SECTION 4

Structures of Seed Plants

Key Concept Seed plants are made up of roots and shoots. Each part carries out functions for the seed plant.

What You Will Learn

- Seed plants have roots and shoots that allow for water and nutrient uptake and provide support.
- Leaves capture light energy for photosynthesis and provide a surface for gas exchange.
- Flowers are the reproductive structures for angiosperms.

Why It Matters

A seed plant's survival relies on both underground and above ground parts.

Vocabulary

- xylem
- phloem
- sepal
- petal
- stamen
- pistil
- ovary
- ovule

READING STRATEGY

Outlining In your **Science Journal,** create an outline of the section. Use the headings from the section in your outline.

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

phloem (FLOH EM) the tissue that conducts food in vascular plants

Just like the human body, a plant has different parts that carry out many functions. Plants have roots, shoots, and reproductive structures. A plant's roots and shoots supply the plant with what it needs to survive. The roots are often found underground. The shoot includes stems and leaves. It is often found above ground.

The vascular tissues of the root and shoot are connected. There are two kinds of vascular tissue—xylem and phloem. **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.

Roots

Most roots are underground, as **Figure 1** shows. 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 absorb water and dissolved minerals from the soil. The water and minerals are transported by the xylem to the shoots.
- 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.

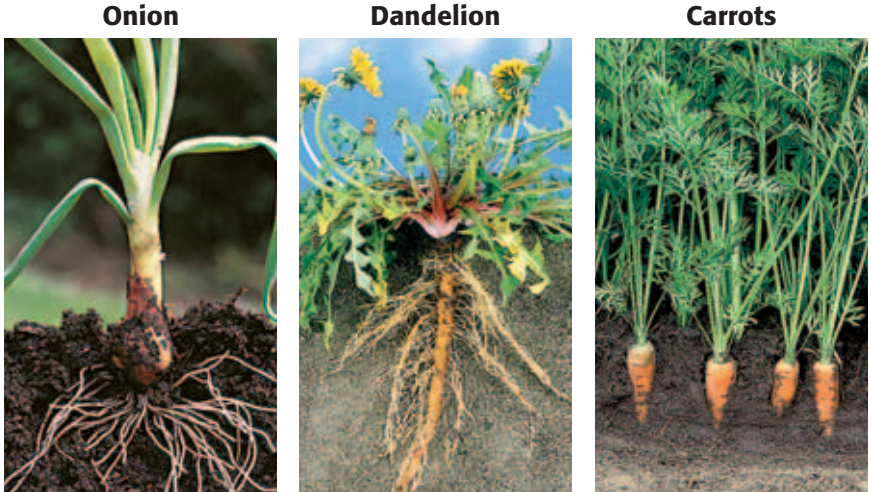


Figure 1 *The roots of these plants absorb and store water and minerals.*

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. Eudicots 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.

Standards Check What are two types of root systems? 7.5.a

MATH PRACTICE

Practice with Percentages

The table gives an estimate of the number of species in each plant group. What percentage of plant species do not produce seeds?

Plant Species

Plant group	Number of species
Mosses, liverworts, and hornworts	16,000
Ferns, horsetails, and club mosses	12,200
Gymnosperms	840
Angiosperms	300,000

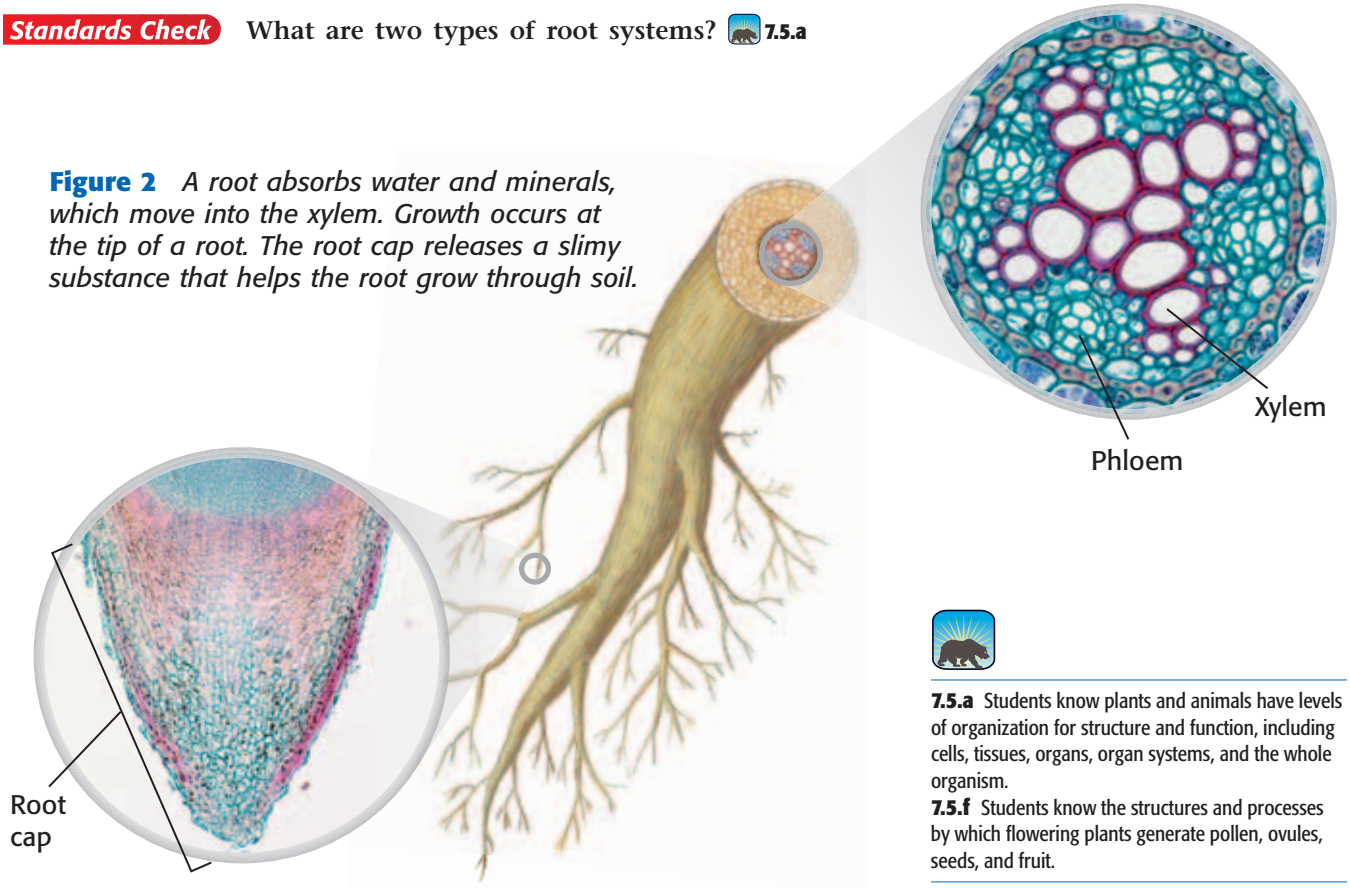


Figure 2 *A root absorbs water and minerals, which move into the xylem. Growth occurs at the tip of a root. The root cap releases a slimy substance that helps the root grow through soil.*

7.5.a Students know plants and animals have levels of organization for structure and function, including cells, tissues, organs, organ systems, and the whole organism.

7.5.f Students know the structures and processes by which flowering plants generate pollen, ovules, seeds, and fruit.

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

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.

Stem Functions

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

- Stems support the plant body. Leaves are arranged along stems. This arrangement helps leaves get sunlight for photosynthesis. Stems hold up reproductive structures, like flowers, which helps pollinators, such as bees, find the flowers.
- Stems transport materials between the root system and the leaves and reproductive structures. 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.**

Standards Check **What is an herbaceous stem? Give an example of a plant that has an herbaceous stem.** 7.5.a

Figure 4 *Buttercups are just one plant that has herbaceous stems. Wildflowers and many vegetables have soft, thin, and flexible stems.*

Figure 5 *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 size, shape, and thickness can change based on the environment in which the plant lives.

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

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.

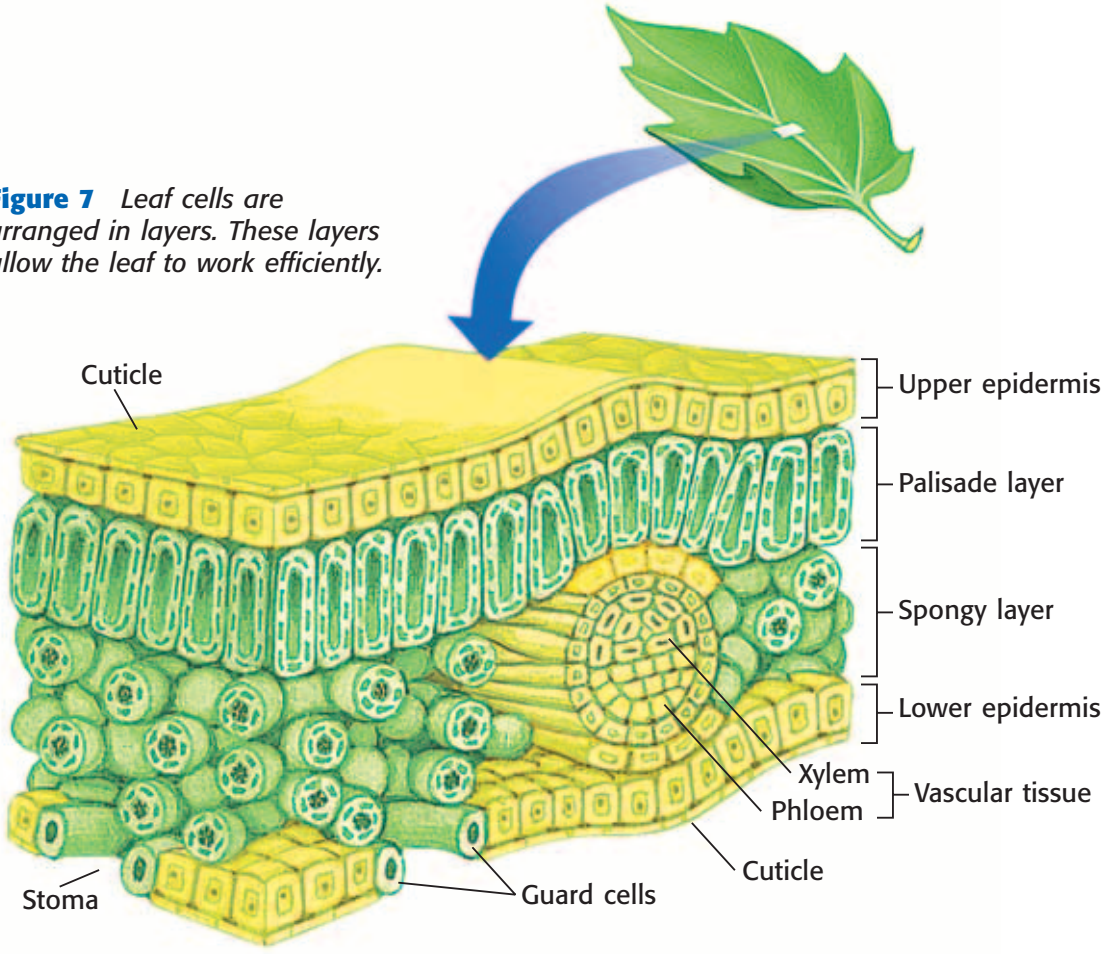


Figure 7 *Leaf cells are arranged in layers. These layers allow the leaf to work efficiently.*

Leaf Structure

The structure of leaves, shown in **Figure 7,** is related to their main function—photosynthesis. A cuticle covers the outer surfaces of a leaf. The cuticle prevents the leaf from losing water. 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.

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 the nitrogen that it needs to survive.

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 the arrangement of the leaves 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, but why do plants have flowers? Flowers are structures of sexual reproduction for flowering plants. Flowers come in many shapes, colors, and fragrances. Brightly colored and fragrant flowers usually rely on animals for pollination. Other 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 may have the following basic parts: sepals, petals, stamens, and one or more pistils. Flowers that have all four basic parts are called *perfect flowers*. Flowers that have sepals, petals, and stamens are male flowers. And flowers that have sepals, petals, and one or more pistils are female flowers.

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 in color and shape. Petals attract insects or other animals to the flower. Animals help plants reproduce by carrying pollen from flower to flower.

sepal (SEE puhl) in a flower, one of the outermost rings of modified leaves that protect the flower bud

petal (PET uhl) one of the usually brightly colored leaf-shaped parts that make up one of the rings of a flower

Standards Check **What is a perfect flower?** 7.5.f

Quick Lab

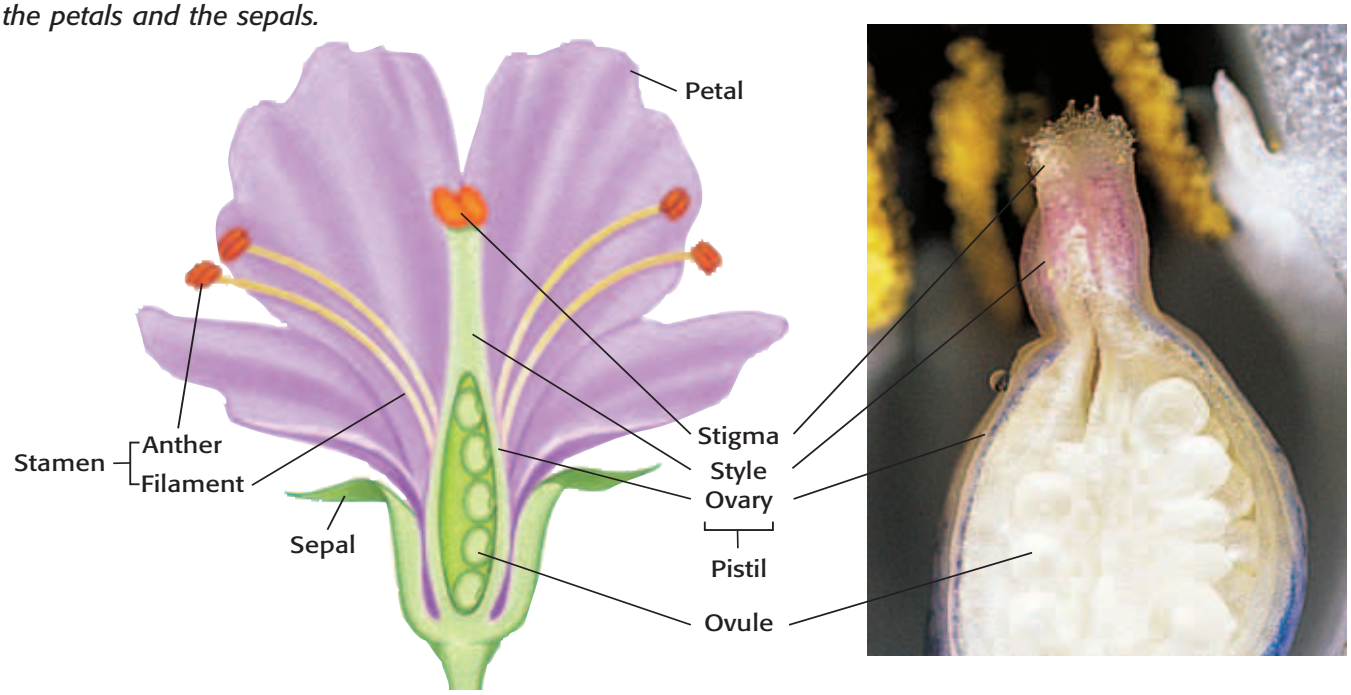
How Do the Parts of a Plant Work Together?

7.5.a
7.7.c

1. Obtain a **potted plant** from your teacher.
2. Water the plant until the soil is damp to the touch.
3. Record the mass of the potted plant.
4. Place the plant in a **large, resealable bag.** Seal the bag.
5. Record the appearance of the plant and bag.
6. For the next week, record your observations of the plant without removing it from the plastic bag.
7. At the end of one week, remove the plant from the plastic bag. Record the final mass of the potted plant.
8. What changes occurred over the course of your observations?
9. Draw a picture of your plant. Label the different parts of the plant. How did these parts work together during the week that you observed the plant?
10. What do you think happened to make the mass of the plant change?

20 min plus follow-up

Figure 8 *The stamens, which produce pollen, and the pistil, which produces eggs, are surrounded by the petals and the sepals.*



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

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

ovary (OH vuh ree) in flowering plants, the lower part of a pistil that produces eggs in ovules

ovule (AHV YOOL) a structure in the ovary of a seed plant that contains an embryo sac and that develops into a seed after fertilization

Stamens and Pistils

As **Figure 8** shows, the stamens of flowers are usually found just above the petals. A **stamen** is the 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, the male gametophyte.

The center of most flowers contains 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.

Standards Check **Describe stamens and pistils. Which are the female parts of a flower? the male parts of a flower?** **7.5.f**

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.