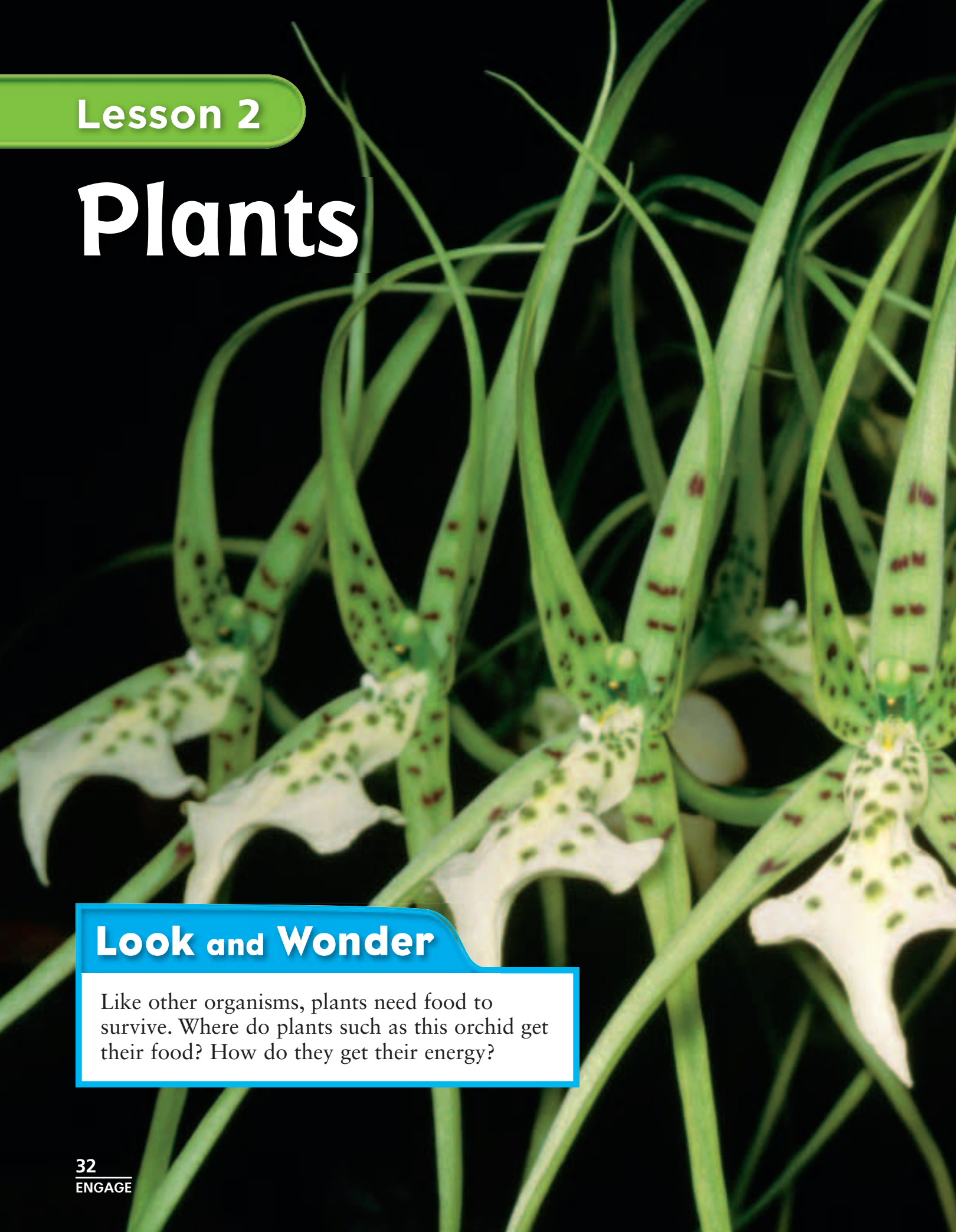
Lesson 2

Plants



Look and Wonder

Like other organisms, plants need food to survive. Where do plants such as this orchid get their food? How do they get their energy?

Explore

Inquiry Activity

How does light affect plants?

Form a Hypothesis

Plants need light to grow. What do you think will happen to a plant's leaves if you cover parts of them so that no light reaches those parts? Write your answer in the form of a hypothesis: "If parts of a plant's leaves do not receive any light, then . . ."

Test Your Hypothesis

1. Wrap small pieces of aluminum foil over parts of several leaves of a growing plant. Secure the foil with paper clips. Wash your hands after handling the plant.
2. **Use Variables** Cover at least four different leaves of the plant in the same way.
3. Place the plant in a window where it will have lots of light. Water the plant as needed.
4. **Experiment** After one day, carefully lift the foil and check each leaf. Write down your observations. Gently replace the foil in the same position. Continue your observations each day for one week, placing the foil back in the same position each time. How do the areas covered by the foil differ from the other parts of the leaves?

Draw Conclusions

5. **Interpret Data** What changes did you observe after 1 day? After 2 days? After 1 week? How do light and darkness seem to affect the growth of leaves?

Explore More

What will happen if the leaves are no longer covered? Remove the foil from the leaves, and continue to water and observe the plant for another week. Share your findings with the rest of your class.

Materials

- aluminum foil
- growing plant (a large-leafed plant will work best)
- paper clips
- water

Read and Learn

Main Idea

Plants have structures that carry out specific functions. They use sunlight to make their own food.

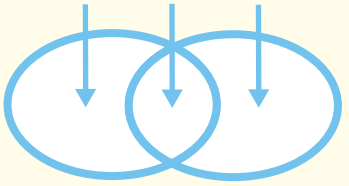
Vocabulary

stem, p. 34
root, p. 35
photosynthesis, p. 37
reproduction, p. 38
seed, p. 38
sperm, p. 38
egg, p. 38
pollination, p. 38

Reading Skill

Compare and Contrast

Different Alike Different



Technology

SCIENCE QUEST

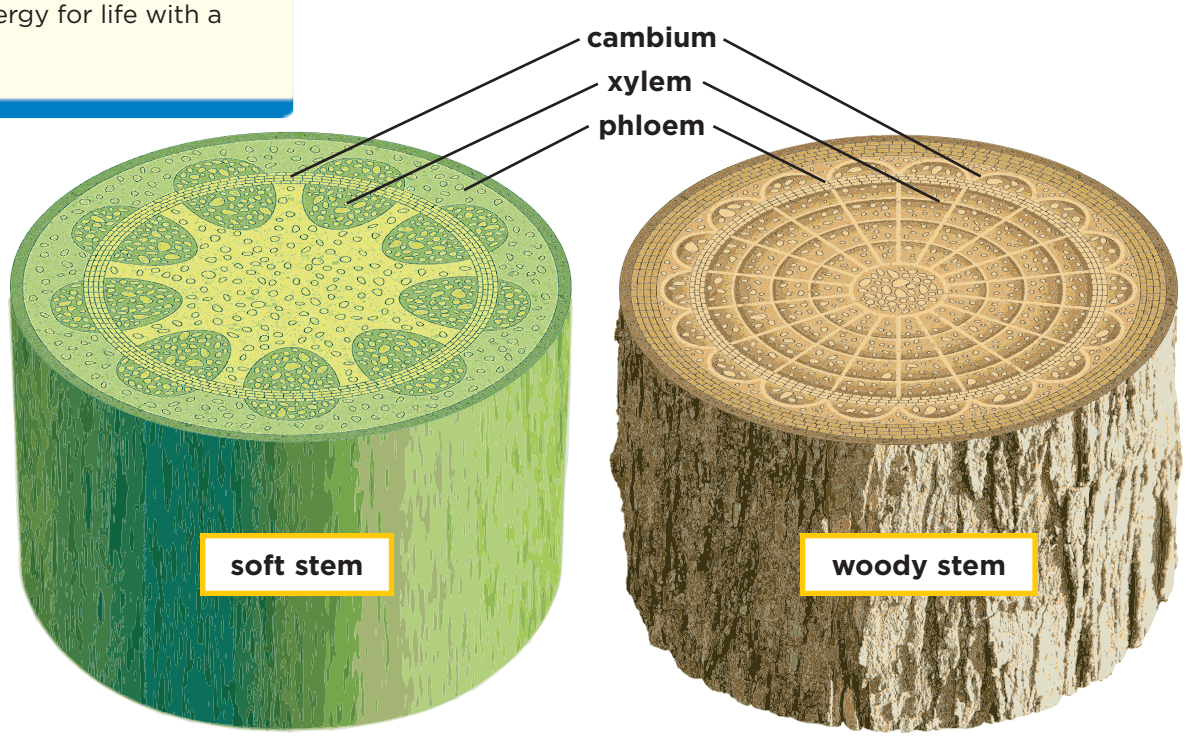
Explore energy for life with a farmer.

What are roots and stems for?

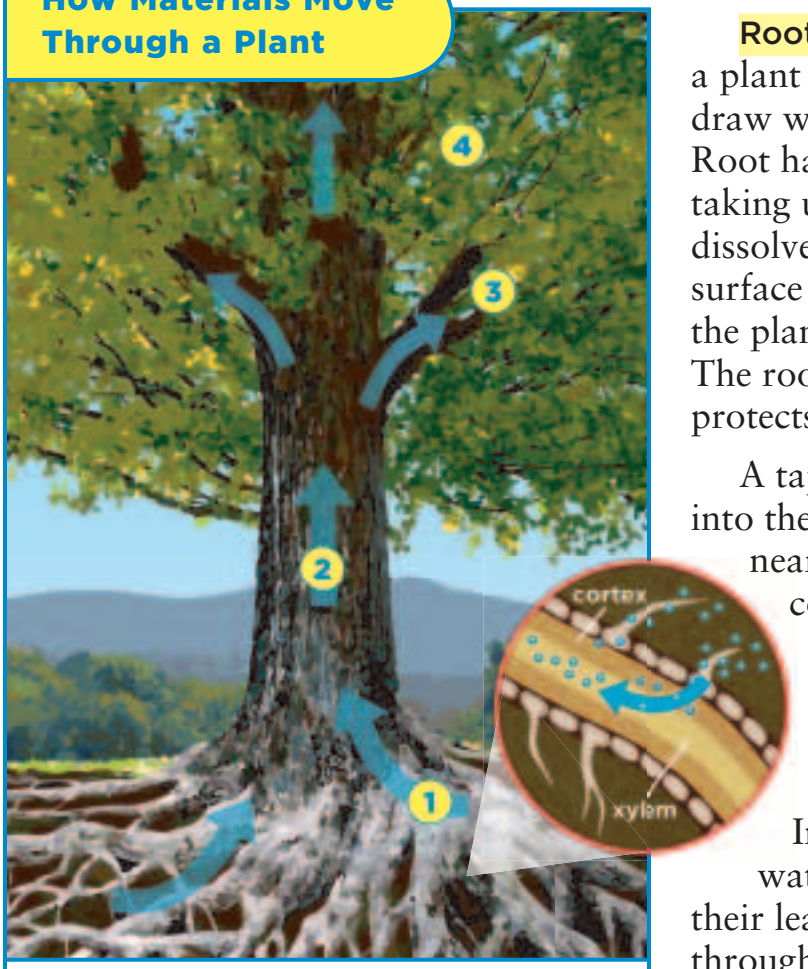
Think about the water supply in a tall apartment building. The water comes in at the basement level and flows through pipes to every floor. Water moves through vascular plants in a similar way. Vascular plants draw water from the soil into their roots and up through their stems to their top branches. They use a system of "pipes" called xylem (ZIGH•luhm) to move water and minerals from the soil upward. The "pipes" that move food back down through plants are called phloem (FLOH•em). The xylem and phloem are separated by a layer of cells called the cambium (CAM•bee•uhm). The layer of tissue just beneath the surface of a plant's roots and stems is the cortex.

Stems are structures that hold a plant up and support its leaves. Some stems, such as those of many flowers, are soft stems. Woody stems are tough and strong, with protective bark. Some plants, such as sugar cane, store food in their stems. Other plants, such as cactuses, use their stems to store water.

Parts of a Stem



How Materials Move Through a Plant



1. Water and minerals from the soil enter root hairs, pass through the cortex, and then enter the xylem.
2. Transpiration draws water and minerals up the stem and into the leaves.
3. The materials enter the leaves and are carried to each leaf cell.
4. Leaf cells use the water, along with carbon dioxide from the air, to make sugars.

Read a Diagram

How does water travel from a plant's roots to its stem?

Clue: Follow the path of the blue arrows.

LOG ON *Science in Motion* Watch how plants transport water at **www.macmillanmh.com**

Roots

Roots are plant parts that anchor a plant in the ground, store food, and draw water and nutrients from the soil. Root hairs are designed for absorption, taking up most of the water and dissolved minerals. They increase the surface area of the root, allowing the plant to absorb greater quantities. The root cap, a tough layer of cells, protects the tip of each root.

A taproot is a root that grows deep into the ground. Fibrous roots grow near the surface of the soil. They collect water and can form huge networks.

As roots absorb water, pressure pushes water through the stem and toward the leaves. In transpiration, plants release water into the atmosphere through their leaves. As a plant loses water through transpiration, water enters the xylem from the roots.

Quick Check

Compare and Contrast How do roots and stems help move water and nutrients through a plant?

Critical Thinking Daffodils have soft stems, and oak trees have woody stems. What do these two stems have in common?

How do leaves function?

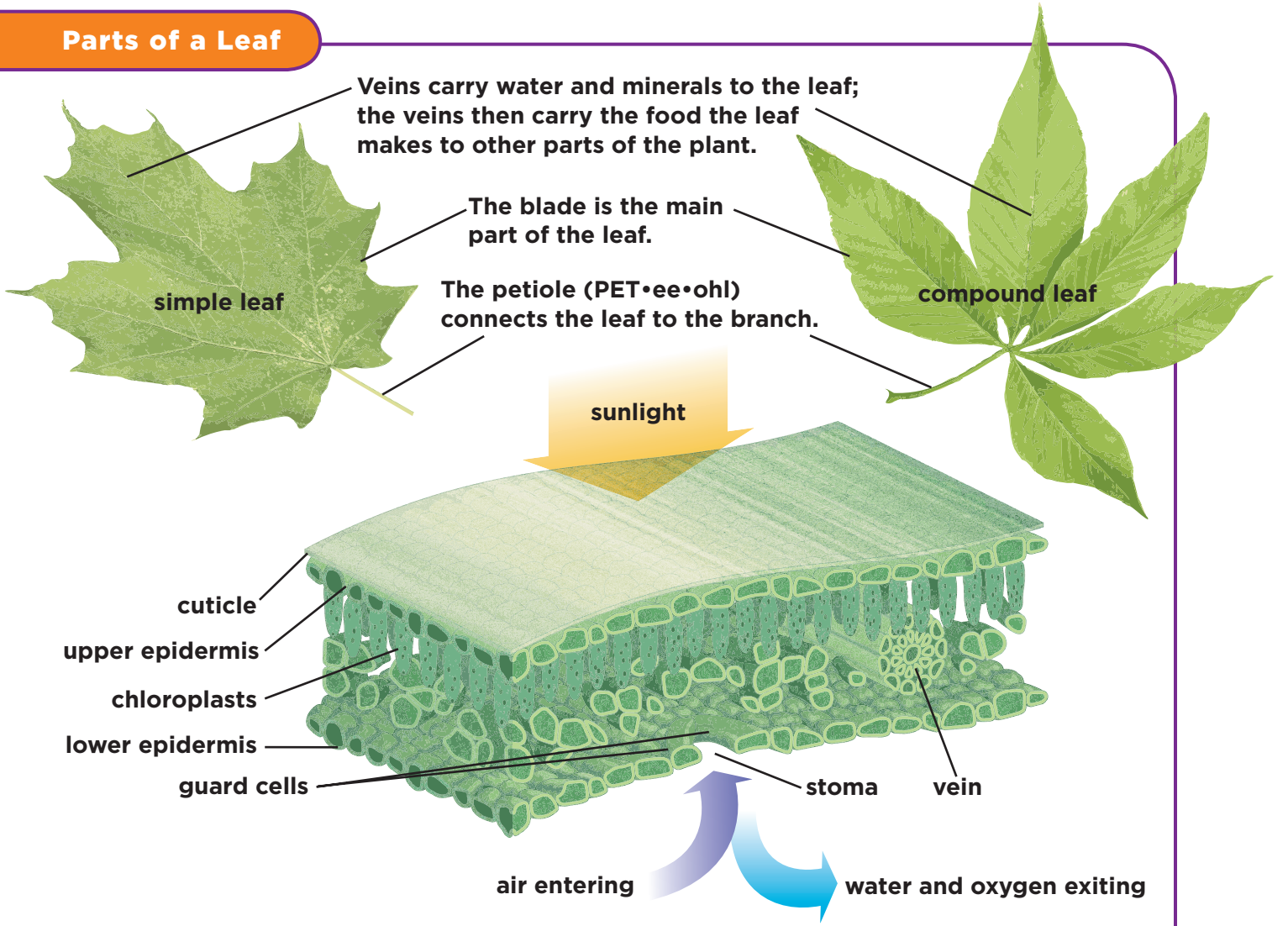
There are many shapes and sizes of leaves. Maple and oak trees have single leaves, or simple leaves. Some plants, such as horse-chestnut and locust trees, have leaves that grow in clusters. These are compound leaves. Other plants have leaves shaped like needles or spines.

The outermost layer of a leaf is the epidermis. It is covered by a waxy coating called the cuticle. On plants that stay green year-round, such as pine trees, the cuticle prevents the leaves or needles from losing too much water, especially during cold or dry weather.

The epidermis on the lower surface of a leaf contains tiny pores called stomata (STOH•muh•tuh) (singular, *stoma*). Guard cells that surround the stomata control the amount of air entering the plant and the amount of water exiting the plant. When the plant has plenty of water, the guard cells swell and pull the stomata open. The stomata close when the temperature is high, in order to minimize water loss.

Plants can lose large amounts of water through transpiration. Almost 99 percent of the water that enters a plant through its roots is given off into the air through transpiration.

Parts of a Leaf



Photosynthesis

Many plants have leaves with broad, flat surfaces that capture sunlight. Plants use sunlight to make their own food in a process called **photosynthesis** (foh•tuh•SIN•thuh•sis). Photosynthesis occurs within the leaves of the plant. In addition to sunlight, plants also use water, minerals, and carbon dioxide. The roots and stems of plants take in water and minerals. Plants obtain carbon dioxide from the air through their stomata.

Photosynthesis occurs in structures called chloroplasts, which are found mainly in plant cells. Chloroplasts use carbon dioxide, water, and solar energy to produce food in the form of glucose. Oxygen is also produced as a waste product of photosynthesis, and it is released into the atmosphere by the plant.

Some of the glucose produced by plants remains in the plants' leaves. However, most of the glucose is transported through the phloem to the stems and roots, where it is stored. When animals eat plants, this stored energy is then available to them.

Quick Check

Compare and Contrast How are simple and compound leaves alike? How are they different?

Critical Thinking How would transpiration differ in plants growing in areas of abundant rain compared to plants in areas of scarce rain?

Quick Lab

Leaves

1. Collect a variety of leaves.
2. **Observe** Examine each leaf with a hand lens, and write down each structure that you can identify.
3. Place a thin piece of white paper over the leaf, and rub back and forth with a crayon, making a print or rubbing of the leaf.
4. **Classify** On the rubbing identify the leaf as simple or compound, and label each structure.
5. Using two colors of crayons, trace the flow of water and food through the veins.

How do plants reproduce?

All living things carry out **reproduction**, which is the production of more individuals of the same species. Reproduction occurs in several ways. *Sexual reproduction* (SEK•shew•uhl ree•pruh•DUK•shuhn) is the production of a new organism by the union of male and female sex cells. *Asexual* (ay•SEK•shew•uhl) *reproduction* is the production of a new organism using only one type of cell. Some organisms use both types of reproduction.

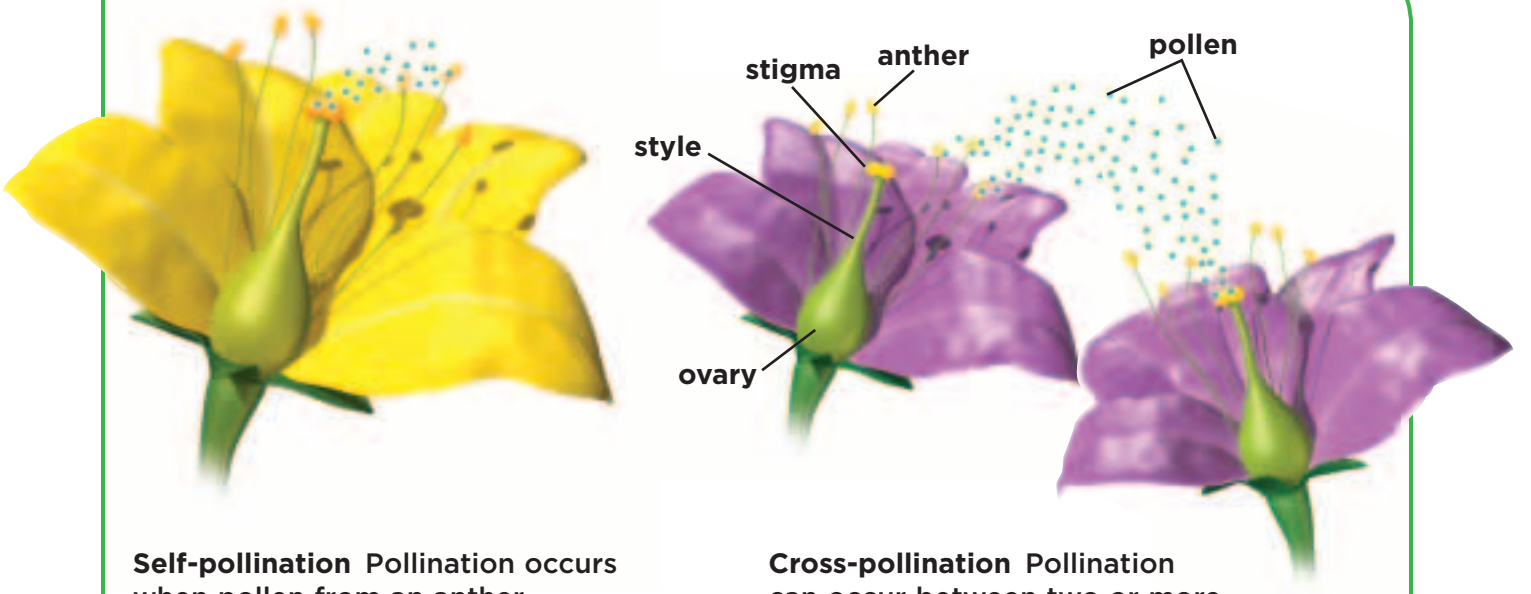
Plants With Seeds

A **seed** is a structure that contains a young, developing plant and stored food. Under the right conditions, the seed will grow into a new plant. Where does a seed come from? Follow the diagrams on these pages to understand the entire process.

Seed plants reproduce by sexual reproduction. The male sex cell, the **sperm**, must unite with the female sex cell, the **egg**. Sperm cells are located within pollen grains. Pollen grains are produced in the anther of a flower. Eggs are located in the flower's ovary. The ovary is located at the bottom of the stigma. The transfer of pollen from an anther to a stigma is called **pollination**. The result of this transfer is the union of male sex cells and female sex cells.

Self-pollination occurs when pollen is transferred from an anther to a stigma on the same flower. Cross-pollination happens when pollen is transferred from the anther of one flower to the stigma of another flower. Organisms that transfer pollen from flower to flower—such as birds and insects—are called *pollinators*.

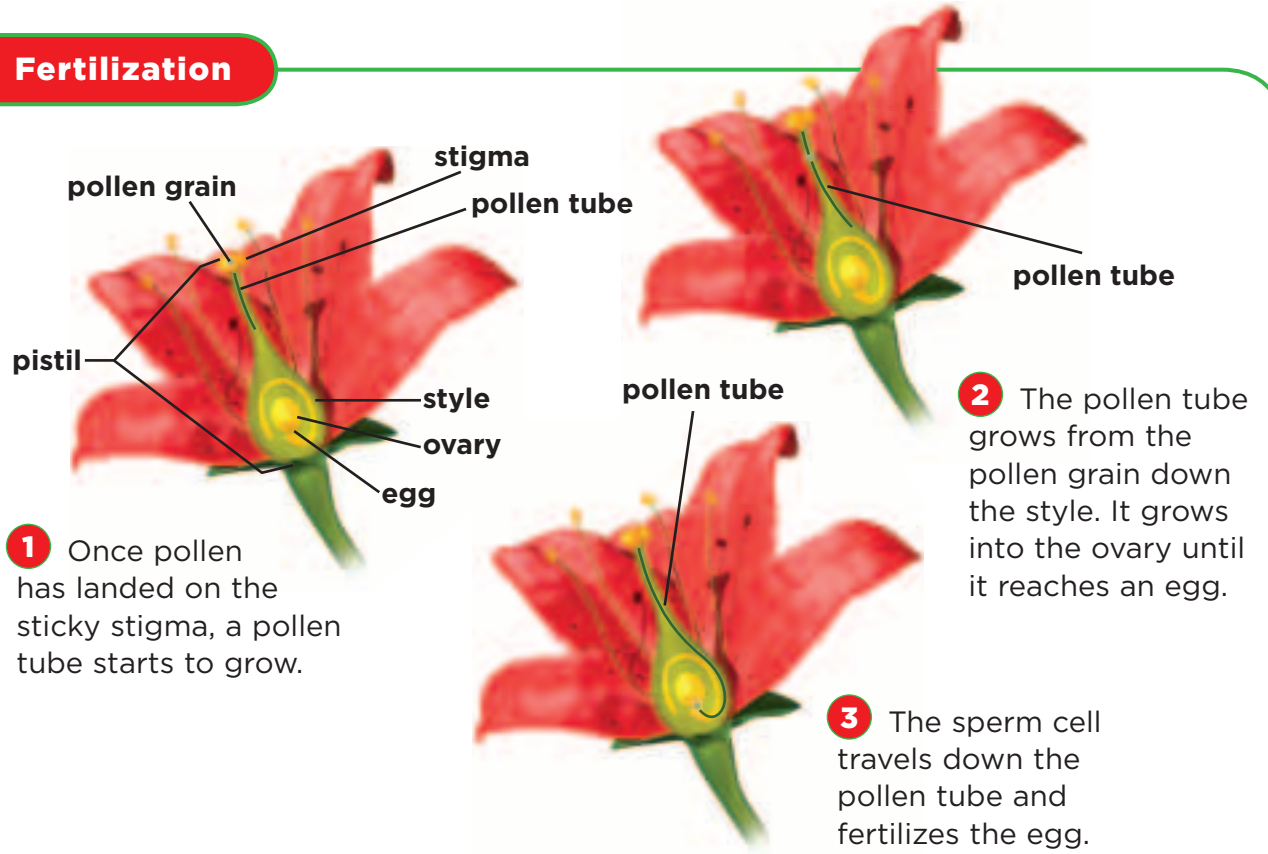
Pollination



Self-pollination Pollination occurs when pollen from an anther reaches the stigma. This flower is pollinating itself, because its pollen is reaching its own stigma.

Cross-pollination Pollination can occur between two or more flowers on separate plants. Here the pollen of one flower reaches the stigma of another.

Fertilization



Once pollen has landed on the stigma, a tube grows from it. The pollen then travels down the pollen tube into the flower's ovary, where the egg is located. At this point, the sperm cell joins with the egg. This joining is called *fertilization*. A seed develops from the fertilized egg.

If seeds always stayed near their parent plants, the competition for food, water, and sunlight would be great. Young plants have a greater chance for survival if they grow away from their parent plants. Seed dispersal is the spreading out of seeds away from their source. Seeds might blow away, or they might attach to animals' fur and then fall off in a distant location. An animal might eat seeds, pass them through its digestive system, and then deposit the seeds far from their parent plants.

Plants Without Seeds

Some plants are seedless. These plants grow from spores instead of seeds. *Spores* are cells that can develop into new organisms. Unlike seeds, spores do not contain food for the young, developing plants. These tiny structures are produced within spore capsules. Nonvascular plants, such as mosses and liverworts, reproduce from spores. Some vascular plants also use spores to reproduce.

Quick Check

Compare and Contrast How are asexual reproduction and sexual reproduction different in plants?

Critical Thinking What would happen to some flowering plants if there were suddenly no pollinators?

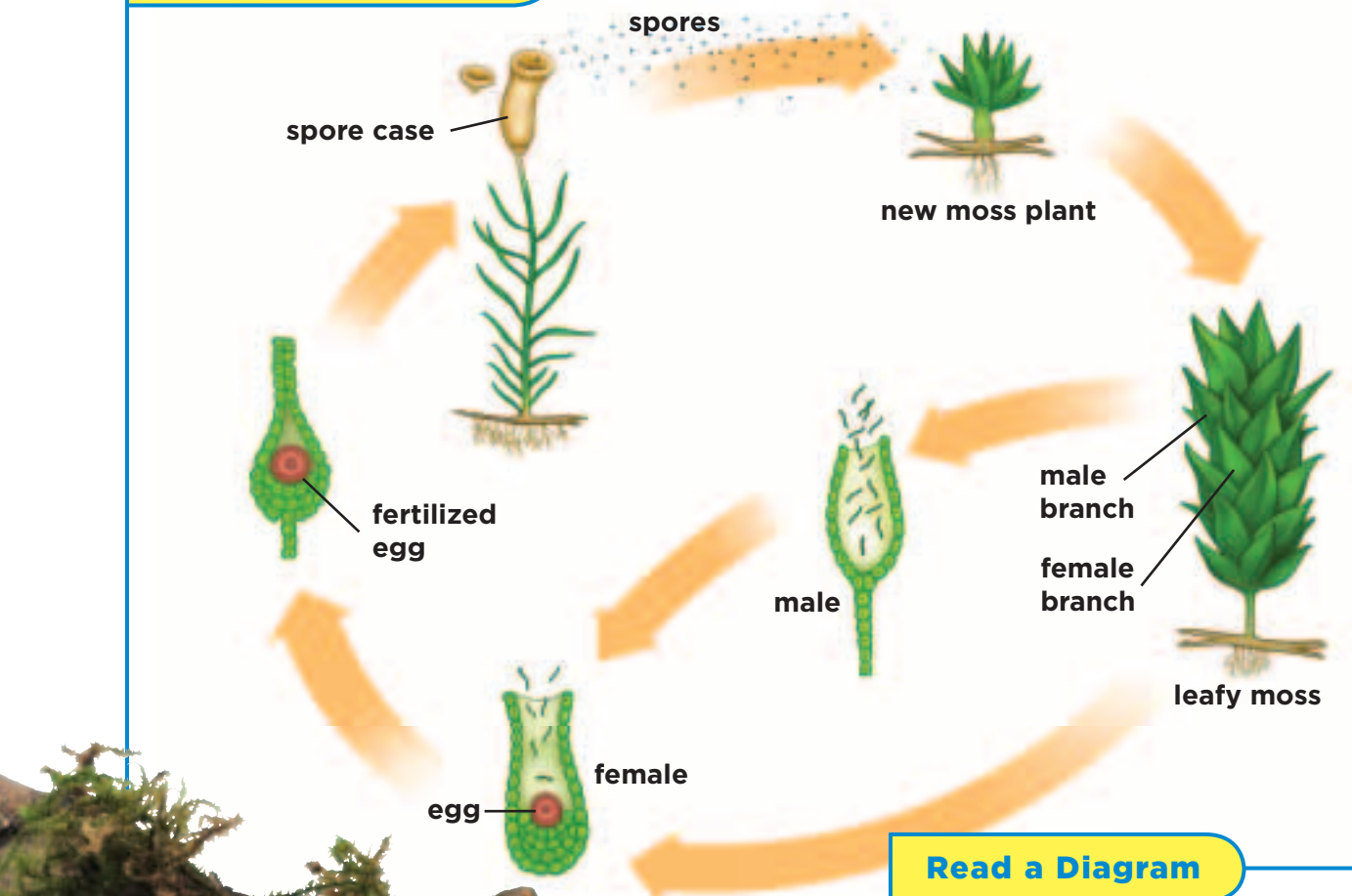
What are some plant life cycles?

Mosses and ferns are seedless plants. They use spores to reproduce. Mosses do not have true roots. However, they stay anchored in one place because they have hairlike fibers that play a role similar to that of roots. These fibers, called *rhizoids* (RIGH•zoydz), can also take in water from their surroundings. The water then travels from one cell in the plant to the next.

The life cycles of mosses and ferns have two separate stages. During one stage, asexual reproduction, the plant produces spores. The plant needs only one type of cell—the spore—to reproduce.

The other stage in the cycle is sexual reproduction. In this stage the plant needs both male sex cells and female sex cells in order to reproduce. The process of going from asexual reproduction to sexual reproduction is called *alternation of generations*.

Life Cycle of a Moss



Read a Diagram

Where could you find spores on the plants on this mossy log?

Clue: Find the place from which spores are scattered.

▲ cones from a bristlecone pine

How Seed Plants Differ

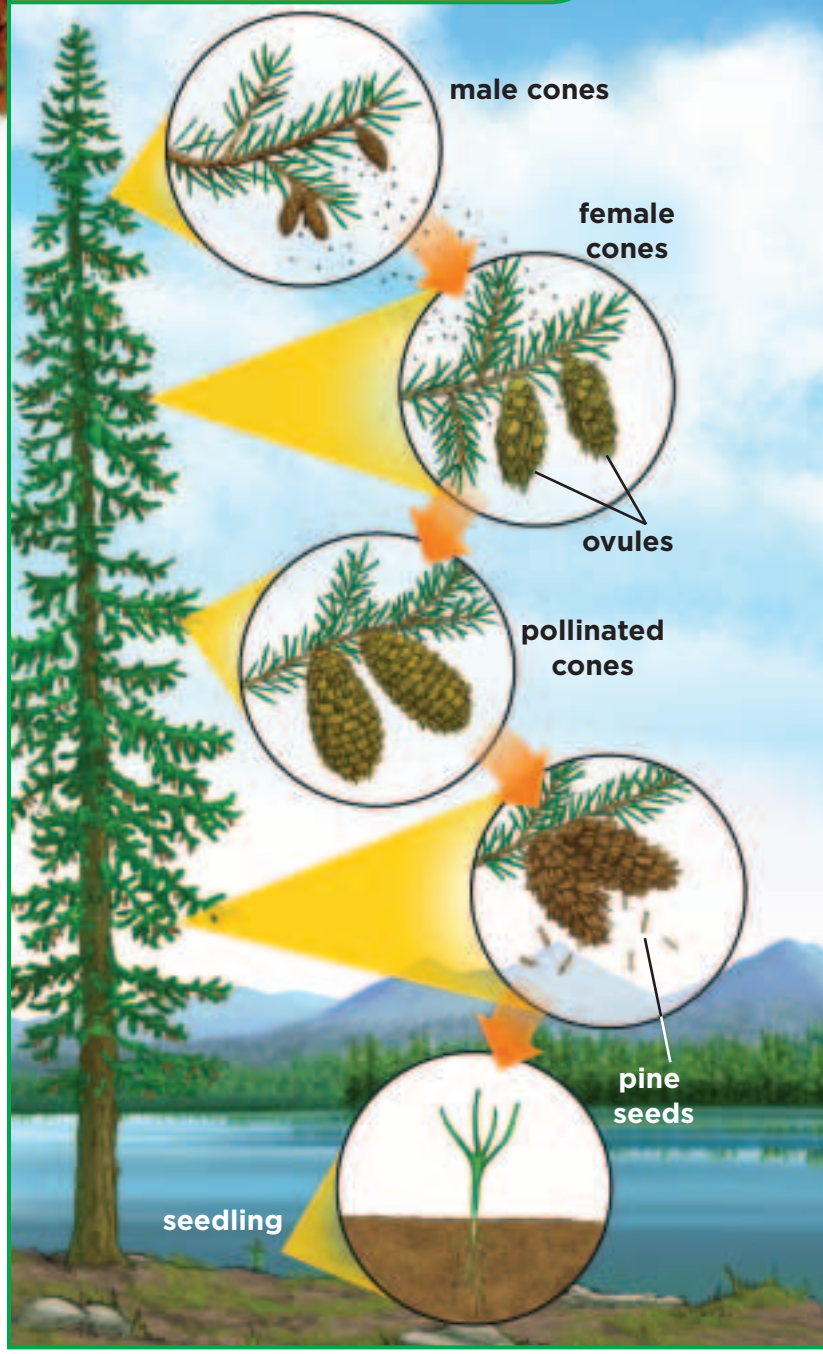
Angiosperms (AN•jee•uh•spurmz) and gymnosperms (JIM•nuh•spurmz) are two types of vascular seed plants. Angiosperms reproduce using flowers, but gymnosperms do not. Instead, the seeds of gymnosperms are produced in cones, such as those on pine trees.

Gymnosperms are the oldest seed plants. During the time when dinosaurs roamed Earth, gymnosperms were the dominant land plants. They first appeared on Earth about 250 million years ago. The first angiosperms did not appear until about 100 million years later.

Some gymnosperms are quite small, but others develop into large trees. In fact, gymnosperms make up most of the forests that are located at northern latitudes in Europe and North America.

The fruits, vegetables, grains, and most of the nuts that you eat are produced by angiosperms. However, one tasty nut—the pine nut, or pignoli—is a gymnosperm seed that is produced by certain pine trees.

Life Cycle of a Gymnosperm



Quick Check

Compare and Contrast How do the life cycles of mosses and gymnosperms differ?

Critical Thinking Why is the production of spores an example of asexual reproduction?

FACT Some bristlecone pines can live more than 5,000 years.

Produce markets sell many different types of fruits and vegetables.

How do plants store food?

The next time you shop for food, observe the produce section. All fruits and vegetables come from plants that capture energy from the Sun and store it as food.

Sweet potatoes, beets, parsnips, and carrots all come from plants that store food in their roots. Potatoes, sugar, and ginger all come from plants that store food in their stems. When people drink a cup of tea or eat vegetables such as spinach, cabbage, lettuce, and oregano, they are using plant leaves for food. Cauliflower and broccoli are flowers that are commonly eaten.

Seeds people eat include beans, corn, rice, peanuts, and even chocolate. Plant seeds are usually very nutritious, because they contain both the developing plant and its stored food.

▼ Both the seeds and the fruit of the pumpkin plant are nutritious.

Quick Check

Compare and Contrast How do carrot plants and spinach plants store food differently?

Critical Thinking Why are plants important as a food source for so many organisms?

Lesson Review

Visual Summary

Roots anchor plants and absorb water and nutrients from the soil. **Stems** support plants and transport water and nutrients.

Leaves capture the energy of the Sun and produce food through **photosynthesis**.

Plants carry out **reproduction** in several ways. Some plants produce seeds that each contain a developing plant.

Make a Study Guide

FOLDABLES™

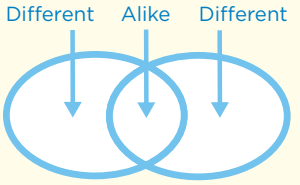
Make a Trifold Book. Complete the statements shown. Add details for each plant structure or process.

Think, Talk, and Write

1. **Main Idea** Plants carry out specific functions by means of various _____.

2. **Vocabulary** What structure holds a plant up and supports its leaves?

3. **Compare and Contrast** Compare the way that plants obtain food to the ways that animals obtain food.



4. **Critical Thinking** How does the life cycle of a flowering plant differ from the life cycle of a moss?

5. **Test Prep** **A bee's role in the reproduction of angiosperms is that of**
   - **A** honey maker.
   - **B** producer.
   - **C** seed disperser.
   - **D** pollinator.

6. **Test Prep** **Plant cells that can develop into new organisms are called**
   - **A** nonvascular plants.
   - **B** self-pollinators.
   - **C** angiosperms.
   - **D** spores.

Writing Link

Writing a Story

What if photosynthesis occurred in a factory instead of a leaf? Write a short story describing how your factory would work. How would food be packaged, stored, and shipped?

Art Link

Transportation Diagrams

Draw two diagrams to compare the transportation system in a vascular plant to the transportation system in your body. Compare how water, nutrients, and waste are transported.

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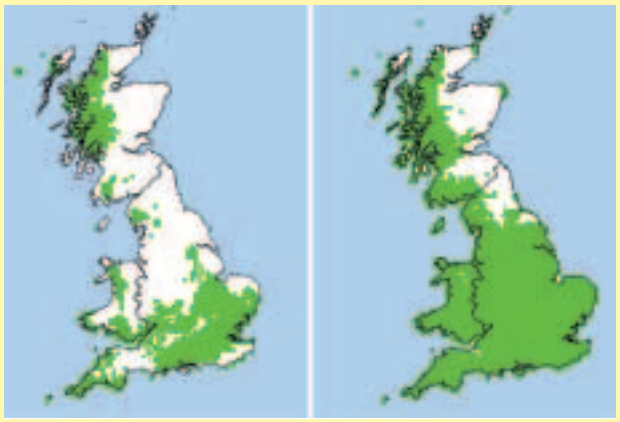
Meet Richard Pearson

Richard Pearson is a biologist. (That's a scientist who studies living organisms.)

What happens to plants when climates and environments change? Plants are well suited to the places in which they live. For example, in the hot, dry desert, cactuses store the scarce water in their stems. In the tropical rain forest, some leaves have special features called drip tips, which shed rainfall quickly and prevent fungi and bacteria from growing.

Climate changes can affect where plants grow. Richard Pearson is a scientist at the American Museum of Natural History. He studies how plants, over thousands of years, migrate or move to new places as rainfall and temperatures gradually change.

White Beaksedge Growth in Great Britain



The first map shows where *Rhynchospora alba* grows today. The second map estimates how it will spread in 50 years as a result of currently projected changes in climate.

Most plants are firmly rooted in the ground, so they can't pick up and move. To relocate, they send their seeds out by a process called seed dispersal. This is an important way in which plant species adapt to climate change. Seeds are dispersed in many ways.

Some plants, such as dandelions, rely on wind to disperse their seeds. Each white, fluffy dandelion thread has a small seed at the end. When the wind blows, it carries the threads like tiny parachutes to a new location—sometimes carrying them a great distance.

When coconuts fall from palm trees, they may roll down the beach to the water. Since coconuts float, ocean currents may then carry them thousands of kilometers away. ▶

Seeds that stick to an animal's fur, feathers, or claws may also travel long distances before dropping off and taking root. Birds eat fruit often, and they may fly far away before excreting the seeds.

In order to take root, seeds need to land in a place with the right soil and the right amounts of water and sunshine. As the climate warms, conditions may become less suitable, and new locations may become more favorable. For example, seeds that land higher up a mountain, where temperatures are cooler, may be more likely to survive.

What effect might people's land use have on seed dispersal? Richard develops computer models to make predictions about how plants might migrate. He looks at the way plants progress over flat, continuous landscapes such as prairies, and he compares it to the way they move across land broken up by highways, railroads, farms, or cities. Richard is looking at how these patterns of land use, coupled with rising global temperatures, might affect plant migration.

Write About It

Classify

1. What types of plants survive well in a desert environment?
2. What main categories of seed dispersal are addressed here?

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

Classify

- Think about how items are grouped into categories.
- Consider which items belong together.

American Museum of Natural History