Understanding Stem Anatomy

WHAT DO YOU think of when you think of a stem? Do you think of a redwood tree or a tree in your area, or do you think of a beanstalk or a flower stalk? Most people probably visualize something like a beanstalk or a flower stalk. Ponder the stem for a while, and you'll learn how incredibly important it is to the life of a plant.

Objective:

Describe the structures and functions of a stem.

Key Terms:

apical meristem
bud
bud scale scar
bud scales
bulb
cambium
corm
cortex
heartwood
internode
lateral bud
leaf scar
lenticels
nodes
phloem
rhizome
sapwood
stolon
terminal bud
translocation
tuber
vascular cambium
xylem

The Stem

The stem has many essential jobs in a plant. One of its most important functions is to support the leaves and flowers. The stem holds the leaves in the most efficient position to collect sunlight. This allows the plant to produce as much food as possible. Flowers are held upright to improve chances of pollination.

The stem moves water, minerals, and manufactured food throughout the plant. A dilute solution of water and dissolved minerals moves through the **xylem**. Sugars move through the

phloem. The movement of materials through vascular tissues is known as **translocation**. Water and dissolved minerals move in only one direction in the xylem. The flow of sugars in the phloem can move in different directions.

The stem plays a role in the manufacture of food and food storage. A green stem helps produce food through photosynthesis. Although this is not usually the primary source of food production, it can be quite important in a plant with no leaves or very small leaves. The stem also stores starches manufactured by the plant.

FIGURE 1. One of its most important functions of the stem is to support the leaves and flowers.

STEM STRUCTURES

The structure of a stem allows it to carry out its various functions. The stem structures of monocots and dicots have some similarities and some differences.

Monocot Stem Structure

A monocot stem has an epidermis. The epidermis provides protection. It also has a waxy cuticle that greatly reduces water loss. Vascular tissues—xylem and phloem—are grouped in bundles. The vascular bundles extend the length of the stem. A cross section of the stem reveals vascular bundles scattered throughout. Surrounding the vascular bundles and making up the remaining bulk of the stem is parenchyma tissue, or ground tissue. Xylem grows on the inside portion of the vascular bundles, and phloem on the outside. The vascular bundles lack **cambium**, which would give rise to woody, secondary growth.

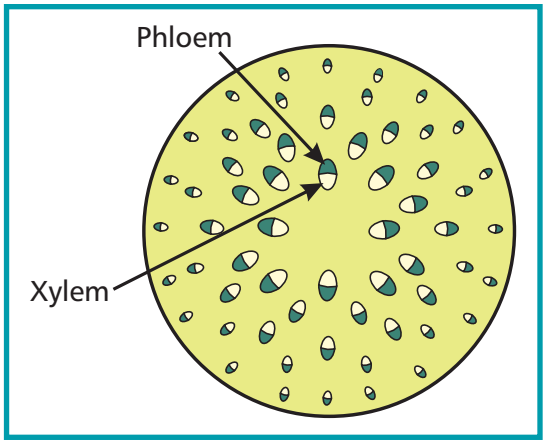

FIGURE 2. A cross section of a monocot stem reveals vascular bundles scattered throughout.

Herbaceous Dicot Stem Structure

A herbaceous dicot stem has an epidermis, as does the stem of a monocot plant, but inside the stem are some differences. Just inside the epidermis is a layer of cells called the **cortex**. Inside the cortex are the vascular bundles. In a cross section of a dicot stem, the vascular bundles are seen to form a ring. The bundles run as continuous strands from the roots to the leaves. The xylem is on the inside portion of the vascular bundles, and the phloem makes up the outside portion. Between the two is a single layer of cells called the vascular cambium. The **vascular cambium** gives rise to new xylem, phloem, and cambium cells. The center of the

stem consists of the pith, which is made up of large, thin-walled parenchyma cells. The vascular bundles are separated by masses of pith cells that extend into areas between the bundles. The cells in the cortex and pith store starches.

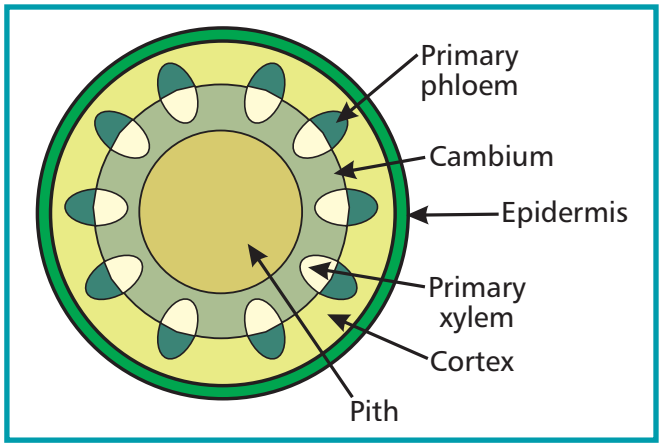

FIGURE 3. In a cross section of a dicot stem, the vascular bundles are seen to form a ring.

Woody Dicot Stem Structure

As the herbaceous dicot stem of a woody plant ages, its growth shifts to woody growth. The vascular cambium, which had been separated, merges to form a continuous cylinder. The layer of cambium cells divides. The cells created on the inside of the cambium become secondary xylem, or the wood of the plant. The new cells on the outside of the cambium are secondary phloem. The secondary phloem is the inner bark of the plant. Cell division also results in new cambium cells. New cambium cells are needed to maintain a continuous cylinder as the stem increases in girth.

Buds form on a stem. A **bud** is an undeveloped shoot. The bud at the end of the stem is called the **terminal bud**. The buds of most woody plants, particularly those adapted to cold climates, are protected by bud scales. **Bud scales** are modified leaves.

The growing point of the stem is called the **apical meristem**. Apical meristems are located at the tips of stems and roots. Cells divide in the apical meristem. The cells go on to elongate and differentiate. During late summer, fall, and winter, the apical meristem lies dormant within a terminal bud.

Leaves are attached to the stem at **nodes**. The stem is usually swollen at nodes. An area of stem between leaves is called an **internode**. At each node, just above where the leaf is attached, is always a bud, called the **lateral bud**. Lateral buds can grow into stems.

When a leaf falls off the stem, a small scar is left just below the lateral bud. This scar is called the **leaf scar**. When the buds sprout each spring, the bud scales fall off, leaving behind a ring of scars called the

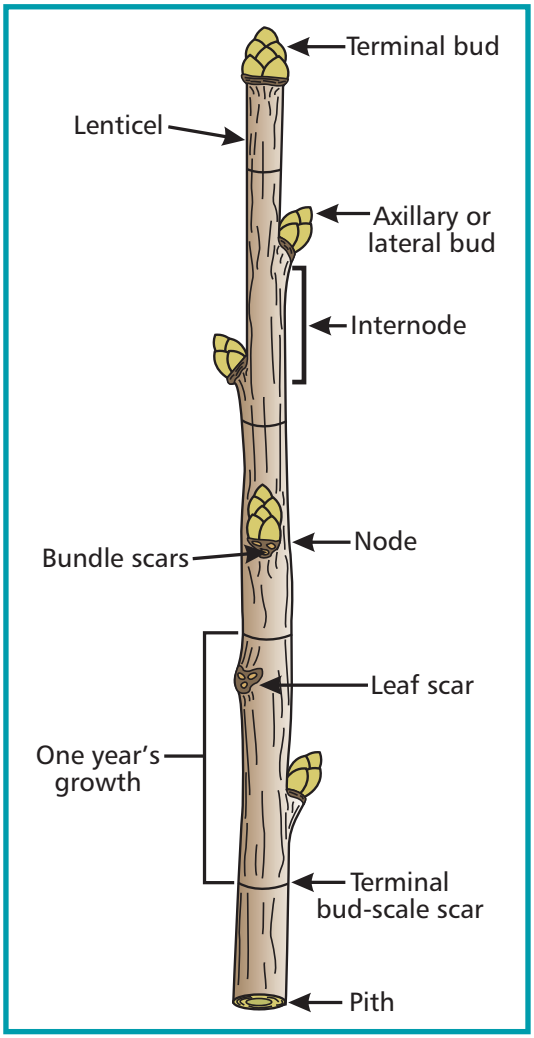

FIGURE 4. The external features of a woody stem.

UNDER INVESTIGATION...

LAB CONNECTION: Monocot and Dicot Plant Tissues

Conduct a laboratory activity to find the vascular tissues and specialized tissues in monocot and dicot plant specimens. Obtain a variety of plant materials for study, such as small woody branches, a cornstalk, a dracaena stem, and a tomato stem.

Carefully cut the specimens straight across with a knife. Study the freshly cut cross sections. Use a magnifying lens to improve the view. Identify the vascular tissues.

Draw the cross sections of the stems. Label the major parts. Based on the internal structures of the stems, classify each as monocot or dicot.

bud scale scar. The distance between bud scale scars represents one year's growth of the stem.

Lenticels can be seen on the epidermis of a stem. **Lenticels** are small spots on a stem that allow the stem to exchange gases with its environment.

Features of a Secondary Woody Stem

When one views the cross section of a tree trunk, two different colors of wood are evident. The darker wood at the center of the tree is called the **heartwood**. The xylem cells of the heartwood have filled with gums, resins, pigments, and tannins. They are no longer functional in conducting materials. They do, however, provide strength. The lighter wood circling the heartwood is called the **sapwood**. The younger sapwood actively conducts water and dissolved minerals.

The age of a tree can be determined by counting annual growth rings. The rate of growth has an impact on the growth rings. Photosynthetic activity is at its highest for six to eight weeks after the leaves have fully developed. This is during the late spring to early summer. The abundance of energy spurs new growth. Ninety percent of a woody plant's annual growth occurs during this time. Growth is greatest with favorable water and nutrient levels. During rapid growth, the cells of the wood are thin walled and large in diameter. As growth slows during mid- to late summer, the wood cells produced by the cambium become smaller and have thicker walls. The differences in the cells may give the appearance of rings. Each ring is the growth during one growing season.

FIGURE 5. By counting growth rings, the age of this Douglas-fir at the time it was felled is determined to be 50. (Courtesy, Henri Grissino-Mayer)

SPECIALIZED STEMS

We generally expect stems to be upright and aboveground. Although we are often right, many stems do not fit into this mold. Some stems are modified to store food or help plants reproduce. Some stems grow beneath the soil instead of above it. The following are some types of specialized stems.

- A **bulb** is a very short, flattened stem that has several fleshy leaves attached to it. Bulbs tend to be found beneath the soil. An onion is a bulb.
- A **corm** is a spherical structure, much like a bulb. The entire structure, however, is stem, as opposed to stem and leaves. A gladiolus is a corm.
- A **rhizome** is a thick, underground stem that lies horizontally. Hostas and mother-in-law's tongue have rhizomes.
- A **stolon** is a horizontal stem that lies above the ground. Stolons are sometimes called runners and tend to be involved with the spreading of a plant. Strawberries spread by stolons.
- A **tuber** is a rhizome with a tip swollen with stored food. Irish potatoes are tubers.

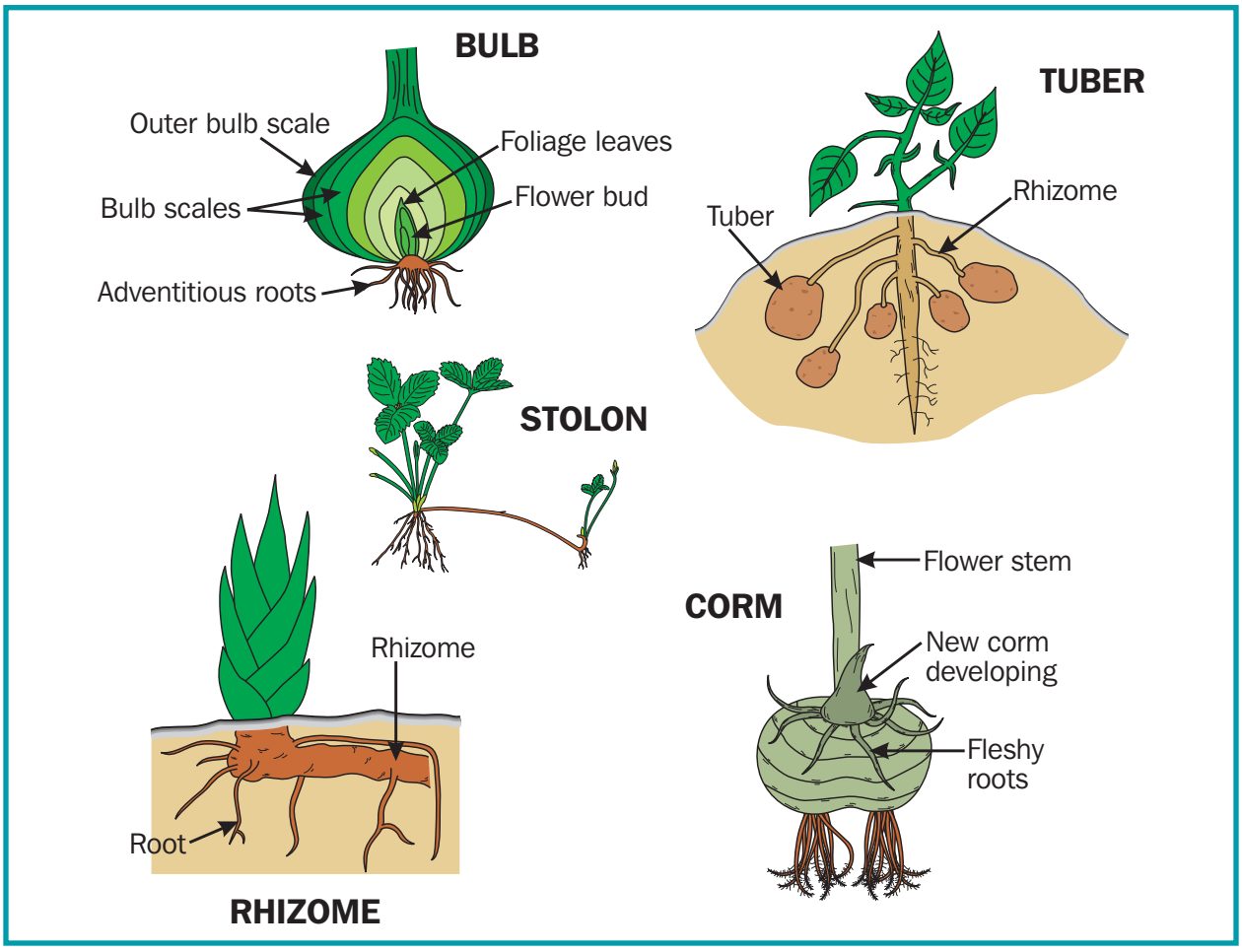

FIGURE 6. Specialized stems.

Summary:

The stem has many essential jobs in a plant. One of its most important functions is to support the leaves and flowers. The stem moves water, minerals, and manufactured food throughout the plant. It plays a role in the manufacture of food and food storage.

The structure of a stem allows it to carry out its various functions. A dilute solution of water and dissolved minerals moves through the xylem. Sugars move through the phloem. The movement of materials through vascular tissues is known as of translocation.

The epidermis provides protection. The vascular cambium gives rise to new xylem, phloem, and cambium cells. The growing point of the stem is called the apical meristem.

Exterior features of woody stems include terminal buds, lateral buds, bud scales, nodes, internodes, leaf scars, bud scale scars, and lenticels. The darker wood at the center of a tree is called the heartwood. The lighter wood circling the heartwood is called the sapwood. The age of a tree can be determined by counting annual growth rings.

Specialized stems include bulbs, corms, rhizomes, stolons, and tubers.

Checking Your Knowledge:

1. What are the main functions of stems?
2. What tissues are involved in translocation?
3. How do monocot and herbaceous dicot stems differ?
4. What are the primary external features of a woody stem?
5. What are five types of specialized stems?

Expanding Your Knowledge:

Collect stems from woody plants that you have identified. Study the external features and note the differences. Practice identifying plants using only the twigs.

Web Links:

Plant Shoot System
http://facweb.furman.edu/~lthompson/bgy34/plantanatomy/plant_shoot.htm

Stem Anatomy
http://www.ualr.edu/botany/stemanatomy.html

Vegetative Characters
http://www.csdl.tamu.edu/FLORA/tfplab/vegchar.htm

Agricultural Career Profiles
http://www.mycaert.com/career-profiles