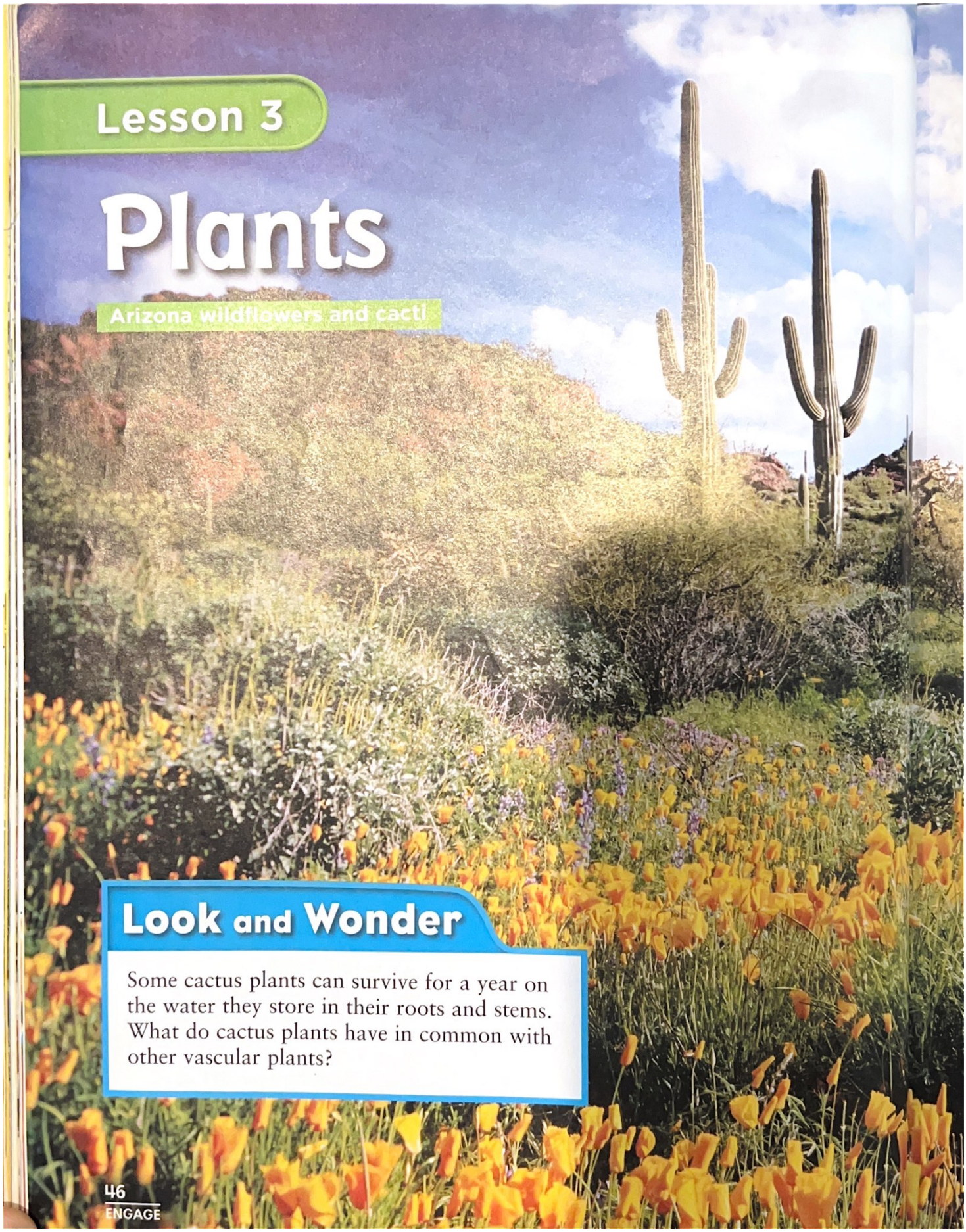


Lesson 3

Plants

Arizona wildflowers and cacti

Look and Wonder

Some cactus plants can survive for a year on the water they store in their roots and stems. What do cactus plants have in common with other vascular plants?

Explore

Inquiry Activity

How is water transported in vascular plants?

Form a Hypothesis

All vascular plants have vessels that transport food and water in the plant. How does the amount of leaves on a plant affect transport through a plant stem? Write your answer as a hypothesis in the form "If the number of the leaves on a plant decreases, then . . .

Test Your Hypothesis

1. Fill 3 plastic cups with water. Be sure that each cup has the same amount. Put 3 drops of food coloring in each cup of water.
2. Break all the leaves off one celery stalk. Remove all but one leaf on another stalk. Leave the third stalk intact. Place a celery stalk in each cup.
3. **Observe** On the following day, examine each cup. What happened to the water? Note any changes.
4. **Measure** Use a ruler to measure how far up the water traveled in each celery stalk.

Draw Conclusions

5. What are the independent and dependent variables in this experiment?
6. **Interpret Data** Did the amount of leaves affect the transport of water?
7. Did your results support your hypothesis?

Explore More

What other variables can affect the movement of water through a plant? How will adding sugar or salt affect water transport in a plant? Form a hypothesis and test it. Then analyze and write a report of your results.

Materials

- 3 plastic cups
- water
- blue food coloring
- 3 celery stalks with leaves
- ruler

Read and Learn

Main Idea

Plants perform photosynthesis, which provides food and energy for most organisms.

Vocabulary

gymnosperm, p. 49
angiosperm, p. 49
xylem, p. 53
phloem, p. 53
cambium, p. 53
photosynthesis, p. 54
transpiration, p. 54
cellular respiration, p. 56

LOG ON e-Glossary
at www.macmillanmh.com

Reading Skill

Draw Conclusions

Text Clues	Conclusions

Technology

SCIENCE QUEST

Explore photosynthesis and respiration with Team Earth.

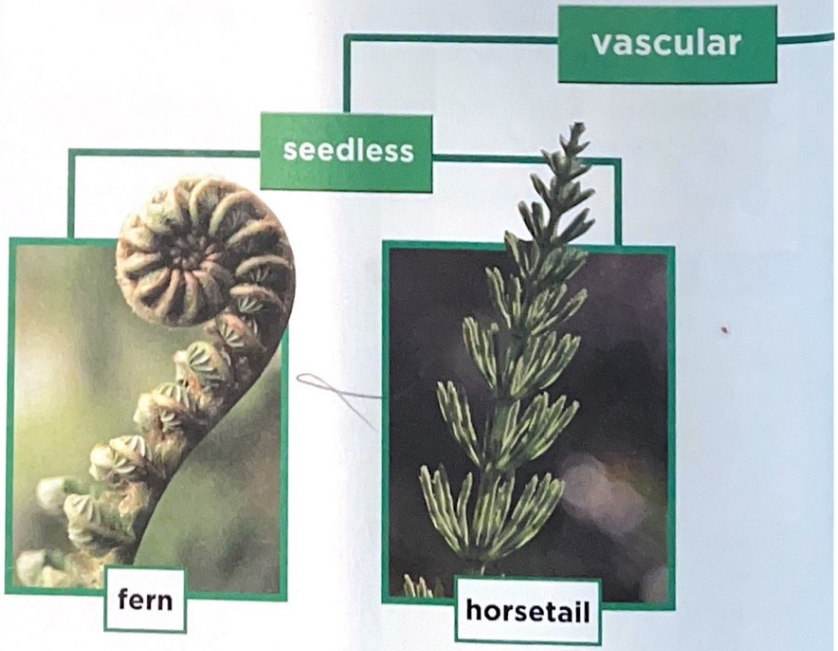
How are plants classified?

All plants need space, air, water, and sunlight. In most cases, plants can obtain air and sunlight directly from their environments. Transporting water and other nutrients can be more difficult.

Nonvascular plants are small and survive without a transport system. Mosses, for example, reach heights of a centimeter or less. Their parts are very close to the ground to absorb water directly.

Vascular plants do not have the same size limitations. Trees, for example, can grow to heights of more than 66 meters (200 feet). How do trees get water up to their higher branches and leaves? Inside a tree trunk there is a *vascular system*, which is a series of hollow tubes. These tubes can transport water and nutrients to the top of the tallest redwood tree where they are used by the plant.

Vascular plants are divided into seed plants and seedless plants. Seed plants, like pine trees and flowering plants, produce seeds. A *seed* contains an undeveloped plant, stored food, and a protective covering. The protective covering prevents the seed from drying out or getting damaged. The



undeveloped plant uses stored food to grow and develop.

Seedless plants, like ferns, produce spores. A *spore* is a single cell that can develop into a new plant exactly like the plant that produced it. Spores have a tough outer covering. It protects them from drying out until they find the right conditions for growth.

There are two main types of seed plants: gymnosperms (JIM•nuh•spurmz) and angiosperms (AN•jee•uh•spurmz). A **gymnosperm** is a seed plant that does not produce a flower. They include pines, firs, and other cone-bearing trees. Gymnosperms have hard seeds that are uncovered.

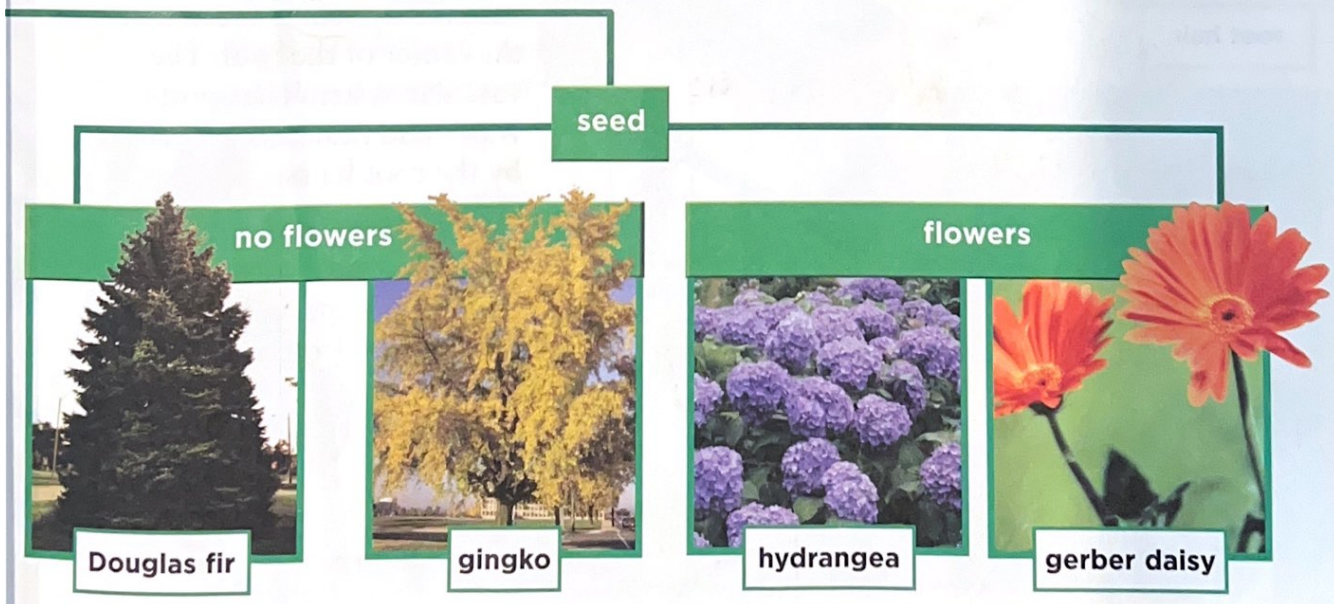
An **angiosperm** is a seed plant that produces flowers. All angiosperms have seeds that are covered by some kind of fruit. Some angiosperms have familiar fruits, like apples and plums. Other angiosperms, like grasses, have smaller and less-colorful fruits.

Angiosperms are the most plentiful of all plant types. There are about 250,000 different kinds of angiosperms. Some familiar angiosperm plants include tulips, maple trees, rose bushes, and corn.

Quick Check

Draw Conclusions A plant is 20 meters (65 feet) tall and it does not produce flowers. What conclusions can you draw about this plant?

Critical Thinking How is height an advantage for some vascular plants?



Quick Lab

Observe a Root

1. **Observe** Look at a carrot cut lengthwise. What structures do you see?
2. Look at a cross section of a carrot. Can you identify the epidermis, cortex, and inner transport layers?
3. Draw a diagram of the carrot in cross section. Label the parts.
4. **Infer** Is the carrot a fibrous root or a taproot?
5. Would it be easier to pull a plant with a taproot from the ground or a plant with a fibrous root system? Explain your answer.

What are roots?

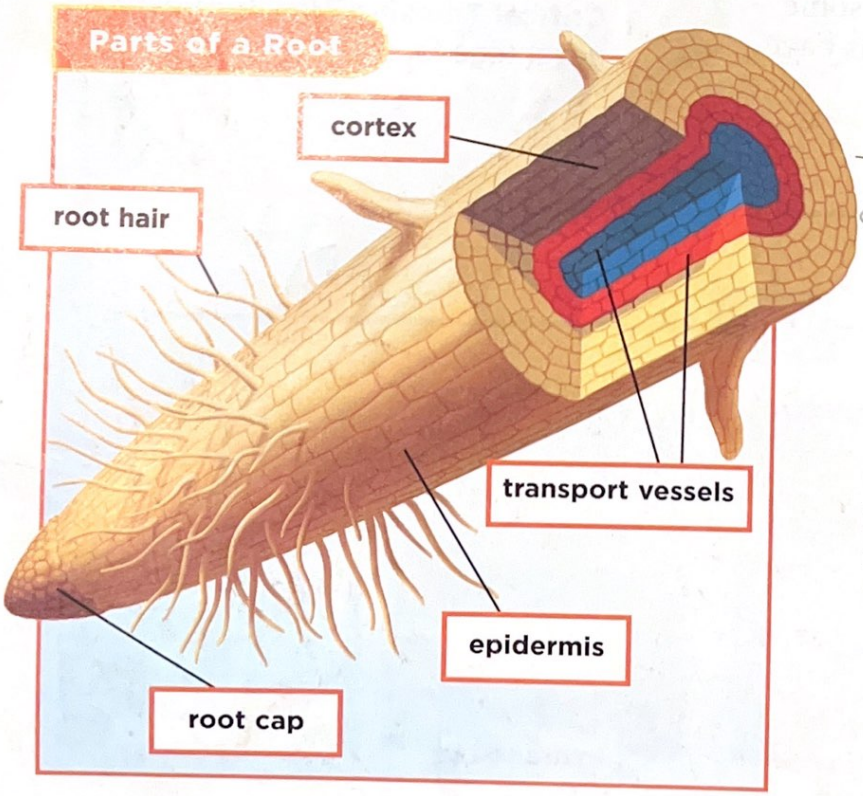
Have you ever tried to dig up a plant? If so, then you might have hit a maze of stringy, cordlike roots. A *root* is the part of the plant that absorbs water and minerals, stores food, and anchors the plant.

Roots absorb water using fuzzy root hairs. A *root hair* is a threadlike projection from a plant root. Each root hair is less than 1 millimeter (0.04 inches) in length, but together they soak up moisture like a sponge.

A typical root of a vascular plant is made of three different layers and a root cap. The *root cap* covers the tip of the root. It protects the root tip while it pushes into the ground.

The outer layer of a root and the whole plant is the *epidermis* (ep•i•DUR•mis). The epidermis of a root has root hairs and absorbs water. A *cortex* layer is located just under the epidermis. It is used to store food and nutrients. The vascular system is located in the center of the root. The vascular system transports water and minerals absorbed by the root hairs.

Different plants have different kinds of roots. Some plants have specialized roots for their environment.

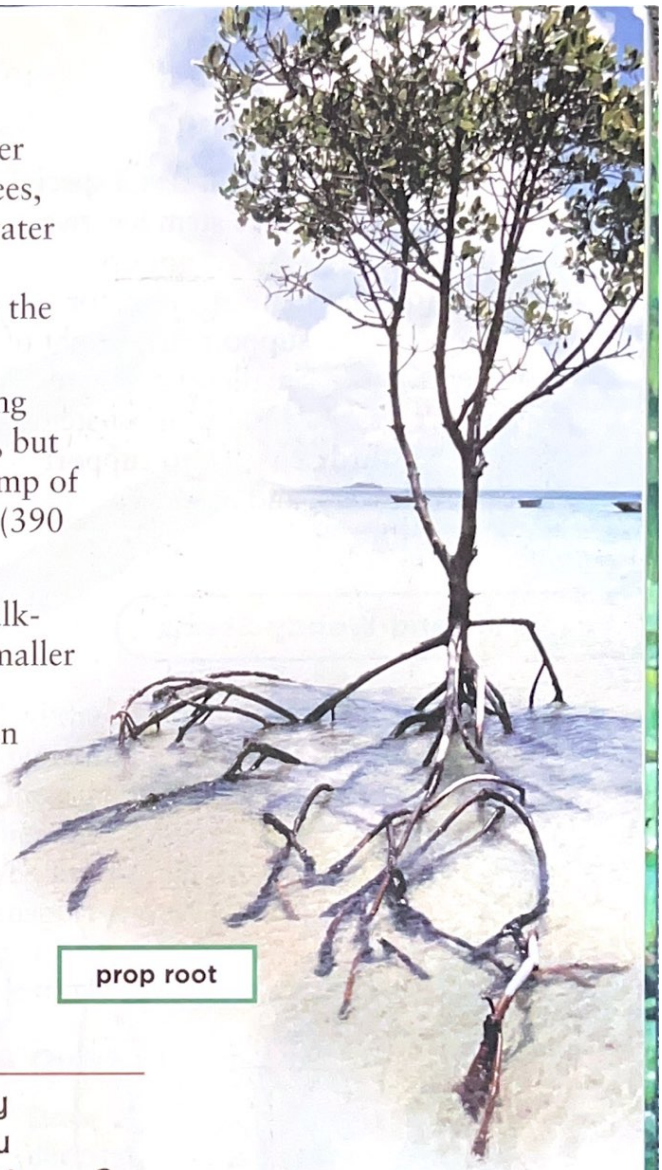


Aerial (AYR•ee•uhl) *roots* are roots that never touch the ground. They anchor the plant to trees, rocks, or other surfaces. Aerial roots absorb water from the air and rain, rather than soil. Many orchids have aerial roots. Some live high up in the rain forest attached to tree bark.

Fibrous (FYE•bruhs) *roots* are thin, branching roots. They do not grow deep into the ground, but they often cover a very wide area. A single clump of grass was found to have some 600 kilometers (390 miles) of fibrous roots.

Plants with *taproots* have a single, main stalk-like root that plunges deep into the ground. Smaller side roots often branch off of a main taproot. Pine trees and plants that live in dry areas often have taproots.

Prop roots usually grow at the bottom of a plant's stem. They prop up and support the plant so it cannot be knocked over. Corn plants and mangrove trees have prop roots.



Quick Check

Draw Conclusions An area has many plants with taproots. Where would you expect to find underground water in this area?

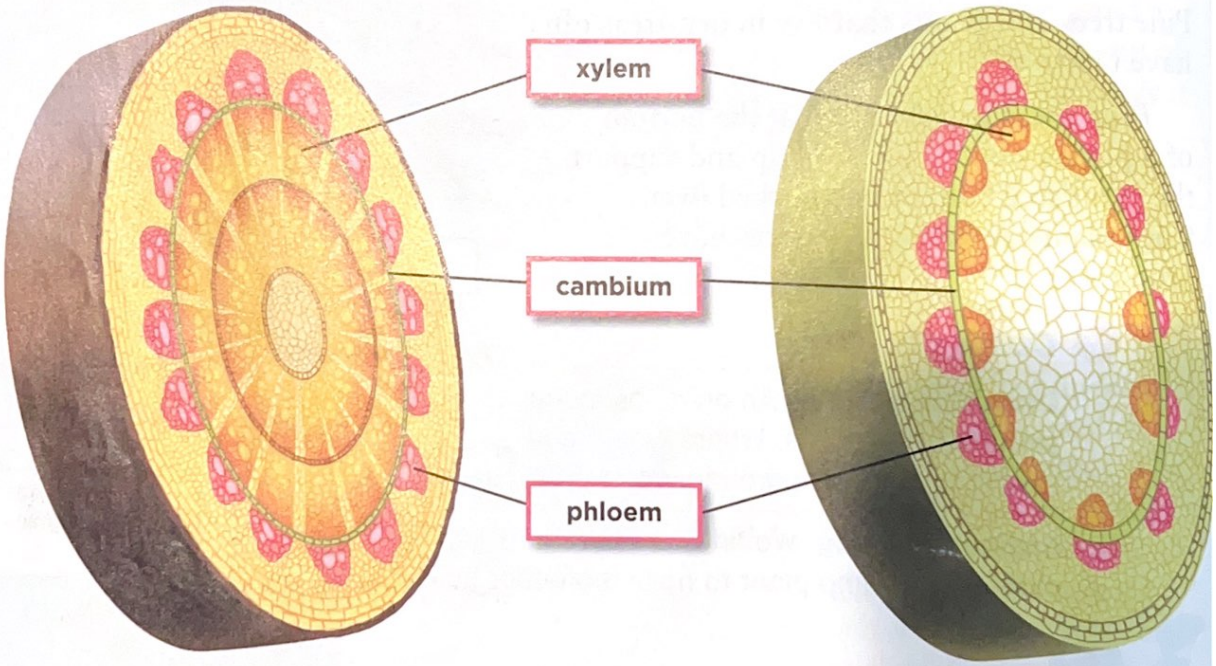
Critical Thinking Would you expect a desert plant or a swamp plant to have more root hairs?

What are stems?

Each part of a plant has a special function. The plant's stem has two functions. First, it is a support structure. The stem of a tree, for example, must support the weight of the entire tree. Smaller plant stems support less weight, but most stems must be sturdy enough to support leaves, flowers, and branches.

Stems come in two basic forms—soft stems and woody stems. Soft stems are not as strong as woody stems. They are soft, green, and can bend. Their green color shows that their cells have chlorophyll and produce food. Shrubs and trees have woody stems. Woody stems are often covered with *bark*, a tough outer covering that serves as a protective layer. Woody stems do not contain chlorophyll.

Soft and Woody Stems



woody stem

soft stem

Read a Diagram

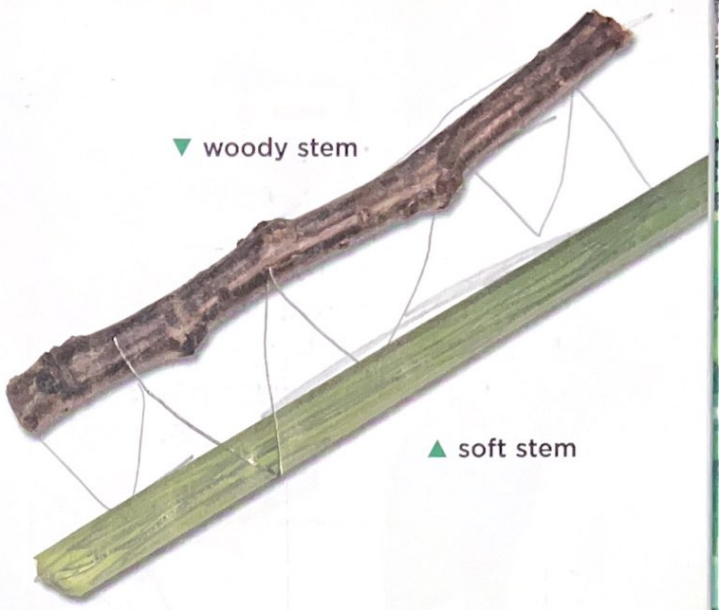
How are the xylem, phloem, and cambium arranged differently in the woody stem and the soft stem?

Clue: Compare the location and shape of the xylem, phloem, and cambium in each stem.

The stem's second function is to serve as a transport system for the plant. The transport system actually begins in the roots of the plant. Two kinds of cells make up the system. **Xylem** (ZYE•luhm) is a series of tubes that moves water and minerals up the stem. Xylem tissue conducts, or transports, in one direction only—up from the plant roots to the leaves.

Phloem (FLOH•em) moves sugars that are made in the plant's leaves to other parts of the plant. Phloem tissue is a two-way transport route. It flows both up and down in a plant. In a carrot, for example, sugars are brought down from the leaves of the plant to the taproot through the phloem. Phloem also transports sugars up from one part of a plant to another.

The xylem and phloem layers in a plant stem are separated by a layer called the **cambium** (KAM•bee•uhm). Xylem and phloem cells are produced in the cambium, then move inward. When they are alive in the cambium layer, xylem cells are not able to transport water. It is only after the cells die and become hollow that they are able to function as transport vessels.

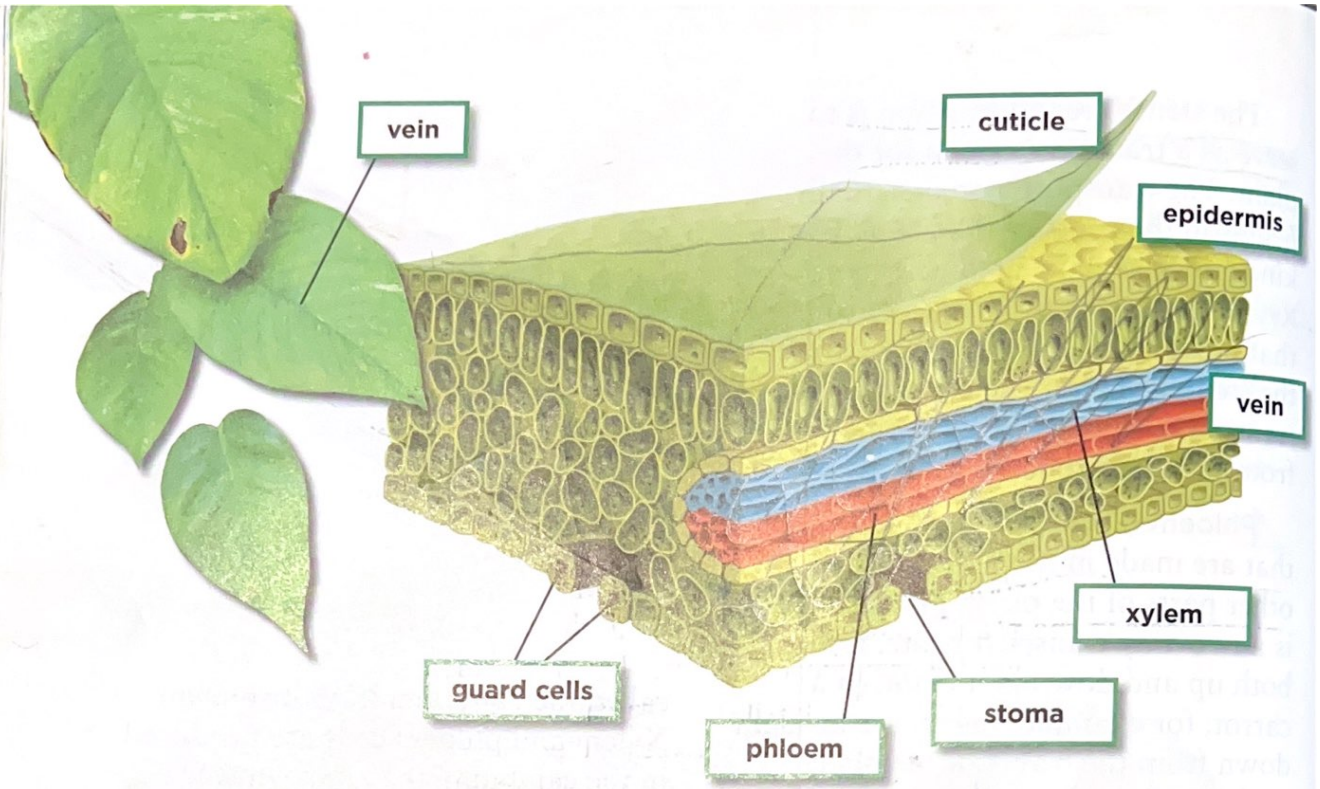


Quick Check

Draw Conclusions In how many directions does xylem move water and minerals?

Critical Thinking Why do most trees have woody stems?

Tree rings are formed by layers of xylem and phloem.



What are leaves?

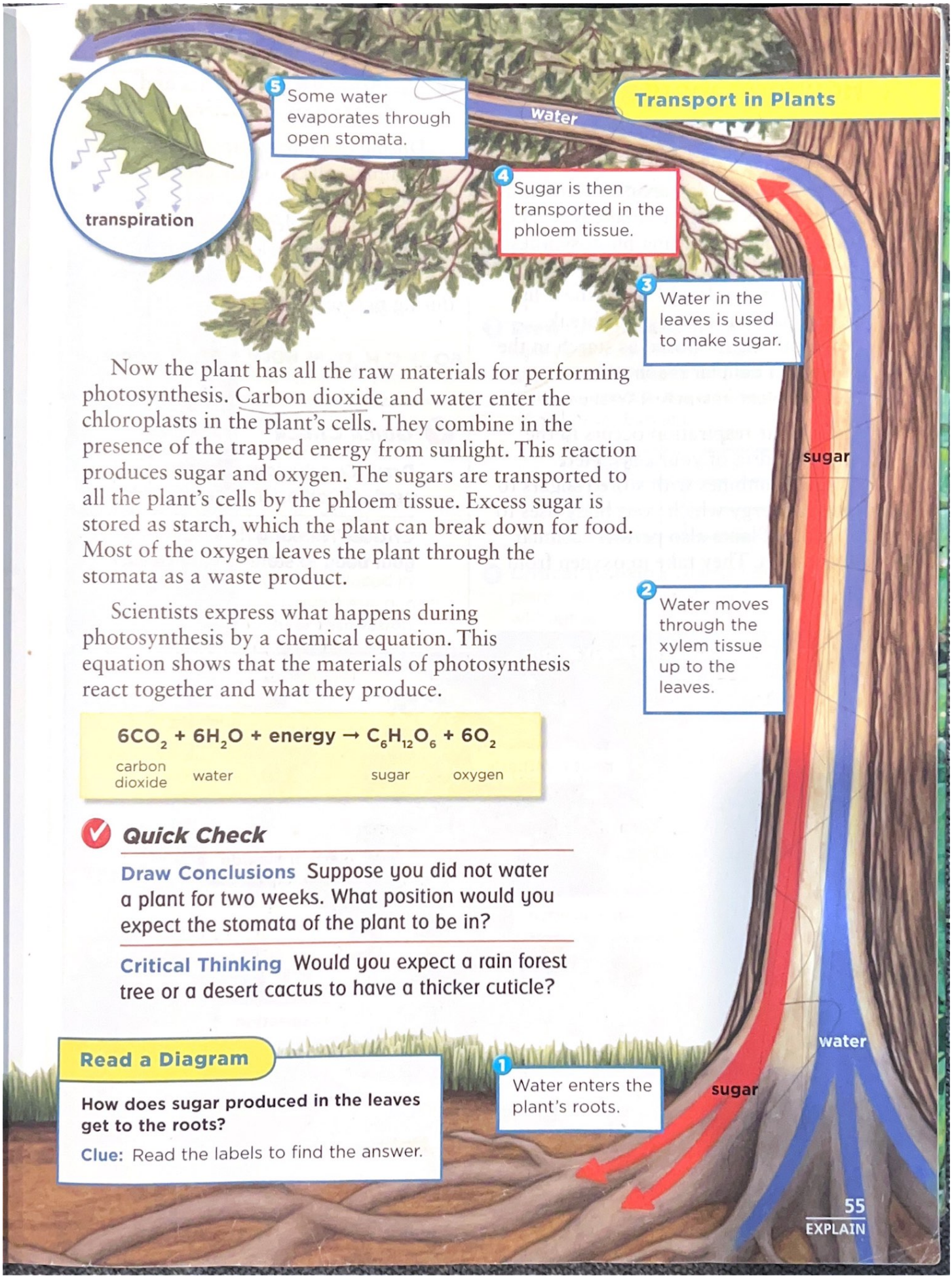
The leaves of a plant have the important function of carrying out **photosynthesis** (foh•tuh•SIN•thuh•sis), or the process of making food. Cells within the leaf's epidermis make up the plant's main food factory. To perform photosynthesis, leaves need three raw materials: sunlight, water, and carbon dioxide from air. Each leaf is designed to obtain these materials.

Many leaves are flat and broad. This allows the leaf to collect the most sunlight possible. Chlorophyll in the chloroplasts of the leaves traps the energy of sunlight.

Water enters the plant through its roots. It is transported up through the xylem tissue in the leaf veins. The top leaf surface also has a waxy *cuticle*, a waterproof layer that prevents moisture from evaporating.

Leaves get carbon dioxide from the air. Air enters and moves out of the plant through tiny pores on the underside of the leaves called *stomata* (STOH•muh•tuh). A single pore is called a *stoma*. Each stoma is controlled by guard cells. When the leaf has plenty of water, the guard cells swell and pull the stomata open. This allows water and air to leave the plant. The loss of water through a plant's leaves is called **transpiration** (tran•spuh•RAY•shuhn). When the plant is low on water, the guard cells shrink. This causes the stomata to close and prevents water from escaping.

As water evaporates from the leaves, more water is carried from the bottom of the plant to the top. Finally, water moves into the leaf, replacing the water that has evaporated.



Now the plant has all the raw materials for performing photosynthesis. Carbon dioxide and water enter the chloroplasts in the plant's cells. They combine in the presence of the trapped energy from sunlight. This reaction produces sugar and oxygen. The sugars are transported to all the plant's cells by the phloem tissue. Excess sugar is stored as starch, which the plant can break down for food. Most of the oxygen leaves the plant through the stomata as a waste product.

Scientists express what happens during photosynthesis by a chemical equation. This equation shows that the materials of photosynthesis react together and what they produce.

$$6CO_2 + 6H_2O + \text{energy} \rightarrow C_6H_{12}O_6 + 6O_2$$

carbon dioxide — water — sugar — oxygen

Quick Check

Draw Conclusions Suppose you did not water a plant for two weeks. What position would you expect the stomata of the plant to be in?

Critical Thinking Would you expect a rain forest tree or a desert cactus to have a thicker cuticle?

Read a Diagram

How does sugar produced in the leaves get to the roots?

Clue: Read the labels to find the answer.

How are photosynthesis and respiration related?

The most important source of energy for Earth is the Sun. Plants can use the Sun's energy to make fuel. The sugars produced during photosynthesis are used by most organisms for energy. The energy is released when the cells of organisms use oxygen to break down the sugars stored as starch in the process of **cellular respiration** (SEL•yuh•luhr res•puh•RAY•shuhn).

Cellular respiration occurs in the mitochondria of your cells. Here oxygen combines with stored sugars to release energy which your body uses to do work. Plants also perform cellular respiration. They take in oxygen from the air through their stomata and break down sugars for energy.

During cellular respiration, plant and animal cells produce carbon dioxide and water as waste products, which are then released back into the air. Plants use the released carbon dioxide and water to produce sugars during photosynthesis.

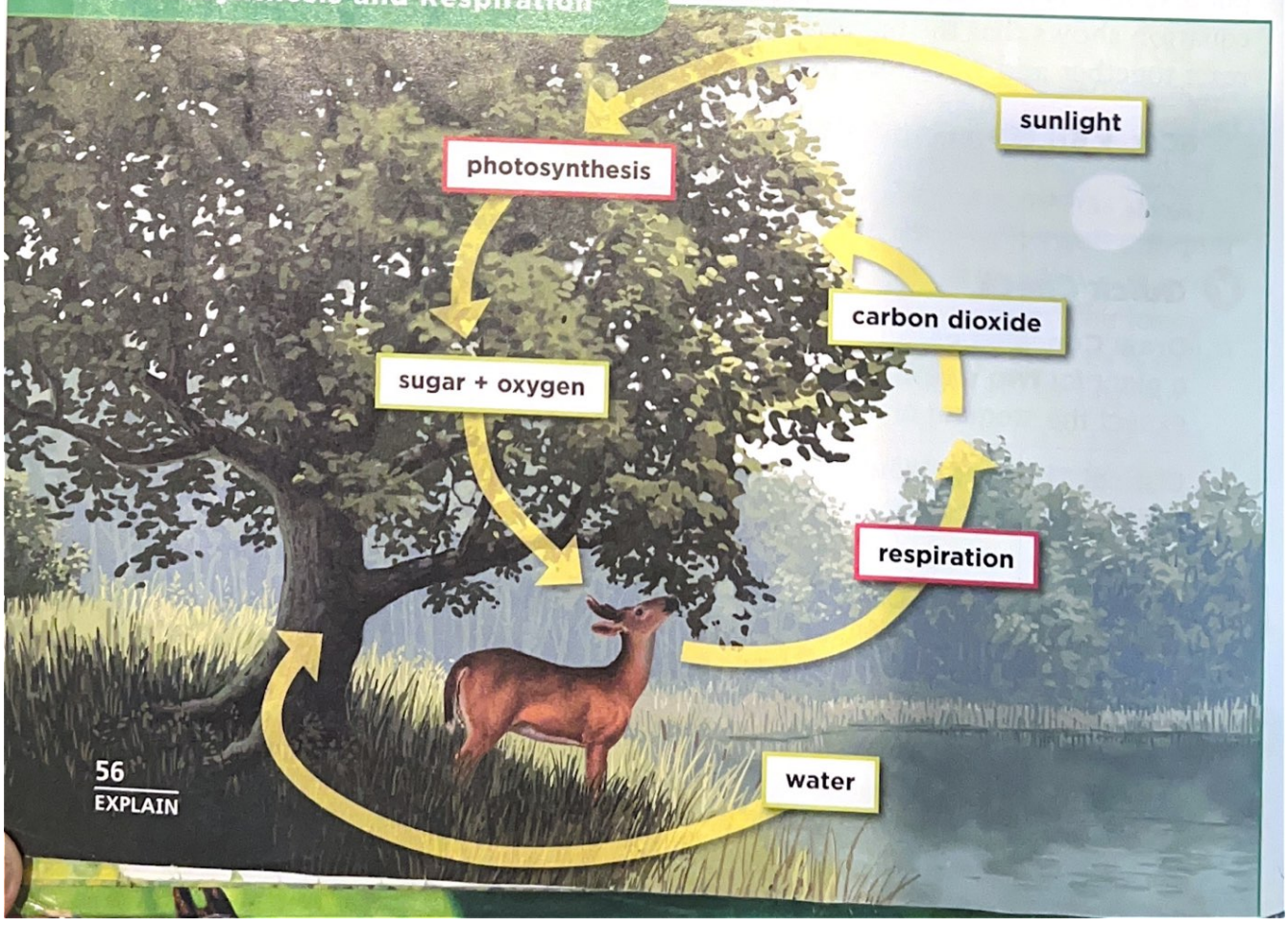
$$6O_2 + C_6H_{12}O_6 \rightarrow 6CO_2 + 6H_2O + \text{energy}$$

Quick Check

Draw Conclusions Do plants produce carbon dioxide? Explain.

Critical Thinking Is it easier for your body to store food or oxygen?

Photosynthesis and Respiration



Lesson Review

Visual Summary

Plants are divided into **vascular** and **nonvascular** plants. Vascular plants are divided into seed plants and seedless plants.

Roots anchor a plant and supply it with water and minerals. **Stems** support a plant and transport materials.

Leaves carry out the process of **photosynthesis**. Organisms burn the sugars produced in photosynthesis during **cellular respiration**.

Make a FOLDABLES™ Study Guide

Make a Trifold Book. Use the titles shown. Tell what you learned about each title.

Main Idea	What I learned	Sketches
Vascular and nonvascular plants		
Roots and stems		
Photosynthesis and cellular respiration		

Think, Talk, and Write

1. **Main Idea** Why do all plants need air, water, and sunlight?

2. **Vocabulary** Flowering plants are called _____.

3. **Draw Conclusions** An insect cannot survive in a covered jar, even though the jar contains food and water. When a plant is added to the jar, the insect can now survive. Explain.

Text Clues	Conclusions

4. **Critical Thinking** Animals depend on plants for food. Could plants make food without animals?

5. **Test Prep** **Which kind of plant produces fruit?**
   - **A** angiosperm
   - **B** nonvascular
   - **C** seedless
   - **D** gymnosperm

6. **Test Prep** **Which of the following is found inside the stem of a plant?**
   - **A** epidermis
   - **B** xylem
   - **C** root hairs
   - **D** leaves

Writing Link

Explanatory Writing

Aliens from another planet want to know how organisms on Earth obtain energy. Write a letter to the aliens explaining how organisms on Earth obtain energy.

Math Link

Energy Fractions

A plant uses $\frac{1}{10}$ of the Sun's energy it receives to make sugars. An animal that eats the plant uses about $\frac{1}{10}$ of the plant's stored energy. What fraction of the Sun's energy does the animal use?

We hate school

Writing in Science

Saving Water the Yucca Plant Way

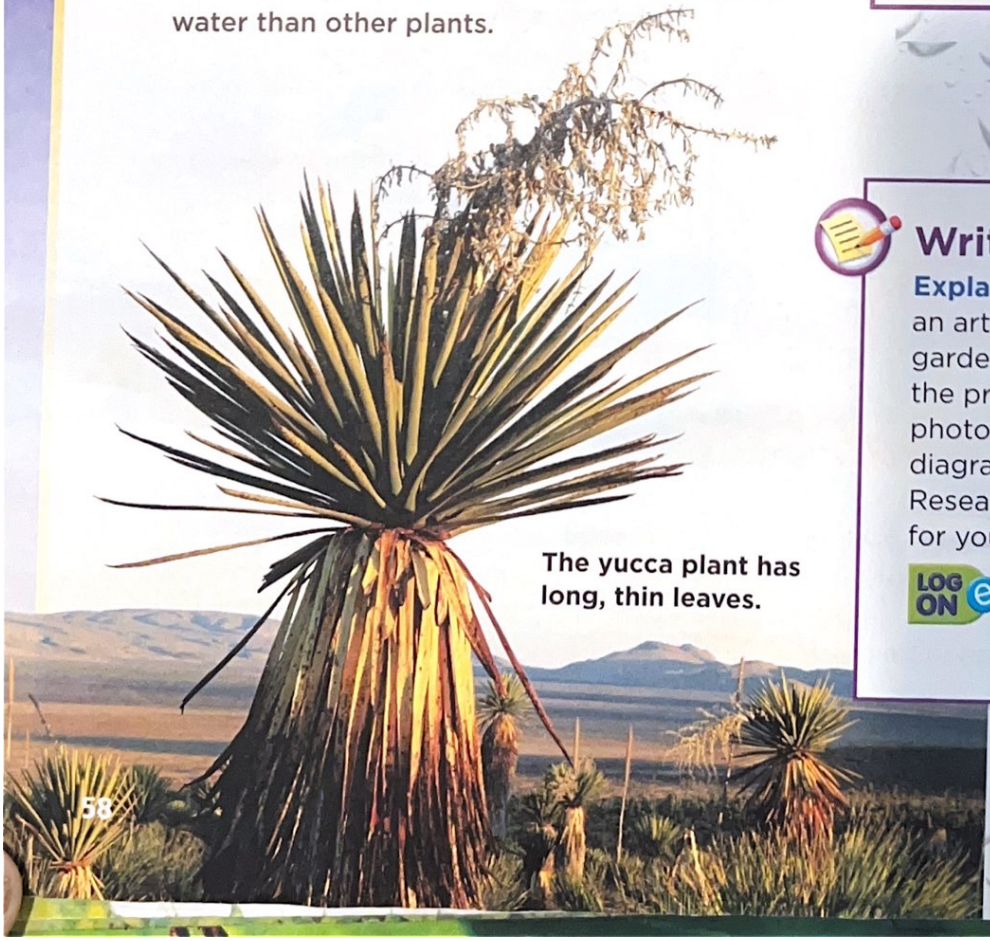
Yucca plants grow in the deserts of California and the southwest parts of North America. They have long, narrow leaves that are adapted to save water. Yuccas use a special kind of photosynthesis called CAM photosynthesis.

Most plants open their stomata during the day. They need carbon dioxide for photosynthesis. Yucca plants only open their stomata at night. This keeps the yucca from losing water through evaporation in the hot desert sun. During the day, the yucca plant uses its stored carbon dioxide to perform photosynthesis. Desert plants that use CAM photosynthesis, like the yucca, lose much less water than other plants.

Explanatory Writing

A good explanation

- develops the main idea with facts and supporting details
- lists what happens in an organized and logical way
- uses time-order words to make the description clear



The yucca plant has long, thin leaves.

Write About It

Explanatory Writing Write an article for young gardeners. Explain the process of CAM photosynthesis. Add a diagram to help explain. Research facts and details for your article.

LOG ON e-Journal Research and write about it online at www.macmillanmh.com

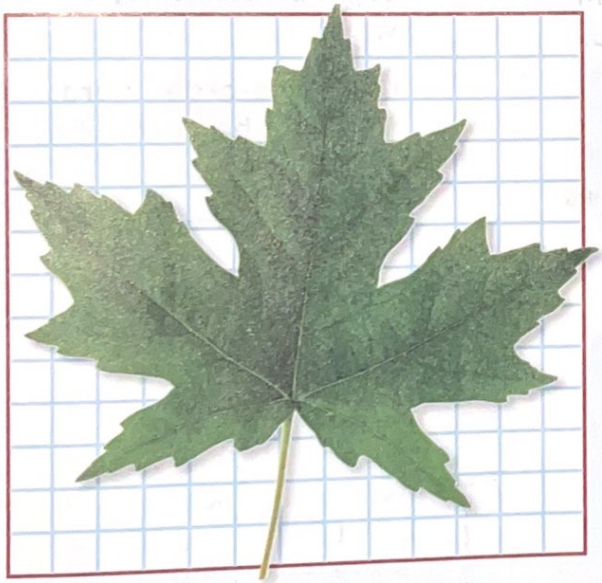
Leave It Be

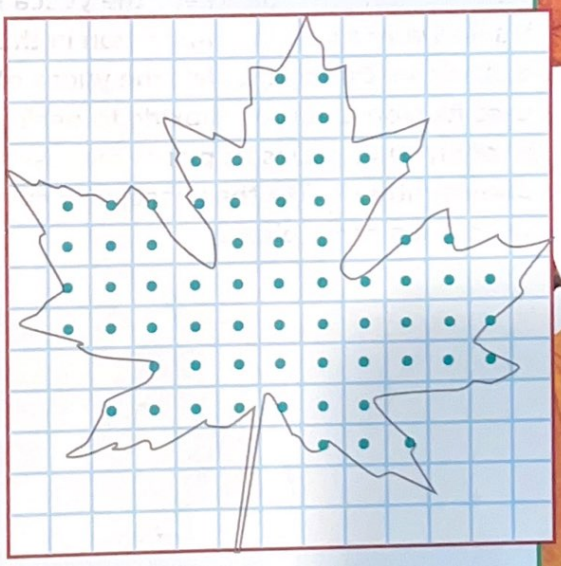
Some leaves, like a tiny pine needle, have a very small surface area. Others, like a maple leaf, have a large surface area. The surface area of leaves is directly connected to the amount of sugar and oxygen they produce. Therefore, one can assume that a single pine needle does not produce as much sugar and oxygen as a maple leaf. How can you find the surface area of a leaf?

Calculating Area

To find the area of an irregular figure

- trace the figure on graph paper
- count the number of whole square units
- count the number of partial square units and divide this number by 2
- add the two numbers





Solve It

1. Find a leaf. Calculate the area of your leaf.
2. Compare the area of your leaf to the area of the maple leaf in the example above.
3. Which produces more sugar and oxygen?

whole squares	+	partial squares	÷ 2	= area
43	+	24	÷ 2	= area
43	+	12		= 55