SECTION 4

Structures of Seed Plants

You have different body systems that carry out many functions. Plants have systems too—a root system, a shoot system, and a reproductive system.

A plant's root system and shoot system supply the plant with what it needs to survive. The root system is made up of roots. The shoot system includes stems and leaves.

The vascular tissues of the root and shoot systems are connected. There are two kinds of vascular tissue—xylem (ZIE luhm) and phloem (FLOH EM). **Xylem** is vascular tissue that transports water and minerals through the plant. Xylem moves materials from the roots to the shoots. **Phloem** is vascular tissue that transports food molecules to all parts of a plant. Xylem and phloem are found in all parts of vascular plants.

What You Will Learn

- List three functions of roots and three functions of stems.
- Describe the structure of a leaf.
- Identify the parts of a flower and their functions.

Vocabulary

xylem
phloem
sepal
petal
stamen
pistil
ovary

READING STRATEGY

Mnemonics As you read this section, create a mnemonic device to help you remember the parts of a plant.

Roots

Most roots are underground, as shown in **Figure 1.** So, many people do not realize how extensive root systems can be. For example, a corn plant that is 2.5 m tall can have roots that grow 2.5 m deep and 1.2 m out and away from the stem!

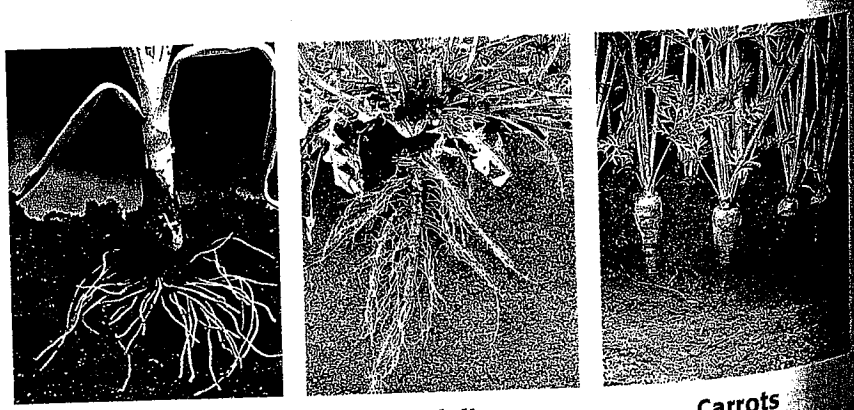
Root Functions

The following are the three main functions of roots:

- Roots supply plants with water and dissolved minerals. These materials are absorbed from the soil. The water and minerals are transported to the shoots in the xylem.
- Roots hold plants securely in the soil.
- Roots store surplus food made during photosynthesis. The food is produced in the leaves. Then, it is transported in the phloem to the roots. In the roots, the surplus food is usually stored as sugar or starch.

xylem the type of tissue in vascular plants that provides support and conducts water and nutrients from the roots

phloem the tissue that conducts food in vascular plants



Onion Dandelion Carrots

Figure 1 *The roots of these plants provide the plants with water and minerals.*

Root Structure

The structures of a root are shown in **Figure 2.** The layer of cells that covers the surface of roots is called the *epidermis*. Some cells of the epidermis extend from the root. These cells, or root hairs, increase the surface area of the root. This surface area helps the root absorb water and minerals. After water and minerals are absorbed by the epidermis, they diffuse into the center of the root, where the vascular tissue is located.

Roots grow longer at their tips. A group of cells called the *root cap* protects the tip of a root. The root cap produces a slimy substance. This substance makes it easier for the root to push through soil as it grows.

Root Systems

There are two kinds of root systems—taproot systems and fibrous root systems. A taproot system has one main root, or a taproot. The taproot grows downward. Many smaller roots branch from the taproot. Taproots can reach water deep underground. Dicots and gymnosperms usually have taproot systems.

A fibrous root system has several roots that spread out from the base of a plant's stem. The roots are usually the same size. Fibrous roots usually get water from close to the soil surface. Monocots usually have fibrous roots.

Reading Check **What are two types of root systems?** (*See the Appendix for answers to Reading Checks.*)

MATH PRACTICE

Practice with Percentages

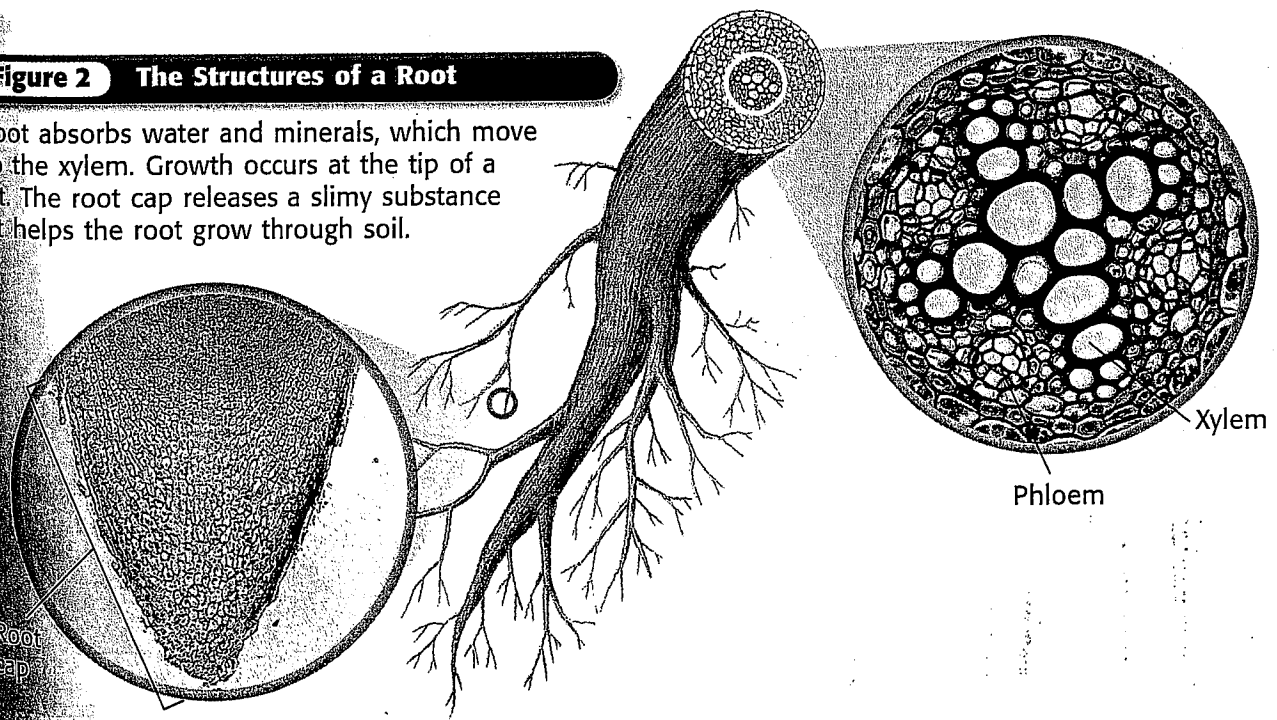
The following table gives an estimate of the number of species in each plant group.[1]

Plant Species	
Plant group	**Number of species**
Mosses, liverworts, and hornworts	15,600
Ferns, horsetails, and club mosses	12,000
Gymnosperms	760
Angiosperms	235,000

What percentage of plants do not produce seeds?

Figure 2 **The Structures of a Root**

A root absorbs water and minerals, which move into the xylem. Growth occurs at the tip of a root. The root cap releases a slimy substance that helps the root grow through soil.



Stems

Stems vary greatly in shape and size. Stems are usually located above ground. However, many plants have underground stems. The trunk of the valley oak in **Figure 3** is a stem.

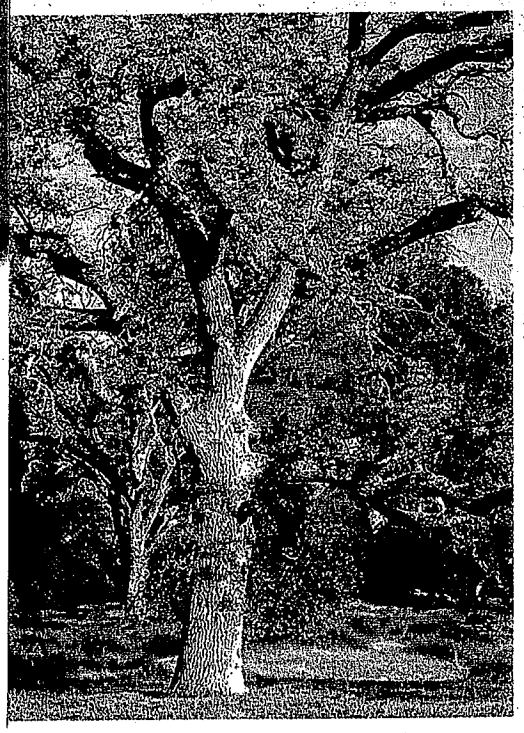


Figure 3 *The stem, or trunk, of this valley oak keeps the tree upright, which helps leaves get sunlight for photosynthesis.*

Stem Functions

A stem connects a plant's roots to its leaves and flowers. A stem also has the following functions:

- Stems support the plant body. Leaves are arranged along stems or on the ends of stems. This arrangement helps leaves get sunlight for photosynthesis. Stems hold up flowers, which helps pollinators, such as bees, see the flowers.
- Stems transport materials between the root system and the shoot system. Xylem carries water and dissolved minerals from the roots to the leaves and other shoot parts. Phloem carries the food made during photosynthesis to roots and other parts of the plant.
- Some stems store materials. For example, the stems of cactuses and some trees are adapted for water storage.

Herbaceous Stems

Many plants have stems that are soft, thin, and flexible. These stems are called *herbaceous stems* (huhr BAY shuhs STEMZ). Examples of plants that have herbaceous stems include wildflowers, such as clovers and poppies. Many crops, such as beans, tomatoes, and corn, have herbaceous stems. A cross section of an herbaceous stem is shown in **Figure 4.**

Reading Check **What are herbaceous stems? Give an example of a plant that has an herbaceous stem.**

Figure 4 Cross Section of an Herbaceous Stem

Buttercups are just one plant that has herbaceous stems. Wildflowers and many vegetables have soft, thin, and flexible stems.

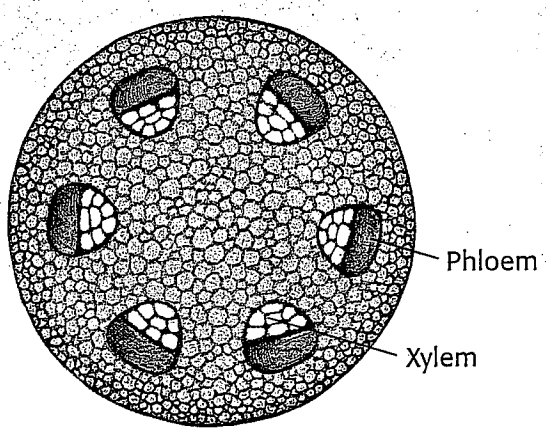
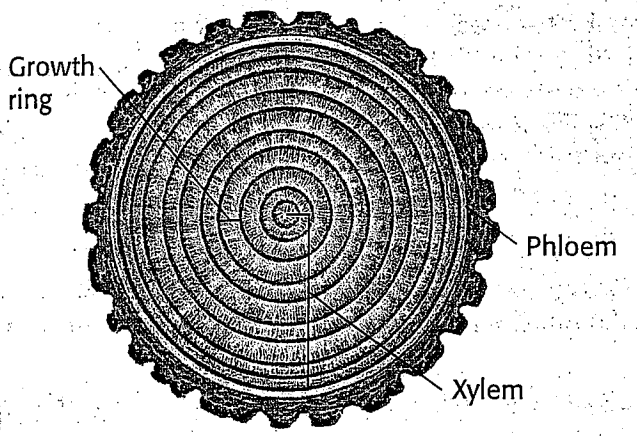


Figure 5 **Cross Section of a Woody Stem**

Some plants, such as these trees, have woody stems. Plants that have woody stems usually live for many years. People can use growth rings to estimate the age of a plant.



Woody Stems

Trees and shrubs have rigid stems made of wood and bark. These stems are called *woody stems*. **Figure 5** shows a cross section of a woody stem. Trees or shrubs that live in areas with cold winters have a growing period during the spring and summer. These plants have a dormant period during the winter. At the beginning of each growing period, large xylem cells are produced. As fall approaches, the plants produce smaller xylem cells, which appear darker. In the fall and winter, the plants stop producing new cells. The cycle begins again the next spring. A ring of dark cells surrounding a ring of light cells makes up a growth ring.

Leaves

Leaves vary greatly in shape. They may be round, narrow, heart-shaped, or fan-shaped. Leaves also vary in size. The raffia palm has leaves that may be six times longer than you are tall. The leaves of duckweed, a tiny aquatic plant, are so small that several of the leaves can fit on your fingernail. **Figure 6** shows a poison ivy leaf.

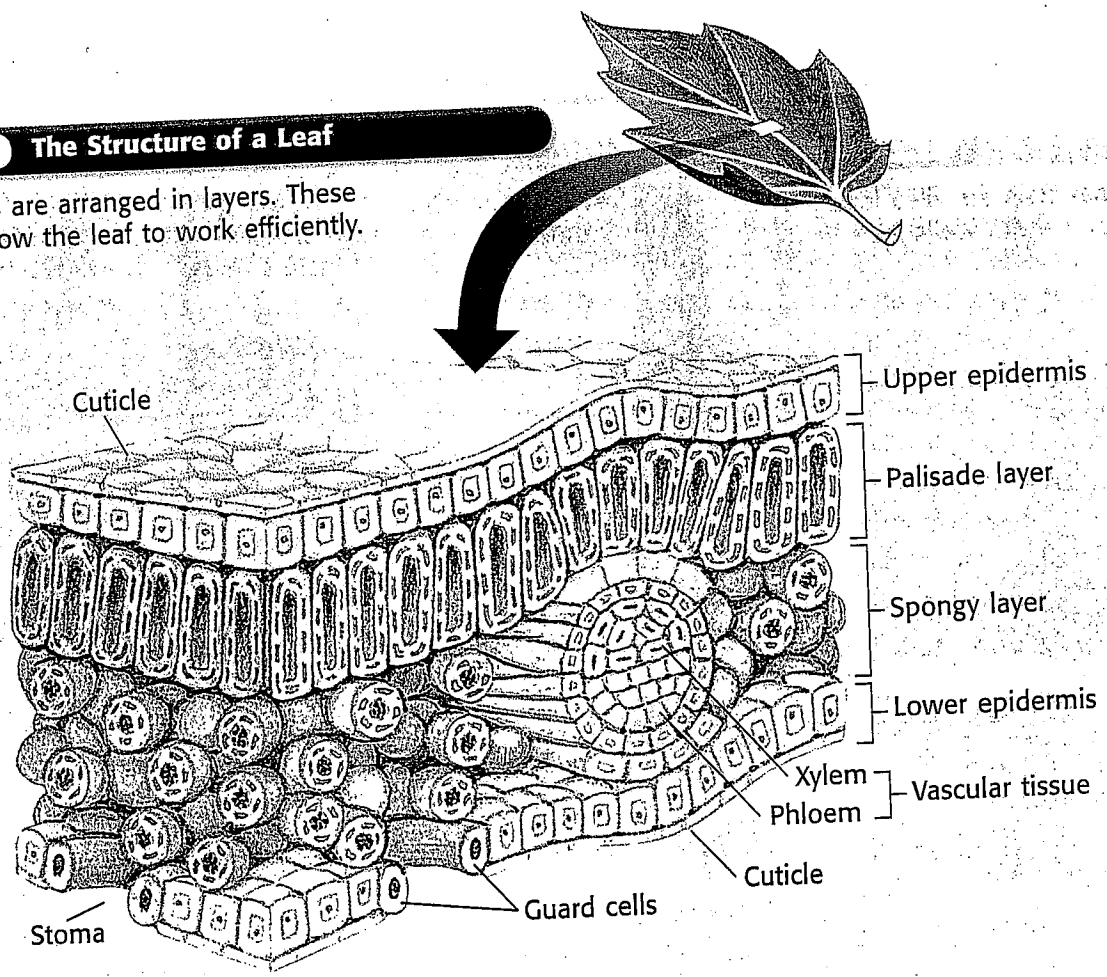
Leaf Functions

The main function of leaves is to make food for the plant. Chloroplasts in the cells of leaves capture energy from sunlight. The leaves also absorb carbon dioxide from the air. The leaves use the captured energy to make food, or sugar, from carbon dioxide and water.

Figure 6 *The leaves of poison ivy are very distinctive. They make food to help the plant survive.*

Figure 7 The Structure of a Leaf

Leaf cells are arranged in layers. These layers allow the leaf to work efficiently.



Leaf Structure

The structure of leaves, shown in **Figure 7,** is related to their main function—photosynthesis. The outer surfaces of a leaf are covered by a cuticle. The cuticle prevents water loss from the leaf. A single layer of cells, the epidermis, lies beneath the cuticle. Light passes through the epidermis. Tiny openings in the epidermis, called *stomata* (singular, *stoma*), let carbon dioxide enter the leaf. Guard cells open and close the stomata.

Most photosynthesis takes place in the middle of a leaf. This part of a leaf often has two layers. Cells in the upper layer, the palisade layer, contain many chloroplasts. Photosynthesis takes place in the chloroplasts. Carbon dioxide moves freely in the space between the cells of the second layer, the spongy layer. Xylem and phloem are also found in the spongy layer.

Reading Check What are the cell layers of a leaf?

Leaf Adaptations

Some leaves have functions other than photosynthesis. For example, the leaves of many cactuses are modified as spines. These spines keep animals from eating the cactuses. The leaves of another plant, the sundew, are modified to catch insects. Sundews grow in soil that does not contain enough nitrogen to meet the plants' needs. By catching and digesting insects, a sundew is able to get enough nitrogen.

SCHOOL to HOME

Looking at Leaves

Leaves are many shapes and sizes. They are also arranged on a stem in many ways. Walk around your home. In your **science journal,** sketch the leaves of the plants you see. Notice how the leaves are arranged on the stem, the shapes of the leaves, and the veins in the leaves. Use a ruler to measure the size of the leaves.

ACTIVITY

Flowers

Most people admire the beauty of flowers, such as the wildflowers in **Figure 8.** But why do plants have flowers? Flowers are adaptations for sexual reproduction.

Flowers come in many shapes, colors, and fragrances. Brightly colored and fragrant flowers usually rely on animals for pollination. For example, some flowers look and smell like rotting meat. These flowers attract flies. The flies pollinate the flowers. Plants that lack brightly colored flowers and fragrances, such as grasses, depend on the wind to spread pollen.

Many flowers also produce nectar. Nectar is a fluid that contains sugar. Nectar attracts birds and insects. These animals move from flower to flower and drink the nectar. As they do so, they often carry pollen to the flowers.

Sepals and Petals

Flowers usually have the following basic parts: sepals, petals, stamens, and one or more pistils. The flower parts are usually arranged in rings around the central pistil.

Sepals are modified leaves that make up the outermost ring of flower parts and protect the bud. Sepals are often green like other leaves. Sepals cover and protect the flower while it is a bud. As the blossom opens, the sepals fold back. Then, the petals can unfold and become visible. **Petals** are broad, flat, thin leaflike parts of a flower. Petals vary greatly in color and shape. Petals attract insects or other animals to the flower. These animals help plants reproduce by carrying pollen from flower to flower.

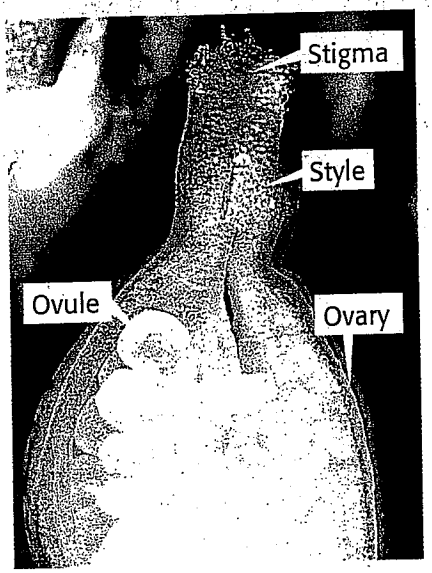
sepal in a flower, one of the outermost rings of modified leaves that protect the flower bud

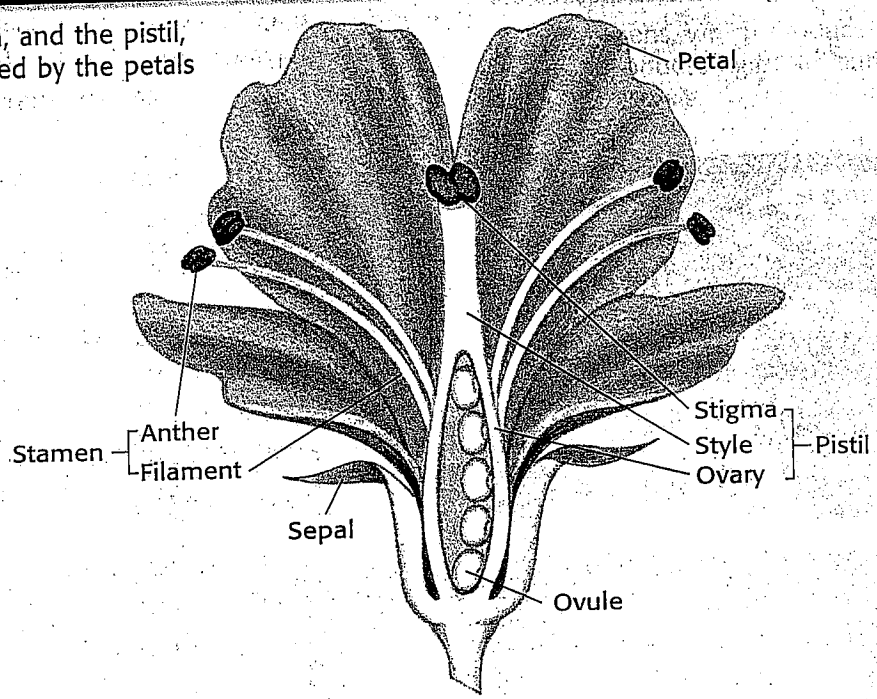
petal one of the ring or rings of the usually brightly colored, leaf-shaped parts of a flower

Figure 8 *Many flowers help the plants reproduce by attracting pollinators with bright petals and strong fragrances.*

Figure 9 The Structure of a Flower

The stamens, which produce pollen, and the pistil, which produces eggs, are surrounded by the petals and the sepals.





stamen the male reproductive structure of a flower that produces pollen and consists of an anther at the tip of a filament

pistil the female reproductive part of a flower that produces seeds and consists of an ovary, style, and stigma

ovary in flowering plants, the lower part of a pistil that produces eggs in ovules

Stamens and Pistils

As you can see in **Figure 9,** the stamens of flowers are usually found just above the petals. A **stamen** is a male reproductive structure of flowers. Each stamen has a thin stalk called a *filament.* The filament is topped by an anther. Anthers are saclike structures that produce pollen.

Found in the center of most flowers is one or more pistils. A **pistil** is the female reproductive structure of flowers. The tip of the pistil is called the *stigma.* Pollen grains collect on stigmas, which are often sticky or feathery. The long, slender part of the pistil is the style. The rounded base of a pistil that contains one or more ovules is called the **ovary.** Each ovule contains an egg. When the egg is fertilized, the ovule develops into a seed. The ovary develops into a fruit.

Reading Check Describe stamens and pistils. Which are the female parts of a flower? the male parts of a flower?

The Importance of Flowers

Flowers help plants reproduce. Humans also use flowers for many things. Roses and many other flowers are used for floral arrangements. Some flowers, such as artichokes, broccoli, and cauliflower, can be eaten. Other flowers, such as hibiscus and chamomile flowers, are used to make tea. Flowers used as spices include cloves and saffron. Flowers are also used in perfumes, lotions, and shampoos.