chapter 9

Plants

section 1 An Overview of Plants

What You'll Learn

- the characteristics common to all plants
- the adaptations that make it possible for plants to live on land
- how vascular and nonvascular plants are similar and different

Before You Read

What are your favorite plants? Why are they your favorites?

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Read to Learn

What is a plant?

Plants include trees, flowers, vegetables, and fruits. More than 260,000 plant species have been identified. Scientists expect more species will be found, mostly in tropical rain forests. Plants are important sources of food for humans. Most life on Earth would not be possible without plants.

All plants are made of cells and need water to live. Many have roots that hold them in the ground or onto an object such as a rock. Plants come in many sizes and live in almost every environment on Earth. Some grow in cold, icy regions. Others grow in hot, dry deserts.

What are the parts of a plant cell?

Every plant cell has a cell wall, a cell membrane, a nucleus, and other cell structures. A cell wall surrounds every plant cell. The cell wall gives the plant structure and provides protection. Animal cells do not have cell walls.

Many plant cells have the green pigment, or coloring, called chlorophyll (KLOR uh fihl). Most green plants use chlorophyll to make food through a process called photosynthesis. Chlorophyll is found in cell structures called chloroplasts. The green parts of a plant usually have cells that contain many chloroplasts.

Study Coach

Identify Answers Read each question heading aloud. When you have finished reading the section, read the question heading again. Answer the question based on what you have just read.

Reading Check

1. **Explain** What surrounds every plant cell?

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Central Vacuole Most of the space inside a plant cell is taken up by a large structure called the central vacuole. The central vacuole controls the water content of the cell. Many other substances also are stored in the central vacuole, including the pigments that make some flowers red, blue, or purple.

Origin and Evolution of Plants

Think it Over

2. **Conclude** What do plants and green algae have in common?

The first land plants probably could survive only in damp areas. Their ancestors may have been green algae that lived in the sea. Green algae are one-celled or many-celled organisms that use photosynthesis to make food. Because plants and green algae have the same type of chlorophyll, they may have come from the same ancestor.

Plants do not have bones or other hard parts that can become fossils. Plants usually decay instead. But there is some fossil evidence of plants. The oldest fossil plants are about 420 million years old. Scientists hypothesize that some of these early plants evolved into the plants that live today.

Plants that have cones, such as pine trees, probably evolved from plants that lived about 350 million years ago. Plants that have flowers most likely did not exist until about 120 million years ago. Scientists do not know the exact beginning of flowering plants.

Life on Land

Think it Over

3. **Conclude** How would a drought affect green algae?

Life on land has some advantages for plants. One advantage is that more sunlight and carbon dioxide are available on land than in water. Plants need sunlight and carbon dioxide for photosynthesis. During photosynthesis, plants give off oxygen. Over millions of years, as more plants grew on land, more oxygen was added to Earth's atmosphere. Because of this increase in oxygen, Earth's atmosphere became an environment in which land animals could live.

Adaptations to Land

Algae live in water or in very moist environments. Like green plants, algae make their own food through photosynthesis. To stay alive, algae need nutrients that are dissolved in the water that surrounds them. The water and dissolved nutrients enter and leave through the algae's cell membranes and cell walls. If the water dries up, the algae will die. Land plants have adaptations that allow them to conserve water.

How are land plants supported and protected?

Plants cannot live without water. Plants that live on land have adaptations that help them conserve water. The stems, leaves, and flowers of many land plants are covered with a **cuticle** (KYEW tih kul). The cuticle is a waxy, protective layer that slows the loss of water. The cuticle is a structure that helps plants survive on land.

Land plants also have to be able to support themselves. The cell walls that surround all plant cells contain **cellulose** (SEL yuh lohs). Cellulose is a chemical compound that plants can make out of sugar. Long chains of cellulose molecules form fibers in plant cell walls. These fibers give the plant structure and support.

The cell walls of some plants contain other substances besides cellulose. These substances help make the plant even stronger. Trees, such as oaks and pines, could not grow without very strong cell walls. Wood from trees can be used for building because of strong cell walls.

Life on land means that each plant cell is not surrounded by water. Land plants have tubelike structures that deliver water, nutrients, and food to all plant cells. These structures also help provide support for the plant.

How do plants reproduce on land?

Land plants reproduce by forming spores or seeds. These structures can survive dryness, cold, and other harsh conditions. They grow into new plants when the environmental conditions are right.

Classification of Plants

Plants can be classified into two major groups, vascular (VAS kyuh lur) and nonvascular plants. **Vascular plants** have tubelike structures that carry water, nutrients, and other substances to all the cells of the plant. **Nonvascular plants** do not have these tubelike structures.

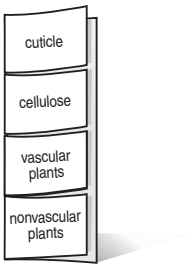
Scientists give each plant species its own two-word name. For example, the scientific name for a pecan tree is *Carya illinoiensis* and the name for a white oak is *Quercus alba.* In the eighteenth century a Swedish scientist, Carolus Linnaeus, created this system for naming plants.

Reading Check

4. **Identify** the part of the plant that slows the loss of water.

FOLDABLES™

A Define Make a four-tab book Foldable, as shown below. List each vocabulary word on the tabs. Inside, write a complete sentence definition of the word.



Reading Check

5. **Recall** the two major groups of plants.

After You Read

Mini Glossary

cellulose: a chemical compound that forms the walls of plants; plants make it out of sugar

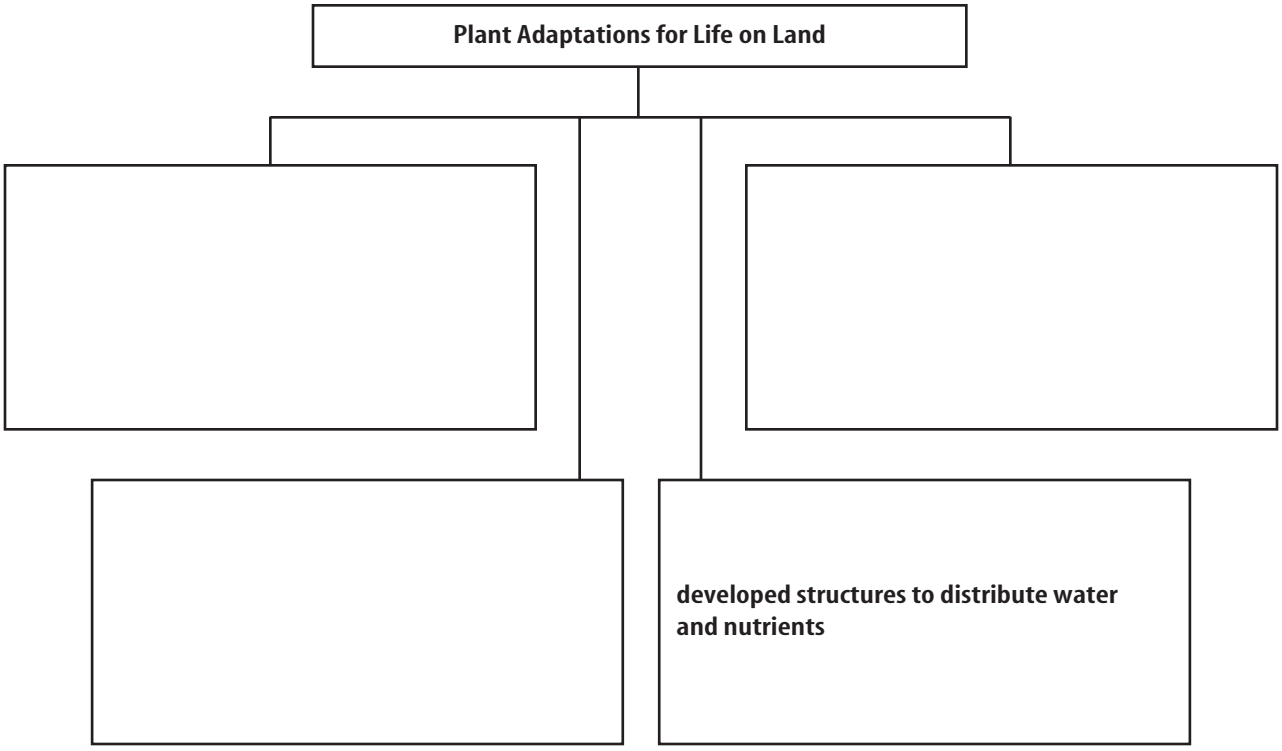
cuticle: a waxy, protective layer on the surface of the plant

nonvascular plants: plants without tubelike structures; move water and other substances through the plant in other ways

vascular plants: plants that have tubelike structures to carry water, nutrients, and other substances to the cells of the plant

1. Review the terms and their definitions in the Mini Glossary. Write a sentence that explains the difference between vascular and nonvascular plants.

2. In the boxes below, describe four adaptations in plants that allow them to live on land. One adaptation is supplied for you.



End of Section

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chapter 9 Plants

section 2 Seedless Plants

Before You Read

Ferns are a type of seedless plant that people grow as house plants. What do you think you would need to do to keep a fern alive indoors?

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What You'll Learn

- the differences between seedless nonvascular plants and seedless vascular plants
- the importance of some nonvascular and vascular plants

Read to Learn

Seedless Nonvascular Plants

Nonvascular plants are small and not always easy to notice. They include mosses, which you may have seen as green clumps on moist rocks or stream banks. Some other nonvascular plants are called hornworts and liverworts.

What are characteristics of seedless nonvascular plants?

Nonvascular plants do not grow from seeds. Instead, they reproduce by forming spores. They also do not have all of the parts that plants that grow from seed have. Nonvascular plants are usually only a few cells thick. They are not very tall, usually about 2 cm to 5 cm high. Nonvascular plants have structures that look like stems and leaves. Nonvascular plants do not have roots. Instead, they have **rhizoids** (RI zoydz). Rhizoids are threadlike structures that help to anchor the plants where they grow. Most nonvascular plants grow in damp places. They absorb water through their cell membranes and cell walls.

Study Coach

Summarize As you read, make an outline to summarize the information in the section. Use the main headings in the section as the main headings in the outline. Complete the outline with the information under each heading in the section.

Reading Check

1. **Identify** How do rhizoids help a plant?

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FOLDABLES™

B Organize On quarter sheets of notebook paper, make notes about characteristics of vascular and nonvascular plants.

Mosses Most nonvascular plants are mosses. Mosses have green, leaflike growths arranged around a stalk. They also have rhizoids that anchor them to the ground. Moss rhizoids are made up of many cells. Mosses often grow on tree trunks, rocks, or the ground. Although most mosses live in damp places, some can live in deserts. Like all nonvascular plants, mosses reproduce by forming spores. In many moss species, a stalk grows up from the plant when it is ready to reproduce. Spores form in a cap at the top of the stalk.

Liverworts Liverworts got their name because people who lived during the ninth century used them to treat diseases of the liver. Liverworts have flattened, leaflike bodies. They usually have one-celled rhizoids.

Hornworts Hornworts have flattened, leaflike bodies like liverworts. Hornworts are usually less than 2.5 cm in diameter. Hornworts have one chloroplast in each of their cells. They get their name from the structures that produce spores, which look like tiny cattle horns.

How are nonvascular plants important?

Nonvascular plants need damp conditions to grow and reproduce. However, many species can withstand long, dry periods. Nonvascular plants can grow in thin soil and in soils where other plants cannot grow.

The spores of mosses, liverworts, and hornworts are carried by the wind. When a spore lands on the ground, it will grow into a new plant only if there is enough water and if other growing conditions are right.

Mosses, such as those pictured below, often are the first plants to grow in a new or disturbed environment, such as after a forest fire. Organisms that are the first to grow in new or disturbed areas are called **pioneer species.** As pioneer plant species die, they decay. As more and more plants grow and die, the decayed matter builds up. The decaying material and slow breakdown of rocks build soil. After enough soil is made, other organisms can move into the area.

Aaron Haupt

Think it Over

2. Draw Conclusions
Why are mosses pioneer species?

Seedless Vascular Plants

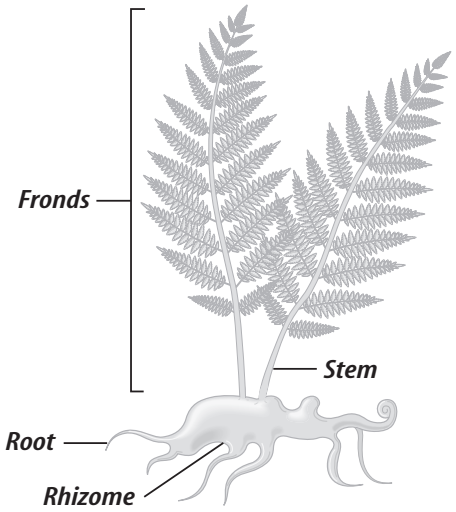
Both ferns and mosses reproduce by spores instead of seeds. But ferns are different from mosses because ferns have vascular tissues. Their long, tubelike cells carry water, minerals, and food to cells throughout the plant. Vascular plants can grow larger and thicker than nonvascular plants because the vascular tissue carries water and nutrients to all plant cells.

What are the types of seedless vascular plants?

Seedless vascular plants include ferns, ground pines, spike mosses, and horsetails. Many species of seedless vascular plants are known only from fossils because they are now extinct. These plants covered much of Earth 360 million to 286 million years ago.

What are ferns?

Ferns are the largest group of seedless vascular plants. Ferns have stems, leaves, and roots. Fern leaves are called fronds as shown in the figure to the right. Spores form in structures found on the underside of the fronds. Although thousands of species of ferns are found on Earth today, many more species existed long ago. Scientists have used clues from rock layers to learn that 360 million years ago much of Earth was covered with steamy swamps. The tallest plants were species of ferns that grew as tall as 25 m. The tallest ferns today are 3 m to 5 m tall and grow in tropical areas.



What are club mosses?

Ground pines and spike mosses are groups of plants that often are called club mosses. Club mosses are more closely related to ferns than to mosses. Club mosses have needle-like leaves. Their spores form at the end of the stems in structures that look like tiny pinecones. Ground pines grow in cold and hot areas. Ground pines are endangered in some places. They have been over-collected to make decorations such as wreaths.

Reading Check

3. **Explain** How is having vascular tissue an advantage for plants?

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Picture This

4. **Identify** Circle the name of the structure where spores are found.

Spike mosses look a lot like ground pines. One species of spike moss, the resurrection plant, lives in desert areas. When there is not enough water, the plant curls up and looks dead. When water becomes available, the resurrection plant unfolds its green leaves and begins making food again. The plant can curl up again whenever conditions make it necessary.

How are horsetails different from other vascular plants?

Horsetails have a stem structure that is different from other vascular plants. The stem has a hollow center surrounded by a ring of vascular tissue. The stem also has joints. Leaves grow out around the stem at each joint. Horsetail spores form in conelike structures at the tips of some stems. The stems of horsetails contain silica, a gritty substance found in sand. In the past, horsetails were used for polishing objects and scouring cooking utensils.

Reading Check

5. **Explain** How do horsetails differ from other vascular plants?

Importance of Seedless Plants

Long ago, when ancient seedless plants died, they sank into water and mud before they decayed. Over time, many layers of this plant material built up. Top layers became heavy and pressed down on the layers below. Over millions of years, this material turned into coal.

Today, the same process is happening in bogs. A bog is a watery area of land that contains decaying plants. Most plants that live in bogs are seedless plants like mosses and ferns.

When bog plants die, the watery soil slows the decaying process. Over time, the decaying plants are pressed into a substance called peat. Peat is mined from bogs to use as a low-cost fuel in places such as Ireland and Russia. Scientists hypothesize that over time, if the peat remains in the bog, it will become coal.

How are seedless vascular plants used?

Peat is used to enrich garden soil. Many people keep ferns as houseplants. Ferns also are sold as landscape plants for shady outdoor areas. Ferns sometimes are woven into baskets.

The rhizomes and fronds of some ferns can be eaten. The dried stems of one kind of horsetail can be ground into flour. Some seedless plants have been used as medicines for hundreds of years. For example, ferns have been used to treat bee stings, burns, and fevers.

Reading Check

6. **Identify** two ways seedless plants are used.

After You Read

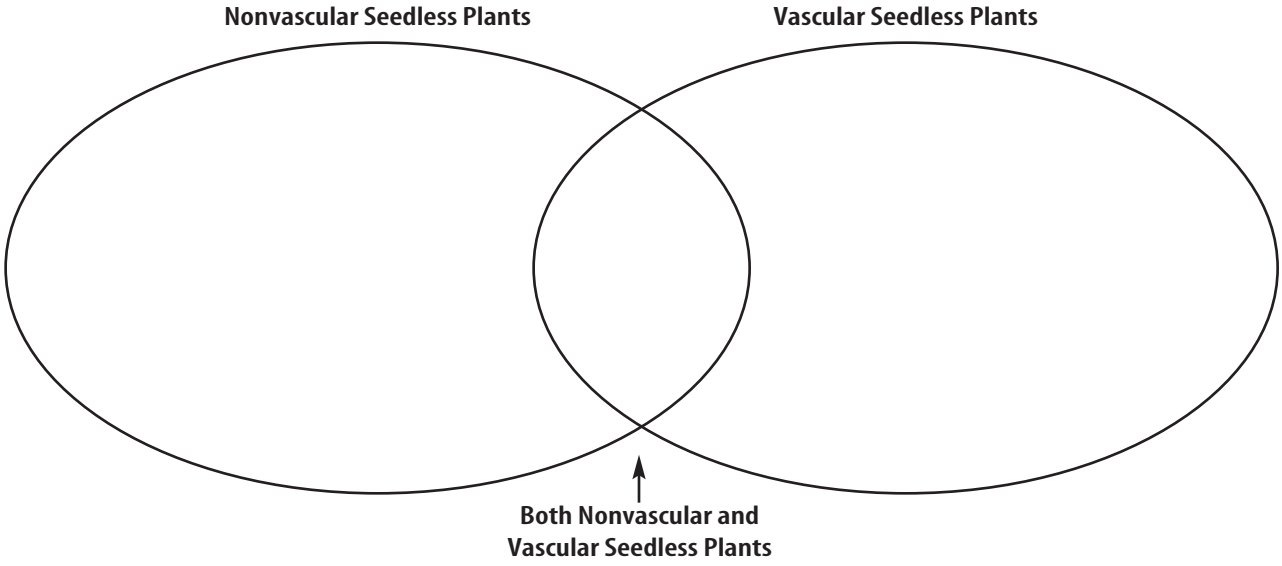
Mini Glossary

pioneer species: organisms that are the first to grow in new or disturbed areas

rhizoid: threadlike structures that anchor nonvascular plants

1. Review the terms and their definitions in the Mini Glossary. Write a sentence to explain the importance of pioneer species to the environment.

2. Complete the Venn diagram below to help you compare nonvascular and vascular seedless plants. Include phrases that describe how the plant cells get nutrients and how the plants reproduce.



3. How did summarizing the information in this section help you learn about nonvascular and vascular seedless plants?

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End of Section

chapter 9

Plants

section 3 Seed Plants

What You'll Learn

- the characteristics of seed plants
- how roots, stems, and leaves function
- the characteristics of gymnosperms and angiosperms
- how monocots and dicots are different

Before You Read

What are your favorite fruits? Where do these fruits come from?

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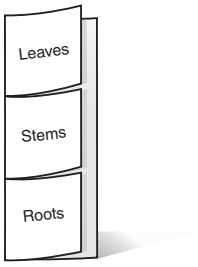
Study Coach

Identify Main Ideas
Highlight the main idea in each paragraph. Then underline one detail that supports the main idea.

FOLDABLES™

Classify Make a three-tab Foldable to write notes about the importance of plant leaves, stems, and roots.



Read to Learn

Characteristics of Seed Plants

Seed plants reproduce by forming seeds. A seed contains a plant embryo and stored food. The stored food provides energy for the embryo so that it can grow into a plant. Scientists classify seed plants into two groups: gymnosperms (JIHM nuh spurmz) and angiosperms (AN jee uh spurmz). Most seed plants have four main parts: roots, stems, leaves, and vascular tissue.

Why are leaves important?

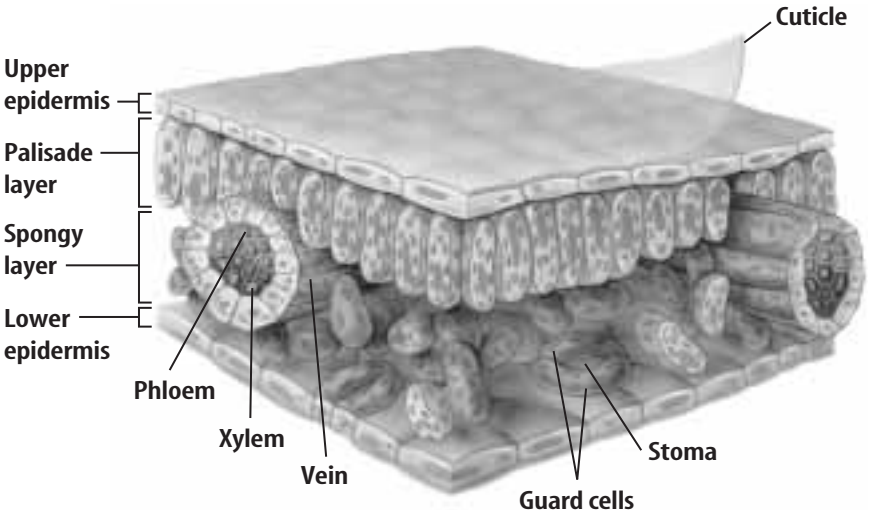
The leaves of seed plants are the organs where food is made. The food-making process is called photosynthesis. Leaves come in many shapes, sizes, and colors.

What are the cell layers of a leaf?

A leaf has several layers of cells. A thin layer of cells called the epidermis covers and protects the top and bottom of the leaf. The epidermis of some leaves is covered with a waxy cuticle. Most leaves have small openings in the epidermis called **stomata** (STOH muh tuh) (singular, *stoma*). The stomata allow carbon dioxide, water, and oxygen to enter and exit the leaf. **Guard cells** located around each stoma open and close the stoma.

The palisade layer of a leaf is located just below the upper epidermis. This layer has long, narrow cells that contain chloroplasts. Plants make most of their food in the palisade cells.

The spongy layer is found between the palisade layer and the lower epidermis. The spongy layer is made of loosely arranged cells separated by air spaces. The veins of a leaf are made of vascular tissue and are located in the spongy layer. All the parts of the leaf can be seen in the figure below.



Picture This

1. **Identify** Color in blue the plant layer that contains the chloroplasts. Color in red the plant layer that protects the leaf. Finally, underline the name of the part of the leaf that allows carbon dioxide, water, and oxygen to enter and exit the leaf.

What is the purpose of a plant's stem?

Plant stems are usually found above the ground. They support the branches, leaves, and reproductive structures of the plant. Materials move between the leaves and roots through vascular tissues in the stem. The stems of some plants also store food and water.

Plant stems can be woody or herbaceous (hur BAY shus). Herbaceous stems are soft and green, like those of a tulip. Woody stems are hard and rigid, like those of trees and shrubs. The trunk of a tree is a stem.

What do plant roots do?

The root system of most plants is the largest part of the plant. Roots contain vascular tissue. Water and dissolved substances move from the soil into the roots, and on up through the stems to the leaves. Roots also anchor plants and prevent them from being blown or washed away. Roots support the parts of the plant that are above ground—the stem, branches, and leaves.

Reading Check

2. **Identify** two things roots do for a plant.

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Roots can store food and water. They can take in oxygen that the plant needs for the process of cellular respiration. For plants that grow in water, part or all of a plant's roots may grow above ground. Water does not have as much oxygen as air. The roots take in more oxygen from the air.

What are vascular tissues made of?

The vascular system in a seed plant contains three kinds of tissue—xylem, phloem, and cambium. **Xylem** (ZI lum) tissue is made of hollow, tubelike cells that are stacked one on top of the other to form a structure called a vessel. Vessels move water and dissolved substances from the roots to the rest of the plant. Xylem's thick cell walls also help support the plant.

Phloem (FLOH em) tissue is made of tubelike cells that are stacked to form structures called tubes. Phloem tubes move food from where it is made to other parts of the plant where the food is used or stored.

Some plants have a layer of cambium tissue between xylem and phloem. **Cambium** (KAM bee um) tissue produces most of the new xylem and phloem cells.

Reading Check

3. **Describe** What does phloem tissue do?

Gymnosperms

Gymnosperms are vascular plants that produce seeds that are not protected by a fruit. Gymnosperms do not have flowers. The leaves of gymnosperms are usually shaped like needles or scales. Many gymnosperms are called evergreens because some green leaves always stay on their branches.

The gymnosperms are divided into four divisions. These four divisions are conifers, cycads, ginkgoes, and gnetophytes (NE tuh fites). The conifers are the most familiar gymnosperm division. Pines, firs, spruces, redwoods, and junipers are conifers. Conifers produce two types of cones—male and female. Seeds develop only on the female cone.

Think it Over

4. **Compare** What is the difference between gymnosperms and angiosperms?

Angiosperms

An **angiosperm** is a vascular plant that forms flowers and produces one or more seeds that are protected inside a fruit. Peaches, apples, and tulips are examples of angiosperms. Angiosperms are common in all parts of the world. More than half of all known plant species are angiosperms.

What are the flowers of angiosperms like?

The flowers of angiosperms come in different shapes, sizes, and colors. Some parts of a flower grow into a fruit. Most fruits have seeds inside, like an apple. Some fruits have seeds on the surface, like a strawberry. Angiosperms are divided into two groups—monocots and dicots.

How do monocots and dicots differ?

A cotyledon (kah tul EE dun) is the part of a seed that stores food for the new plant. **Monocots** are angiosperms that have one cotyledon inside their seeds. **Dicots** are angiosperms that have two cotyledons inside their seeds.

Many foods come from monocots, including corn, rice, and wheat. Bananas and pineapples also are monocots. Familiar foods such as peanuts, peas, and oranges come from dicots. Most shade trees, such as oaks and maples, are dicots.

What is the life cycle of an angiosperm?

All organisms have life cycles—a beginning and an end. The angiosperm's life cycle begins with the seed and ends when the mature plant flowers and/or produces seed. Some angiosperms grow from seeds to maturity in less than a month. Some plants take as long as 100 years to grow from seed to maturity. Plants that complete their life cycles in one year are called annuals. Annuals must be grown from new seeds each year.

Plants that complete their life cycles in two years are called biennials (bi EH nee ulz). Biennials produce flowers and seeds only during the second year of growth. Angiosperms with life cycles that take longer than two years are called perennials. Most trees and shrubs are perennials.

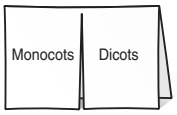
Importance of Seed Plants

Gymnosperms are used for many purposes. Conifers are the most commonly used gymnosperm. Most of the wood used in building comes from conifers. Resin used to make chemicals found in soap, paint, and varnish also comes from conifers.

Angiosperms are widely used by humans. Many of the foods you eat come from seed plants. Angiosperms are the source of many of the fibers used in making clothes. Paper is made from wood pulp that comes from trees. Desks and chairs are made from wood.

FOLDABLES™

D Compare Make notes listing the characteristics of monocots and dicots in a two-tab Foldable. Include ways in which humans use each.



Reading Check

5. Explain Why are conifers important to the economy?

After You Read

Mini Glossary

angiosperm: vascular plant that flowers and produces one or more seeds inside a fruit

cambium: plant tissue that produces most of the new xylem and phloem cells

dicot: angiosperm that has two cotyledons inside its seeds

guard cells: cells that surround a stoma and open and close it

gymnosperm: vascular plant that produces seeds that are not protected by fruit

monocot: angiosperm that has one cotyledon inside its seeds

phloem: plant tissue made up of tubelike cells that are stacked to form tubes; tubes move food from where it is made to parts of the plant where it is used

stomata: small openings in the epidermis of the leaf

xylem: plant tissue made up of hollow, tubelike cells that are stacked one on top of the other to form vessels; vessels transport water and dissolved substances from the roots to all other parts of the plant

1. Review the terms and their definitions in the Mini Glossary. Write two sentences that explain what xylem and phloem do.

_____

_____

_____

2. Complete the chart below to list the four main parts of seed plants and describe what they do.

Parts of Seed Plants	What They Do

End of Section

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