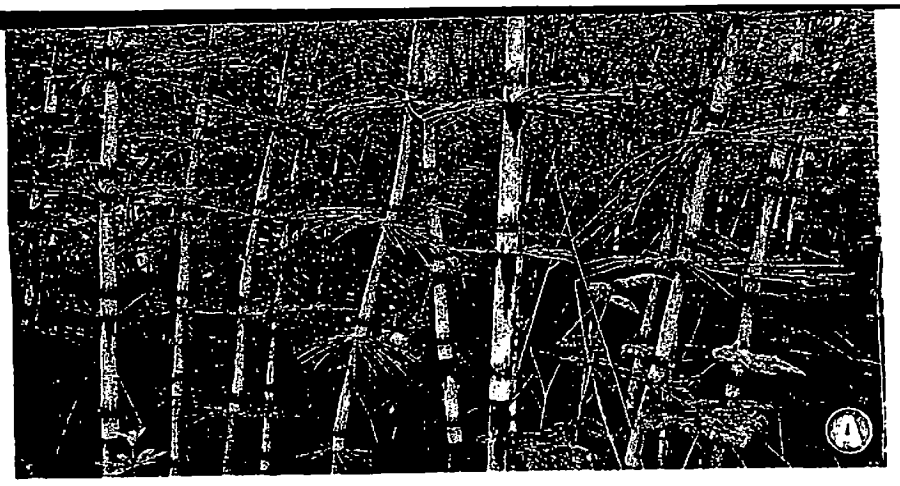


Figure 11 Horsetails and club mosses are other seedless vascular plants. A. These horsetail plants have jointed stems. Needle-like branches grow out of each joint. B. This club moss looks like a tiny pine tree.

Club Mosses and Horsetails

Two other groups of seedless, vascular plants are the club mosses and horsetails. Like ferns, club mosses and horsetails have true leaves, stems, and roots. They also have a similar life cycle. However, there are relatively few species of club mosses and horsetails alive today.

Unlike their larger ancestors, today's club mosses are small. Do not be confused by the name *club mosses.* Unlike the true mosses, the club mosses have vascular tissue. You may be familiar with the club moss you see in Figure 11. The plant, which looks like the small branch of a pine tree, is sometimes called ground pine or princess pine. It grows in moist woodlands and near streams.

There are 30 species of horsetails on Earth today. As you can see in Figure 11, the stems of horsetails are jointed. Long, coarse, needlelike branches grow in a circle around each joint. Small leaves grow flat against the stem just above each joint. The stems contain silica, a gritty substance also found in sand. During colonial times, Americans called horsetails "scouring rushes" because they used the plants to scrub their pots and pans.

Section 3 Review

1. What two characteristics do ferns, club mosses, and horsetails share? How do these characteristics differ from those of mosses?
2. Describe the structure of a fern plant. What do its leaves, stems, and roots look like?
3. List three ways that ferns are useful to people today.
4. **Thinking Critically Applying Concepts** Although ferns have vascular tissue, they still must live in moist, shady environments. Explain why this is true.

Check Your Progress

You should now be caring for your moss, and providing the best conditions for its survival and growth. Be sure to keep in mind how mosses differ from other familiar kinds of plants. (*Hint:* Keep your terrarium warm, but not hot, and make sure it remains moist.)

SECTION 4

Feeding the World

DISCOVER ACTIVITY

Will There Be Enough to Eat?

1. Choose a numbered tag from the bag that your teacher provides. If you pick a tag with the number 1 on it, you're from a wealthy country. If you pick a tag with the number 2, you're from a middle-income country. If you pick a tag with the number 3, you're from a poor country.
2. Find classmates that have the same number on their tag. Sit down as a group.
3. Your teacher will serve your group a meal. The amount of food you receive will depend on the number on your tag.
4. As you eat, observe the people in your group and in the other groups. After you eat, record your observations. Also, record how you felt and what you were thinking during the meal.

Think It Over

Predicting Based on this activity, predict what effect an increase in the world's population would have on the world's food supply.

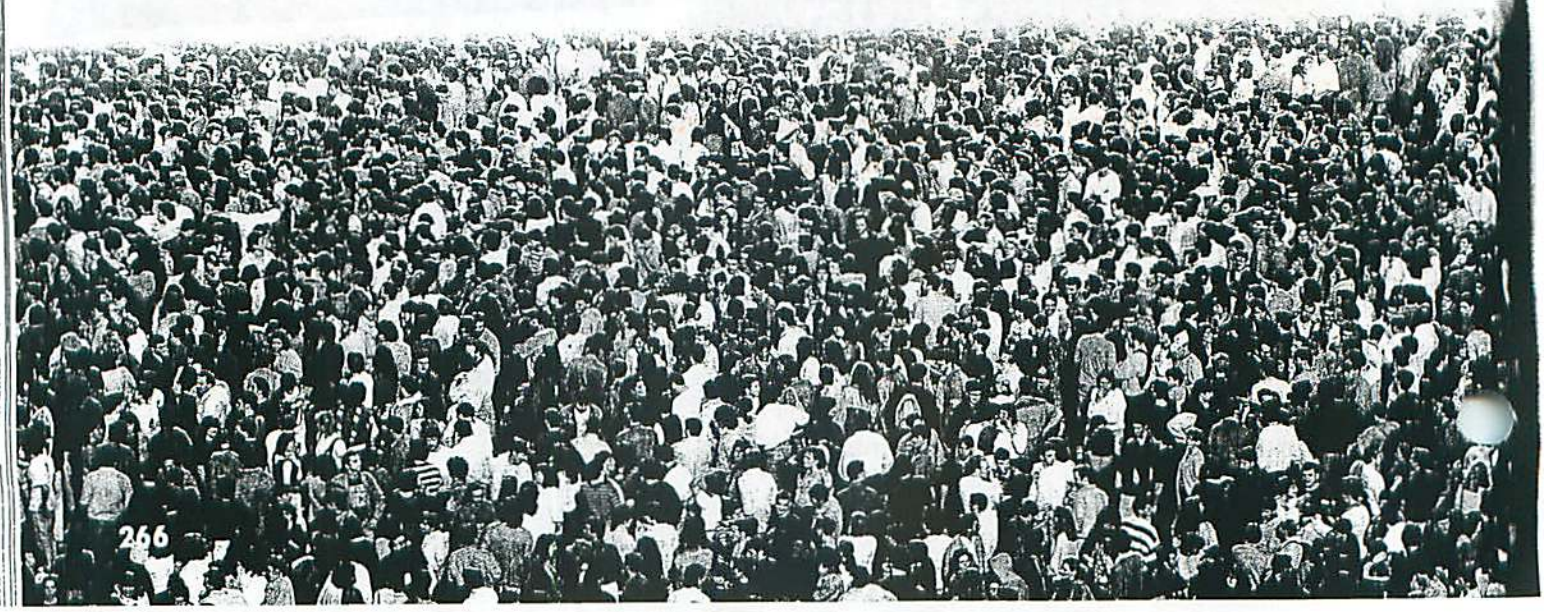
GUIDE FOR READING

- What methods may help farmers produce more crops?

Reading Tip As you read, make a list of the technologies being used to increase Earth's food supply.

Today, about six billion people live on Earth. Some scientists predict that by the year 2050 the population will grow to ten billion people. Think about how much additional food will be needed to feed the growing population. How will farmers be able to grow enough food?

Fortunately, both scientists and farmers are already hard at work trying to find answers to this question. In laboratories, scientists are developing plants that are more resistant to insects, disease, and drought. They are also developing plants that produce more food per plant. On farms, new, efficient, "high-tech" farming practices are being used.



Producing Better Plants

Wheat, corn, rice, and potatoes are the major sources of food for people on Earth today. To feed more people, then, the production, or yields, of these crops must be increased. This is not an easy task. One challenge facing farmers is that these crops grow only in certain climates. Another challenge is that the size and structure of these plants limit how much food they can produce.

Today scientists are using new technologies to address these challenges. Recall from Chapter 4 that scientists can manipulate the genetic material of certain bacteria to produce human insulin. The process that these scientists use is called genetic engineering. In genetic engineering, scientists alter an organism's genetic material to produce an organism with qualities that people find useful.

Figure 12 In this high-tech greenhouse, scientists control the environmental conditions as they develop new types of plants. *Applying Concepts How might new plant types lead to increased crop yields in the future?*

Scientists are using genetic engineering to produce plants that can grow in a wider range of climates. They are also engineering plants to be more resistant to damage from insects. For example, scientists have inserted genetic material from a bacterium into corn and tomato plants. The new genetic material enables the plants to produce substances that kill insects. Caterpillars or other insects that bite into the leaves of these plants are killed. Today, many kinds of genetically engineered plants are grown on experimental farms. Some of these plants may produce the crops of the future.

☑ ***Checkpoint*** *What are the four crops on which people depend?*

Improving the Efficiency of Farms

On the farms of the future, satellite images and computers will be just as important as tractors and harvesters. These new tools will allow farmers to practice "precision farming"—knowing just how much water and fertilizer different fields require. First, satellite images of the farmer's fields are taken. Then, a computer analyzes the images to determine the makeup of the soil in different fields on the farm. The computer uses the data to prepare a watering and fertilizing plan for each field. Precision farming benefits farmers because it saves time and money. It also increases crop yields by helping farmers maintain ideal conditions in all fields.

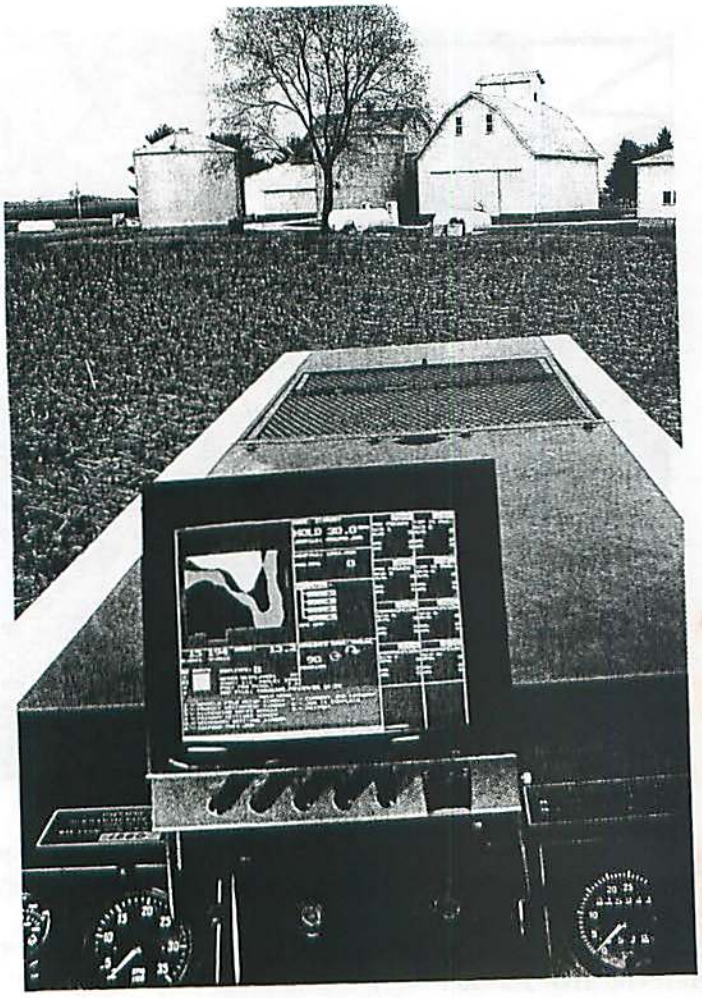


Figure 13 The map on the computer screen of this tractor shows the makeup of the soil in a farm's fields. The map was obtained by satellite imaging.

INTEGRATING Precision farming also benefits the environment because farmers use only as much fertilizer as the soil needs. When less fertilizer is used, fewer nutrients wash off the land into lakes and rivers. As you read in Chapter 7, reducing the use of fertilizers is one way to prevent algal blooms from damaging bodies of water.

Hydroponics

In some areas of the world, poor soil does not support the growth of crops. For example, on some islands in the Pacific Ocean, the soil contains large amounts of salt from the surrounding ocean. Food crops will not grow in the salty soil.

On these islands, people can use hydroponics to grow food crops. **Hydroponics** (hy druh PAHN iks) is a method by which plants are grown in solutions of nutrients instead of in soil. Usually, the plants are grown in containers in which their roots are anchored in gravel or sand. The nutrient-rich water is pumped through the gravel or sand. Unfortunately, hydroponics is a costly method of growing food crops. But, the process allows people to grow crops in areas with poor farmland to help feed a growing population.

Section 4 Review

1. List three methods that farmers can use to increase crop yields.
2. Explain how genetic engineering may help farmers grow more food.
3. How does precision farming benefit farmers? How does it benefit the environment?
4. **Thinking Critically Applying Concepts** How are plants that are grown using hydroponics able to survive without soil?

CHAPTER PROJECT

Check Your Progress

Begin planning your brochure as you continue caring for your moss. What's the best way to give clear directions for making a terrarium? What must you say about the amount of light, water, and other conditions that mosses need to survive? (*Hint:* Be sure to include important information about mosses, such as how tall they grow and how they reproduce.)

CHAPTER 8 STUDY GUIDE

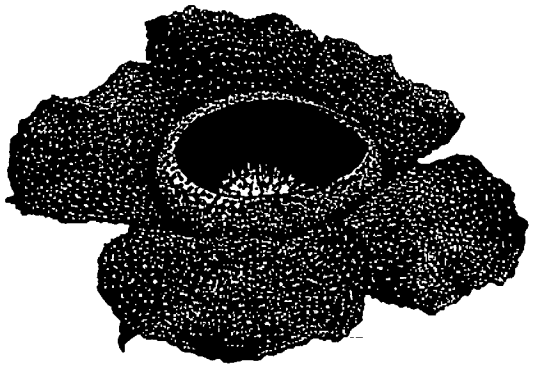
SECTION 1 The Plant Kingdom

Key Ideas

- Plants are multicellular eukaryotes and autotrophs.
- For plants to survive on land, they need ways to obtain water and other materials from their surroundings, retain moisture, support their bodies, transport materials throughout the plant, and reproduce successfully.
- All plants have complex life cycles. In the sporophyte stage, plants produce spores. In the gametophyte stage, plants produce sperm cells and egg cells.

Key Terms

cuticle	zygote
tissue	sporophyte
vascular tissue	gametophyte
fertilization	gamete



SECTION 2 Mosses, Liverworts, and Hornworts

Key Ideas

- Nonvascular plants are small, low-growing plants that lack vascular tissue. Most nonvascular plants transport materials by passing them from one cell to the next.
- Mosses, liverworts, and hornworts are three types of nonvascular plants.

Key Terms

nonvascular plant	bog
rhizoid	peat

SECTION 3 Ferns and Their Relatives

Key Ideas

- Seedless vascular plants have vascular tissue and use spores to reproduce. These plants include ferns, club mosses, and horsetails.
- Although seedless vascular plants grow taller than nonvascular plants, they still need to live in moist places. The plants' spores are released into the environment, where they grow into gametophytes.

Key Terms

vascular plant	frond

SECTION 4 Feeding the World

INTEGRATING TECHNOLOGY

Key Idea

- Genetic engineering, precision farming, and hydroponics can help farmers produce more crops to feed the world's growing population.

Key Term

hydroponics

Organizing Information

Compare/Contrast Table Copy the table comparing mosses and ferns onto a separate sheet of paper. Complete the table by filling in the missing information. Then add a title. (For more on compare/contrast tables, see the Skills Handbook.)

Characteristic	Moss	Fern
Size	a. ?	Can be tall
Environment	Moist	b. ?
Body parts	Rootlike, stemlike, and leaflike	c. ?
Familiar generation	d. ?	sporophyte
Vascular tissue present?	e. ?	f. ?

Reviewing Content

For more review of key concepts, see the Interactive Student Tutorial CD-ROM.

Multiple Choice

Choose the letter of the best answer.

1. The products of photosynthesis are
   a. food and carbon dioxide.
   b. food and water.
   c. food and oxygen.
   d. water and oxygen.
2. Mosses and ferns are both
   a. vascular plants.
   b. nonvascular plants.
   c. seed plants.
   d. plants.
3. The familiar green, fuzzy moss is the
   a. frond.
   b. rhizoid.
   c. gametophyte.
   d. sporophyte.
4. The leaves of ferns are called
   a. rhizoids.
   b. sporophytes.
   c. fronds.
   d. cuticles.
5. The process of growing crops in a nutrient solution is called
   a. genetic engineering.
   b. hydroponics.
   c. precision farming.
   d. satellite imaging.

True or False

If the statement is true, write true. If it is false, change the underlined word or words to make the statement true.

6. Plants are <u>autotrophs</u>.
7. <u>Tissues</u> are groups of similar cells that perform a specific function in an organism.
8. Mosses are <u>vascular</u> plants.
9. The young leaves of <u>liverworts</u> are known as fiddleheads.
10. The four basic food crops of the world are wheat, corn, rice, and <u>potatoes</u>.

Checking Concepts

11. Describe the process of photosynthesis. Explain why it is an important process for a plant.
12. In what two ways is vascular tissue important to a plant? Give an example of a plant that has vascular tissue.
13. Briefly describe the life cycle of a typical plant.
14. Explain why fern plants are found in moist areas.
15. In what ways do mosses and club mosses differ from each other? In what ways are they similar?
16. How can the use of hydroponics help increase the amount of food that can be grown on Earth?
17. **Writing to Learn** Suppose you are living in a farming community. Write a letter to the editor of the local newspaper that explains how precision farming can increase crop yields. Also explain the other benefits of precision farming to farmers and to the environment.

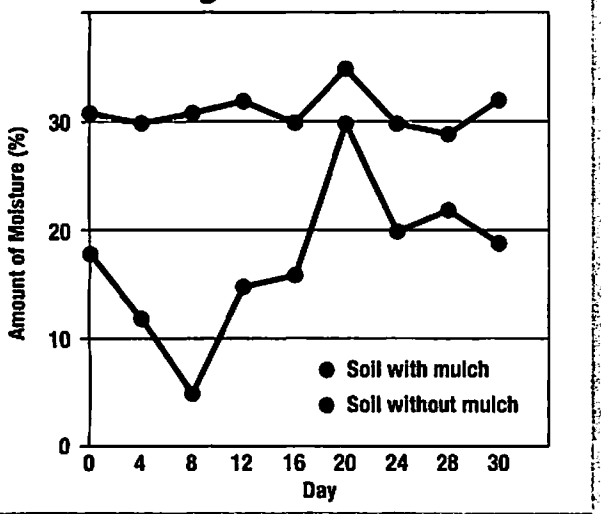
Thinking Critically

18. **Comparing and Contrasting** How does the sporophyte generation of a plant differ from the gametophyte generation?
19. **Applying Concepts** A friend tells you that he has seen moss plants that are about 2 meters tall. Is your friend correct? Explain your reasoning.
20. **Relating Cause and Effect** People have observed that mosses tend to grow on the north side of a tree rather than the south side. Why do you think this is so?
21. **Making Judgments** Suppose you were a scientist using genetic engineering to increase crop yields. What improvements would you try to introduce? How would they be beneficial?

Applying Skills

Some gardeners spread a protective layer of mulch—plant material such as wood chips, peat moss, or straw—on the soil around plants. The graph below compares how much moisture is retained by soil covered with mulch and by soil without mulch. Use the graph to answer Questions 22–24.

Changes in Soil Moisture



22. **Comparing and Contrasting** How does the amount of moisture in soil covered with mulch differ from the amount of moisture in the uncovered soil?
23. **Inferring** The amount of moisture in both soils increased greatly between days 16 and 20. Explain why this might have happened.
24. **Drawing Conclusions** If you were a gardener, would you grow your plants in soil covered with mulch or in soil that was uncovered? Explain.

Performance Assessment

Present Your Project It's time to share your "How to Raise Mosses" brochure with others. Be prepared to explain the information in your brochure. Ask other students about their work.

Reflect and Record What did you learn by keeping the terrarium and making the brochure? Did you discover new ideas from brochures made by others? If you were to repeat this project, how could you improve your work?

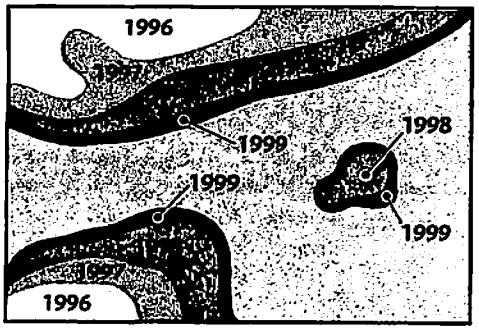
Test Preparation

Use these questions to prepare for standardized tests.

Use the information to answer Questions 25–27.

When bracken ferns grow, their underground stems grow outward and produce new plants. As the map below shows, the new ferns spread into nearby open areas. The bands of color indicate the areas where bracken ferns grew over a four-year period.

Patches of Fern Growth in an Open Field



25. During which year did the ferns grow most slowly?
    a. 1996 b. 1997
    c. 1998 d. 1999
26. In how many areas in the field were bracken ferns growing in 1997?
    a. one b. two
    c. three d. four
27. The underground stems of bracken ferns do not grow far before producing new plants. What is the most likely explanation for how bracken ferns began to grow in the middle of the field in 1998?
    a. It rained less than usual.
    b. The temperatures were higher than normal.
    c. The whole field was fertilized.
    d. Spores blew into a moist part of the field.