

The Characteristics of Seed Plants

Reading Preview

Key Concepts

- What characteristics do seed plants share?
- How do seeds become new plants?
- What are the main functions of roots, stems, and leaves?

Key Terms

- phloem • xylem • pollen
- seed • embryo • cotyledon
- germination • root cap
- cambium • transpiration

Target Reading Skill

Outlining As you read, make an outline about seed plants that you can use for review. Use the red headings for the main ideas and the blue headings for the supporting ideas.

The Characteristics of Seed Plants

- I. What is a seed plant?
 - A. Vascular tissue
 - B.
- II. How seeds become new plants
 - A.
 - B.

Lab
zone

Discover Activity

Which Plant Part Is It?

1. With a partner, carefully observe the items of food your teacher gives you.
2. Make a list of the food items.
3. For each food item, write the name of the plant part—root, stem, or leaf—from which you think it is obtained.



Think It Over

Classifying Classify the items into groups depending on the plant part from which the food is obtained. Compare your groupings with those of your classmates.

Have you ever planted seeds in a garden? If so, then you may remember how it seemed to take forever before those first green shoots emerged. Shortly afterwards, you saw one set of leaves, and then others. Then a flower may have appeared. Did you wonder where all those plant parts came from? How did they develop from one small seed? Read on to find out.

What Is a Seed Plant?

The plant growing in your garden was a seed plant. So are most of the other plants around you. In fact, seed plants outnumber seedless plants by more than ten to one. You eat many seed plants—rice, peas, and squash, for example. You wear clothes made from seed plants, such as cotton and flax. You may live in a home built from seed plants—oak, pine, or maple trees. In addition, seed plants produce much of the oxygen you breathe.

Seed plants share two important characteristics. They have vascular tissue, and they use pollen and seeds to reproduce. In addition, all seed plants have body plans that include roots, stems, and leaves. Like seedless plants, seed plants have complex life cycles that include the sporophyte and the gametophyte stages. In seed plants, the plants that you see are the sporophytes. The gametophytes are microscopic.

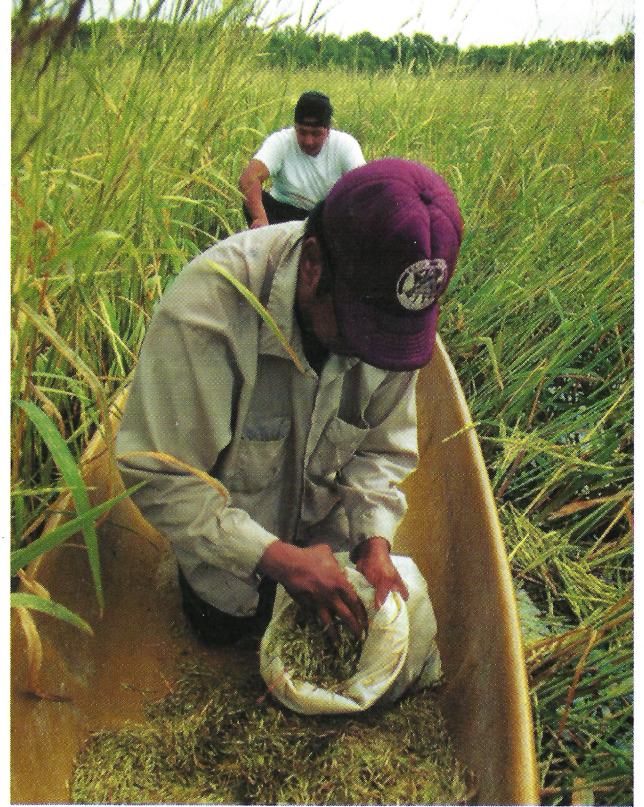


FIGURE 9

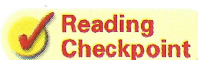
Harvesting Wild Rice

Like all seed plants, wild rice plants have vascular tissue and use seeds to reproduce. The seeds develop in shallow bodies of water, and the plants grow up above the water's surface. These men are harvesting the mature rice grains.

Vascular Tissue Most seed plants live on land. Recall that land plants face many challenges, including standing upright and supplying all their cells with food and water. Like ferns, seed plants meet these two challenges with vascular tissue. The thick walls of the cells in the vascular tissue help support the plants. In addition, food, water, and nutrients are transported throughout the plants in vascular tissue.

There are two types of vascular tissue. **Phloem** (FLOH um) is the vascular tissue through which food moves. When food is made in the leaves, it enters the phloem and travels to other parts of the plant. Water and minerals, on the other hand, travel in the vascular tissue called **xylem** (ZY lum). The roots absorb water and minerals from the soil. These materials enter the root's xylem and move upward into the stems and leaves.

Pollen and Seeds Unlike seedless plants, seed plants can live in a wide variety of environments. Recall that seedless plants need water in their surroundings for fertilization to occur. Seed plants do not need water for sperm to swim to the eggs. Instead, seed plants produce **pollen**, tiny structures that contain the cells that will later become sperm cells. Pollen delivers sperm cells directly near the eggs. After sperm cells fertilize the eggs, seeds develop. A **seed** is a structure that contains a young plant inside a protective covering. Seeds protect the young plant from drying out.



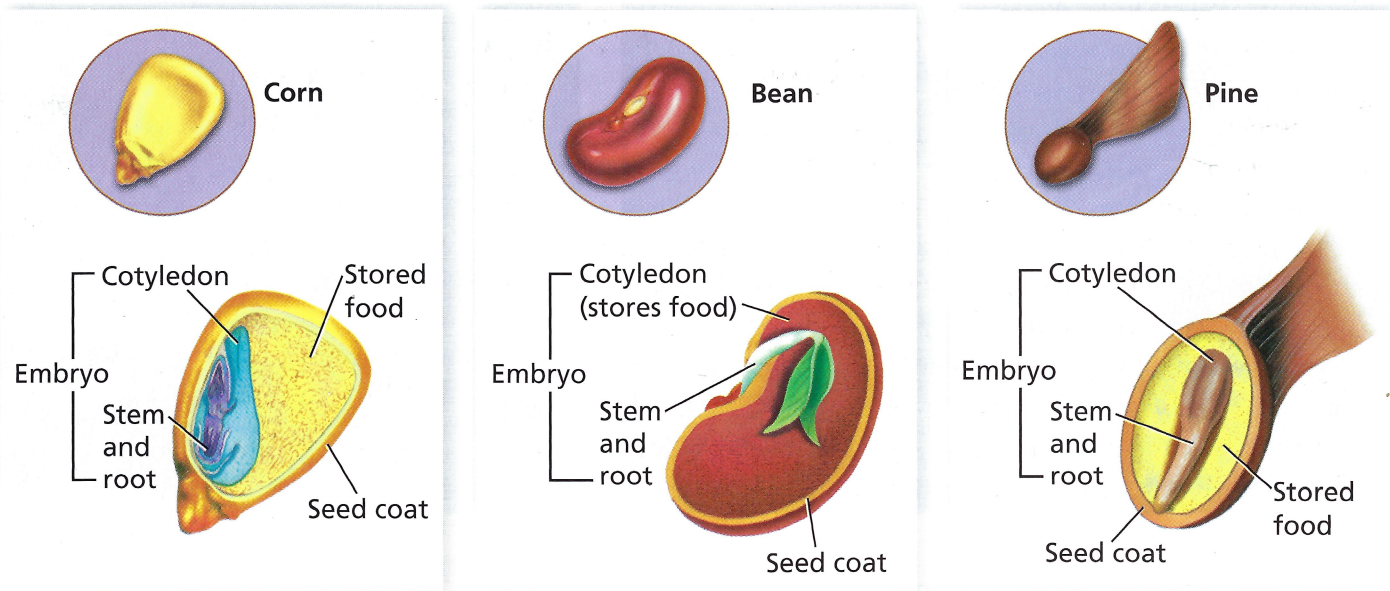
**Reading
Checkpoint**

What material travels in phloem? What materials travel in xylem?

FIGURE 10

Seed Structure

The structures of three different seeds are shown here. **Inferring** How is the stored food used?



Lab zone Try This Activity

The In-Seed Story

1. Your teacher will give you a hand lens and two different seeds that have been soaked in water.
2. Carefully observe the outside of each seed. Draw what you see.
3. Gently remove the coverings of the seeds. Then carefully separate the parts of each seed. Use a hand lens to examine the inside of each seed. Draw what you see.

Observing Based on your observations, label the parts of each seed. Then describe the function of each part next to its label.

How Seeds Become New Plants

All seeds share important similarities. **Inside a seed is a partially developed plant.** If a seed lands in an area where conditions are favorable, the plant sprouts out of the seed and begins to grow.

Seed Structure A seed has three main parts—an embryo, stored food, and a seed coat. The young plant that develops from the zygote, or fertilized egg, is called the **embryo**. The embryo already has the beginnings of roots, stems, and leaves. In the seeds of most plants, the embryo stops growing when it is quite small. When the embryo begins to grow again, it uses the food stored in the seed until it can make its own food by photosynthesis. In all seeds, the embryo has one or more seed leaves, or **cotyledons** (kaht uh LEED unz). In some seeds, food is stored in the cotyledons. In others, food is stored outside the embryo. Figure 10 compares the structure of corn, bean, and pine seeds.

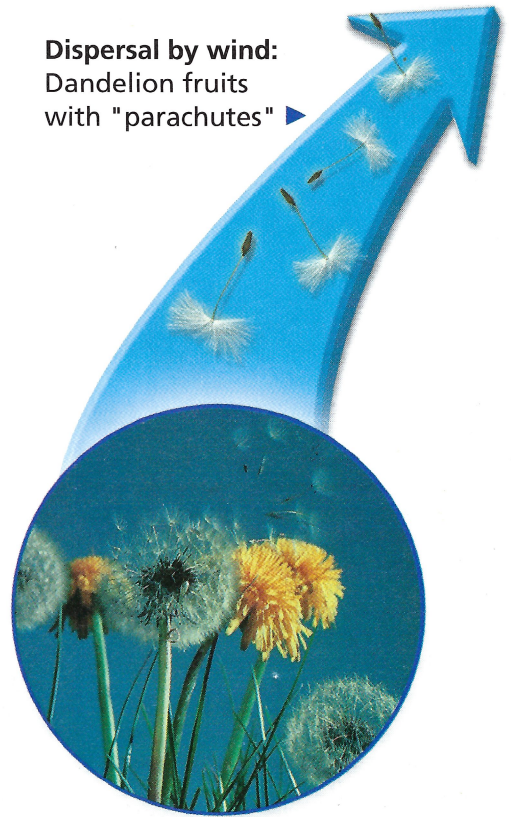
The outer covering of a seed is called the seed coat. Some familiar seed coats are the “skins” on lima beans and peanuts. The seed coat acts like plastic wrap, protecting the embryo and its food from drying out. This allows a seed to remain inactive for a long time. In many plants, the seeds are surrounded by a structure called a fruit.

Seed Dispersal After seeds have formed, they are usually scattered, sometimes far from where they were produced. The scattering of seeds is called seed dispersal. Seeds are dispersed in many ways. One method involves other organisms. For example, some animals eat fruits, such as cherries or grapes. The seeds inside the fruits pass through the animal's digestive system and are deposited in new areas. Other seeds are enclosed in barblike structures that hook onto an animal's fur or a person's clothes. The structures then fall off the fur or clothes in a new area.

A second means of dispersal is water. Water can disperse seeds that fall into oceans and rivers. A third dispersal method involves wind. Wind disperses lightweight seeds that often have structures to catch the wind, such as those of dandelions and maple trees. Finally, some plants eject their seeds in a way that might remind you of popping popcorn. The force scatters the seeds in many directions.

FIGURE 11
Seed Dispersal

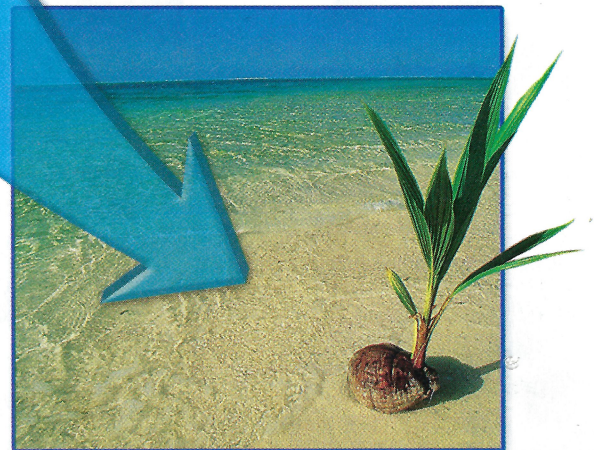
The seeds of these plants are enclosed in fruits with adaptations that help them disperse.



Dispersal by wind:
Dandelion fruits
with "parachutes" ▶



◀ **Dispersal
by animals:**
Barblike fruits



Dispersal by water:
Floating coconut
palm fruit ▶

Seed Plants

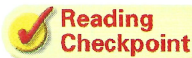
Video Preview

▶ Video Field Trip

Video Assessment

Germination After a seed is dispersed, it may remain inactive for a while before it germinates. **Germination** (jur muh NAY shun) occurs when the embryo begins to grow again and pushes out of the seed. Germination begins when the seed absorbs water from the environment. Then the embryo uses its stored food to begin to grow. As shown in Figure 12, the embryo's roots first grow downward; then its stem and leaves grow upward. Once you can see a plant's leaves, the plant is called a seedling.

A seed that is dispersed far from its parent plant has a better chance of survival. When a seed does not have to compete with its parent for light, water, and nutrients, it has a better chance of becoming a seedling.



What must happen in order for germination to begin?

Roots

Have you ever tried to pull a dandelion out of the soil? It's not easy, is it? That is because most roots are good anchors. Roots have three main functions. **Roots anchor a plant in the ground, absorb water and minerals from the soil, and sometimes store food.** The more root area a plant has, the more water and minerals it can absorb.

Types of Roots The two main types of root systems are shown in Figure 13. A fibrous root system consists of many similarly sized roots that form a dense, tangled mass. Plants with fibrous roots take much soil with them when you pull them out of the ground. Lawn grass, corn, and onions have fibrous root systems. In contrast, a taproot system has one long, thick main root. Many smaller roots branch off the main root. A plant with a taproot system is hard to pull out of the ground. Carrots, dandelions, and cacti have taproots.

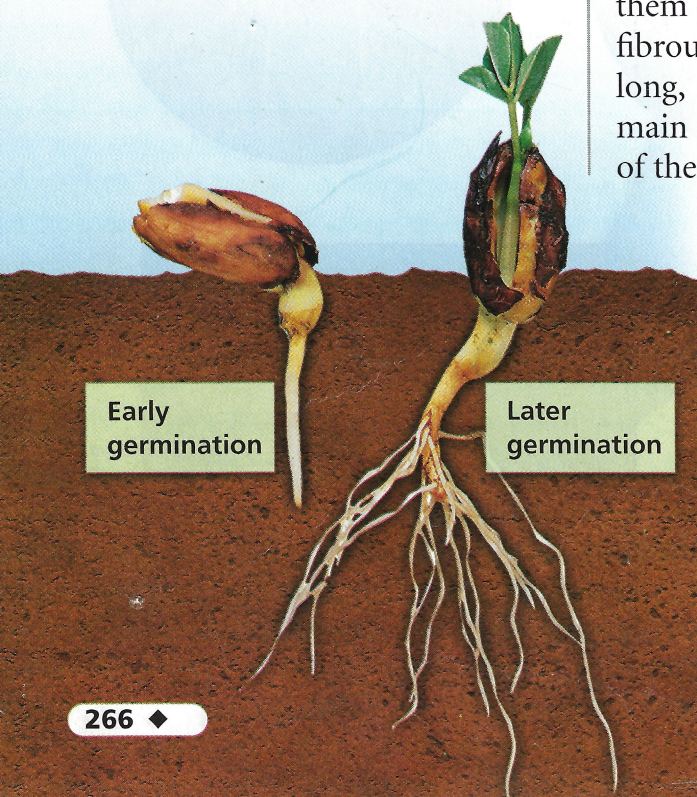


FIGURE 12

Germination

The embryo in this peanut seed uses its stored food to germinate. First, the embryo's roots grow downward. Then, its stem and leaves begin to grow upward.

The Structure of a Root In Figure 13, you can see the structure of a typical root. Notice that the tip of the root is rounded and is covered by a structure called the root cap. The **root cap** protects the root from injury from rocks as the root grows through the soil. Behind the root cap are the cells that divide to form new root cells.

Root hairs grow out of the root's surface. These tiny hairs can enter the spaces between soil particles, where they absorb water and minerals. By increasing the surface area of the root that touches the soil, root hairs help the plant absorb large amounts of substances. The root hairs also help to anchor the plant in the soil.

Locate the vascular tissue in the center of the root. The water and nutrients that are absorbed from the soil quickly move into the xylem. From there, these substances are transported upward to the plant's stems and leaves.

Phloem transports food manufactured in the leaves to the root. The root tissues may then use the food for growth or store it for future use by the plant.

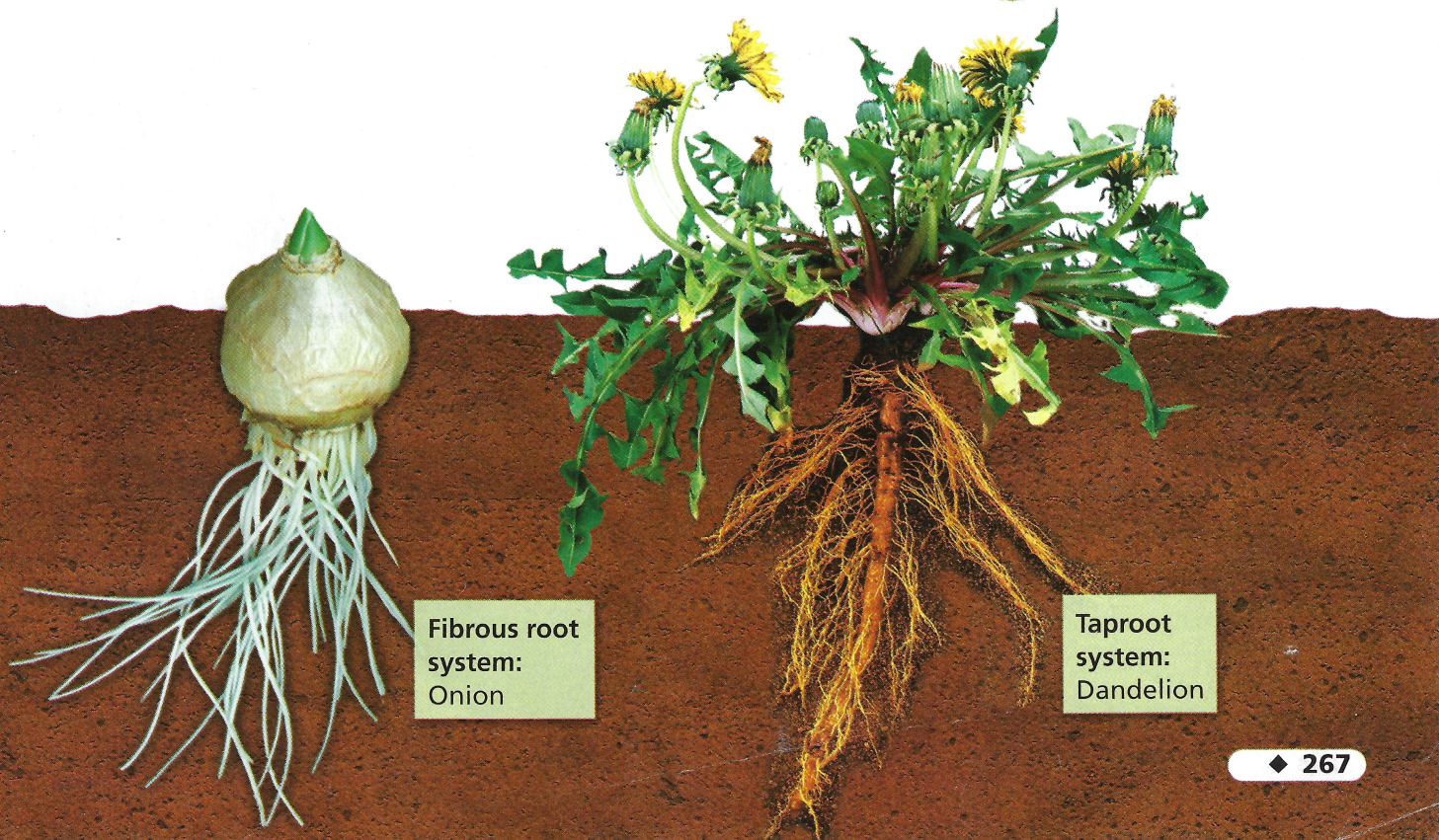
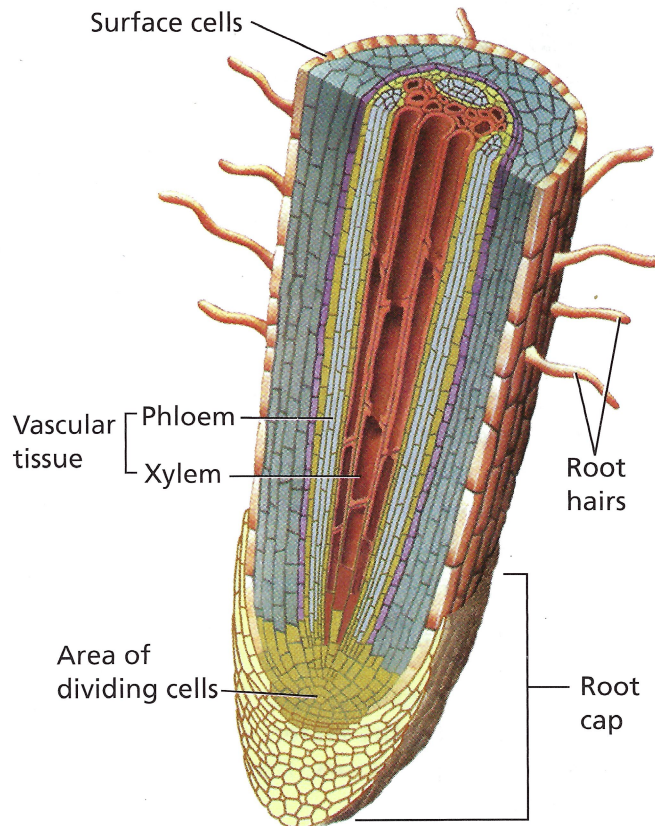


What is a root cap?

FIGURE 13
Root Structure


Some plants have fibrous roots while others have taproots. A root's structure is adapted for absorbing water and minerals from the soil.

Relating Cause and Effect How do root hairs help absorb water and minerals?



Calculating

In this activity, you will calculate the speed at which water moves up a celery stalk.

1.  Pour about 1 cm of water into a tall plastic container. Stir in several drops of red food coloring.
2. Place the freshly cut end of a celery stalk in the water. Lean the stalk against the container's side.
3. After 20 minutes, remove the celery. Use a metric ruler to measure the height of the water in the stalk.
4. Use the measurement and the following formula to calculate how fast the water moved up the stalk.

$$\text{Speed} = \frac{\text{Height}}{\text{Time}}$$

Based on your calculation, predict how far the water would move in 2 hours. Then test your prediction.

Stems

The stem of a plant has two main functions. The stem carries substances between the plant's roots and leaves. The stem also provides support for the plant and holds up the leaves so they are exposed to the sun. In addition, some stems, such as those of asparagus, store food.

The Structure of a Stem Stems can be either herbaceous (hur BAY shus) or woody. Herbaceous stems contain no wood and are often soft. Coneflowers and pepper plants have herbaceous stems. In contrast, woody stems are hard and rigid. Maple trees and roses have woody stems.

Both herbaceous and woody stems consist of phloem and xylem tissue as well as many other supporting cells. Figure 14 shows the inner structure of one type of herbaceous stem.

As you can see in Figure 15, a woody stem contains several layers of tissue. The outermost layer is bark. Bark includes an outer protective layer and an inner layer of living phloem, which transports food through the stem. Next is a layer of cells called the **cambium** (KAM bee um), which divide to produce new phloem and xylem. It is xylem that makes up most of what you call "wood." Sapwood is active xylem that transports water and minerals through the stem. The older, darker, heartwood is inactive but provides support.



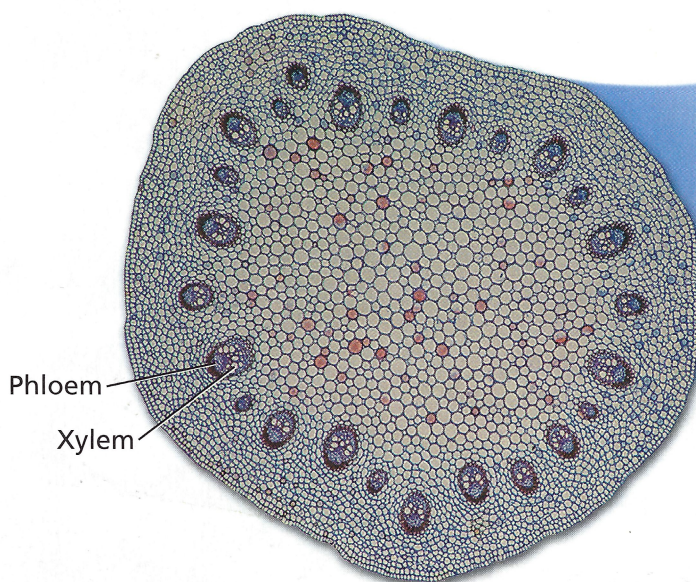
**Reading
Checkpoint**

What function does the bark of a woody stem perform?

FIGURE 14

A Herbaceous Stem

Herbaceous stems, like those on these coneflowers, are often soft. The inset shows the inner structure of one type of herbaceous stem.



Annual Rings Have you ever looked at a tree stump and seen a pattern of circles that looks something like a target? These circles are called annual rings because they represent a tree's yearly growth. Annual rings are made of xylem. Xylem cells that form in the spring are large and have thin walls because they grow rapidly. They produce a wide, light brown ring. Xylem cells that form in the summer grow slowly and, therefore, are small and have thick walls. They produce a thin, dark ring. One pair of light and dark rings represents one year's growth. You can estimate a tree's age by counting its annual rings.

The width of a tree's annual rings can provide important clues about past weather conditions, such as rainfall. In rainy years, more xylem is produced, so the tree's annual rings are wide. In dry years, rings are narrow. By examining annual rings from some trees in the southwestern United States, scientists were able to infer that severe droughts occurred in the years 840, 1067, 1379, and 1632.



FIGURE 15
A Woody Stem

Trees like these maples have woody stems. A typical woody stem is made up of many layers. The layers of xylem form annual rings that can reveal the age of the tree and the growing conditions it has experienced.

Interpreting Diagrams *Where is the cambium located?*

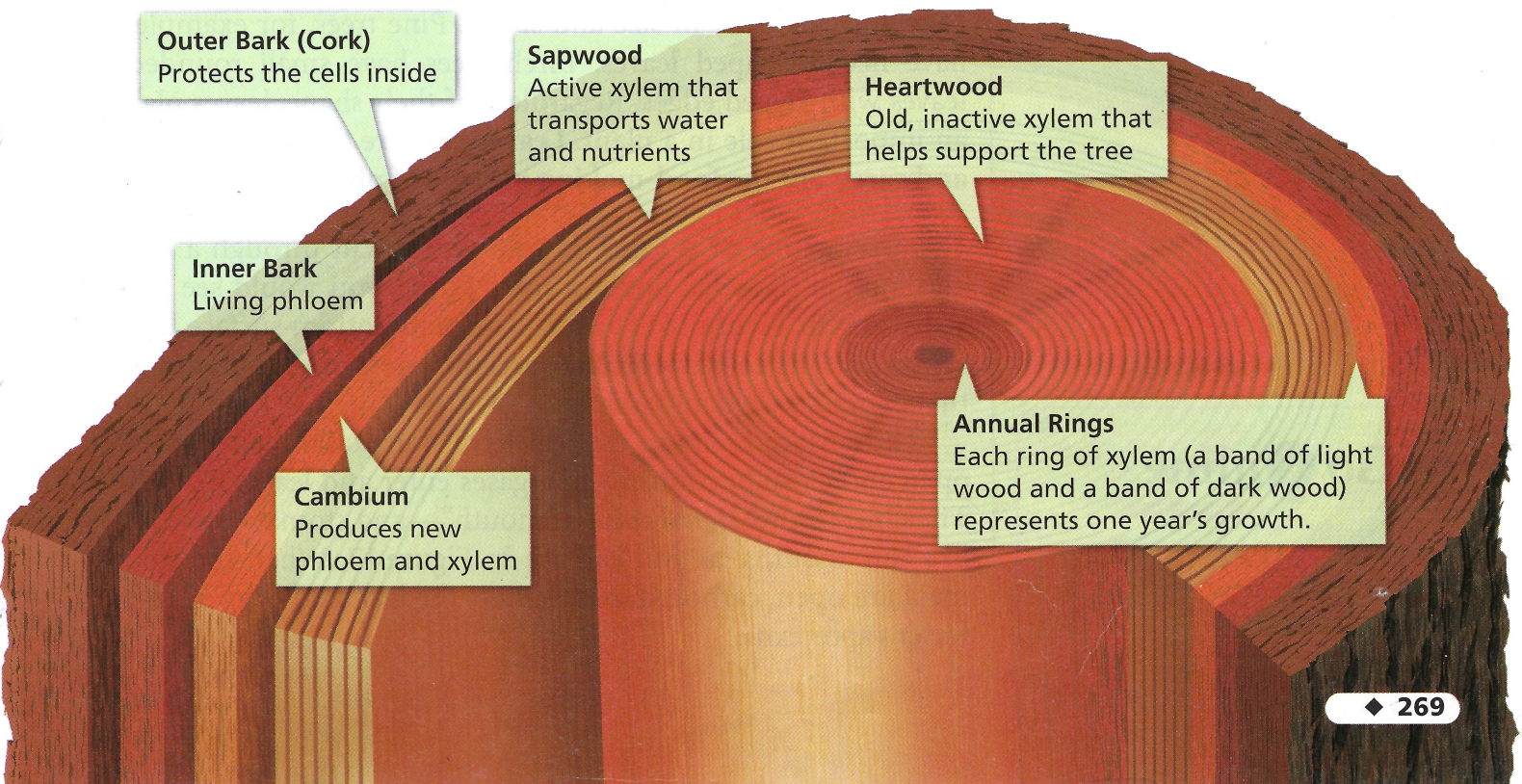
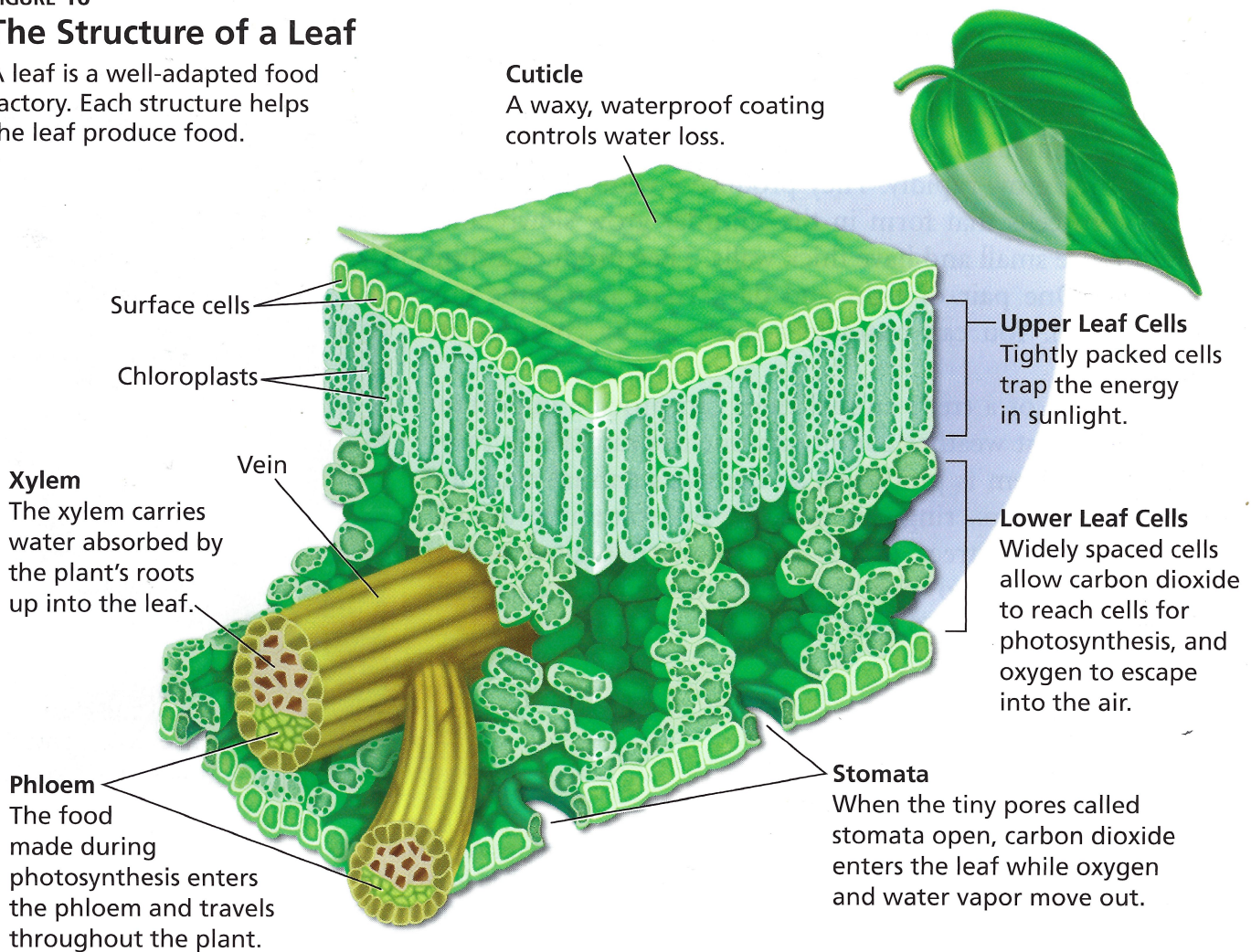


FIGURE 16

The Structure of a Leaf

A leaf is a well-adapted food factory. Each structure helps the leaf produce food.



Leaves

Leaves vary greatly in size and shape. Pine trees, for example, have needle-shaped leaves. Birch trees have small rounded leaves with jagged edges. Regardless of their shape, leaves play an important role in a plant. **Leaves capture the sun's energy and carry out the food-making process of photosynthesis.**

The Structure of a Leaf If you were to cut through a leaf and look at the edge under a microscope, you would see the structures in Figure 16. The leaf's top and bottom surface layers protect the cells inside. Between the layers of cells are veins that contain xylem and phloem.

The surface layers of the leaf have stomata, the pores that open and close to control when gases enter and leave the leaf. The Greek word *stoma* means "mouth"—and stomata do look like tiny mouths, as you can see in Figure 17. When the stomata are open, carbon dioxide enters the leaf, and oxygen and water vapor exit.

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The Leaf and Photosynthesis The structure of a leaf is ideal for carrying out photosynthesis. The cells that contain the most chloroplasts are located near the leaf's upper surface, where they get the most light. Recall that the chlorophyll in the chloroplasts traps the sun's energy.

Carbon dioxide enters the leaf through open stomata. Water, which is absorbed by the plant's roots, travels up the stem to the leaf through the xylem. During photosynthesis, sugar and oxygen are produced from the carbon dioxide and water. Oxygen passes out of the leaf through the open stomata. The sugar enters the phloem and then travels throughout the plant.

Controlling Water Loss Because such a large area of a leaf is exposed to the air, water can quickly evaporate, or be lost, from a leaf into the air. The process by which water evaporates from a plant's leaves is called **transpiration**. A plant can lose a lot of water through transpiration. A corn plant, for example, can lose almost 4 liters of water on a hot summer day. Without a way to slow down the process of transpiration, a plant would shrivel up and die.

Fortunately, plants have ways to slow down transpiration. One way that plants retain water is by closing the stomata. The stomata often close when leaves start to dry out.



Reading Checkpoint

How does water get into a leaf?

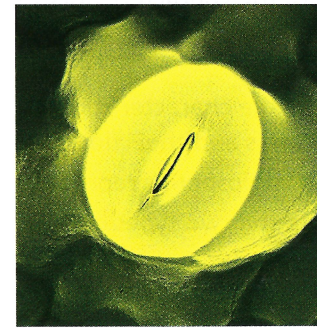
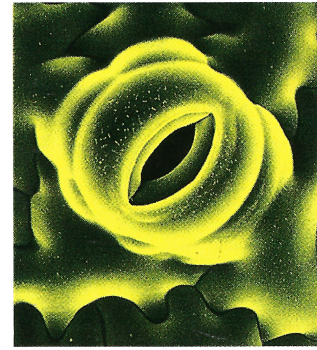


FIGURE 17

Stomata

Stomata open (top) and close (bottom) to control when gases enter and exit the leaf.

Relating Cause and Effect What gases enter and exit when the stomata open?

Section 3 Assessment

Target Reading Skill Outlining Use the information in your outline about seed plants to help you answer the questions below.

Reviewing Key Concepts

- a. **Reviewing** What two characteristics do all seed plants share?

b. **Relating Cause and Effect** What characteristics enable seed plants to live in a wide variety of environments? Explain.
- a. **Listing** Name the three main parts of a seed.

b. **Sequencing** List the steps in the sequence in which they must occur for a seed to grow into a new plant.

c. **Applying Concepts** If a cherry seed were to take root right below its parent tree, what three challenges might the cherry seedling face?

- a. **Identifying** What are the main functions of a plant's roots, stems, and leaves?

b. **Comparing and Contrasting** What type of tissue carries water from the roots to the rest of the plant? What type of tissue carries food away from the leaves?

c. **Applying Concepts** How are the structures of a tree's roots and leaves well-suited for their roles in supplying the tree with water and sugar?

Writing in Science

Product Label Write a "packaging label" for a seed. Include a name and description for each part of the seed. Be sure to describe the role of each part in producing a new plant.